*Journal of Astronomical History and Heritage*, 24(12), 285–314 (2021).

# TIME SIGNALS FOR MARINERS IN SOUTH AFRICA

**Roger Kinns**
*Glenavon, Back Road, Clynder, Helensburgh G84 0QQ,*
*Scotland, United Kingdom.*
E-mail: rogerkinns17@gmail.com

**Abstract**: The aim of this paper is to establish the nature of visual time signals for mariners that used to exist in South Africa. It builds on earlier research concerning the Royal Observatory at the Cape of Good Hope, using Admiralty lists of time signals, notices to mariners and other sources to show how they evolved. South Africa used an extraordinary range of time signals, including the first shuttered lamp in 1823, one of the earliest time balls and a wide range of subsequent time ball types. Various contradictions between different records have been found and resolved as far as possible.

Initial ideas for precise chronometer calibration signals have been attributed to Robert Wauchope during his naval service at the Cape of Good Hope from 1818. The 1836 time ball at the Cape Observatory was constructed locally and supplemented by a manually-operated repeater ball at Lion's Rump in 1853. The Observatory ball was replaced in 1863 using an apparatus supplied from London. The Observatory time balls were not included in Admiralty lists from 1880 onwards. A time ball at Simon's Bay was added in 1857, later replaced by a disc and then by another time ball in 1898. Additional time signals were provided at Alfred Docks, Port Elizabeth, Port Alfred and East London. All were ultimately controlled by electric telegraph from the Cape Observatory. The first 1870s time ball at the Docks was replaced in 1894 and had increased elevation after 1904. A time ball at Durban in Natal was established in 1883 and relocated in 1904. The last time ball service in South Africa was withdrawn in 1934 when wireless and telegraph signals had become almost universally available. The Docks time ball was restored in 1997.

**Keywords:** Time balls, time guns, time discs, South Africa

## 1 INTRODUCTION

Accurate determination of longitude is essential to navigation and was one of the great technical challenges that had to be met when ships ventured into open oceans. Its solution using either the method of lunar distances or marine chronometers to determine time at a prime meridian, has been well-described by Howse (1997) and other authors. The method of lunar distances required accurate predictions of the position of the Moon relative to the stellar background for inclusion in nautical almanacs, as well as development of precision instruments that included the sextant. Easily taken for granted by nineteenth century navigators, the method had been developed over centuries, with contributions from gifted astronomers and engineers in many different countries to take it from an astronomical concept to a precision technique (de Grijs, 2020).

Although marine chronometers were much more accurate than ordinary clocks and watches, there could be significant cumulative errors after a long period at sea. Regular measurements using a sextant and the method of lunar distances were made to check chronometers: a chronometer rate could vary markedly from that determined by its manufacturer, while the accuracy and reduction of astronomical measurements depended on conditions at sea and the skill of the navigator. Land-based signals, with known geographical co-ordinates and measurements of time using star transits, provided a more rigorous test.

### 1.1 Time Signals in Harbour

Land-based signals took many different forms, including discs, guns, flags and lights, but the option preferred by the British Admiralty was a time ball, dropped at a prominent position at the same time each day within sight of ships in harbour. It had been invented by Robert Wauchope (1788–1862), a distinguished Royal Navy officer, with a first trial implementation at Portsmouth, England in 1829, followed by the public time ball at Greenwich in 1833 (Bartky and Dick, 1981). The ball would be raised to cross-trees at a stated time before the signal, so that an observer would know that a signal was imminent. The time to be recorded was the moment a gap first appeared between the top of the ball and the cross-trees, as the ball was released by triggers to descend in initial free fall.

A dissimilar arrangement in Mauritius (Lloyd, 1833; Herschel, 1836) predated Greenwich by six months. In that arrangement, a black ball was hidden behind a shutter in an observatory tower, painted white. A flag was hoisted one hour before the time signal and the shutter was raised to show the ball in a white-painted room. This was the first preparatory signal. The flag was lowered as the second preparatory signal, five minutes before the shutter was dropped. The moment of ball disappearance was the exact time signal. Apart from Greenwich and Mauritius, only two other time balls are known to have preceded the first installation at the Cape of Good Hope. These

were at St. Helena in 1834 (Bartky and Dick, 1981; Kinns, 2021b) and at Calcutta in 1835 (Kinns, 2020c; Phillimore, 1958: 114). Another early time ball in Africa was established in 1839 at the Cape Coast Castle on the Gold Coast, now Ghana (Kinns, 2021b; Maclean, 1840).

To be of value to navigators, the time had to be precise and the signal had to be repeated at regular intervals. Then, the rate at which a chronometer was gaining or losing time, as well as the absolute error on a particular day, could be determined. That calibration would be repeated at other ports. Any adjustment was deferred until return to a chronometer maker. It was only in the 1930s that radio time signals and radio receivers were sufficiently widely available to make most time balls and other visual signals redundant.

#### 1.1.1 The Prime Meridian and Time Zones

Greenwich had been used as the zero longitude origin, or prime meridian, in the British *Nautical Almanac* since the eighteenth century. Other prime meridians had been used by different countries. Following the International Meridian Conference in Washington, USA in October 1884, Greenwich would become the prime meridian for the whole world (Howse, 1997: 145). This was a politically sensitive issue for many countries, notably France, but there was no denying the advantage to mariners in having all marine charts based on the same prime meridian. It took a long time for all countries to discard previously favoured prime meridians (Howse, 1997: 150).

The time-zone system recognised that ideally local mean time should be within about 30 minutes of standard mean time within a time zone, so the Earth was split into time zones at 15° intervals of longitude, each covering a one-hour range of local mean time. That was modified by the positions of coastlines and of boundaries between different countries, and by political considerations. Time zones were subject to modification. In South Africa, for example, the reference meridian was changed in 1903 from 22.5° E to 30° E of Greenwich. They are still subject to change.

#### 1.1.2 Greenwich Civil Time

Before 1925, Greenwich mean time for astronomical purposes, with zero hours at noon, was 12 hours different from the time used by the population at large. Confusingly, both were called Greenwich Mean Time (GMT) and they were often muddled. The decision was then made to introduce the term 'Greenwich Civil Time', with zero hours at midnight, and to use this for astronomical as well as domestic purposes (Howse, 1997: 151). This change is reflected in international lists of time signals that were issued during the 1920s.

### 1.2 Geographical Scope

The present study covers what is now the Republic of South Africa. It is dominated by the development of time signals at the Cape of Good Hope, starting with a time gun by 1807, a shuttered lamp in about 1823 and an array of time balls and time discs around the southern coast from Cape Town to Durban that lasted until the 1930s. The Cape Observatory offered one of the first ever time ball services from 1836.

Mauritius in the Indian Ocean and St. Helena in the South Atlantic had important early time balls because of their locations on the trade routes for sailing ships. Their port facilities declined in commercial importance after the introduction of steam ships and the opening of the Suez Canal in November 1869 but continued to be important strategically. The Mauritius and St Helena time balls have been described in three recent papers (Kinns, 2020a; 2020b; 2021b). There were many other time signals in mainland Africa but they were sparsely distributed in relation to South Africa.

## 2 ADMIRALTY LISTS OF TIME SIGNALS

The British Admiralty published lists of time signals for mariners at regular intervals. The first edition was "Prepared from official sources to December 1880.", so was applicable in 1881. The list dated 1898 was "Prepared from official sources to 31st December 1897." This had become the usual practice, but there was some variation of the closure date between editions. It was usual to include details of preparatory signals and the procedures adopted in case of a signal failure. These preparatory signals included the raising of the ball, first to half height and then to full height, at specified intervals before the drop. The style of presentation varied between editions, but similar levels of detail were retained. In order to expose changes between successive editions, the data from successive editions have been restructured for each location that had time signals, while retaining the key elements concerning location, signal type, timing and reliability.

The Admiralty lists provide a remarkable record of the changes that occurred at particular locations after 1880, but there is always a need to check the accuracy of entries against local announcements that may have been missed. Various errors have become obvious during the present work. Earlier records are used to define signal introductions from the 1830s

onwards. Entries from lists for 1880, 1898, 1904, 1908, 1911, 1922 and 1930 are used in this paper, supplemented by lists issued in the United States and notices to mariners. Admiralty lists for 1922 and 1930 were subdivided into parts that covered specific geographical regions.

## 2.1 Accuracy of Time Signals

Comments about the accuracy and reliability of time signals were often derived from reports by visiting ships. They were usually qualitative and served as a guide to subsequent visitors. Ideally, signals should be accurate to better than ±1 second. One second of time corresponds to a longitude error of 15 arc-seconds, or about 0.46 km at the equator. A more demanding requirement was to allow determination of the chronometer rate from measurements on successive days. Chronometer rates were often several seconds per day and varied according to environmental conditions. They depended on the quality of chronometer design and manufacture. Determination of the rate to an accuracy of ±1 second per day would usually be sufficient. The best-equipped observatories, such as those at Greenwich, Edinburgh and the Cape, aimed for an accuracy of ±0.2 seconds in daily signals. Measurements over 5 days would then give a rate accuracy of better than ±0.1 seconds per day.

## 2.2 The 1880 Admiralty List for Africa

All the 1880 list entries for Africa, apart from Mauritius and St Helena, are transcribed in Table 1. The types of signalling devices included time balls, discs and a time gun. All the entries in Table 1 are in South Africa.

There is an anomaly in the 'local' time specified for the Table Bay time ball (highlighted in red): it did not correspond to the stated longitude for the specified GMT. The Table Bay ball was 33 arc-seconds West of the Simon's Bay disc so local astronomical time was 2.2 sec-

Table 1: 1880 Admiralty list of time signals in Africa, excluding Mauritius and St. Helena.

| Latitude & Longitude | Place | Signal Adopted | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h. m. s. | |
| British Possessions – Cape of Good Hope Colony | | | | | | |
| 33° 54′ 27″ S.<br>18° 25′ 15″ E. | Table Bay | Ball<br><br>also<br><br>Gun | At Alfred Docks.<br><br>47 feet above high water<br>36 feet above ground.<br>(Drop 6 feet.)<br><br>On Imhoff Battery. | 22 46 5<br><br><br><br><br><br>23 46 5 | 00 00 00<br><br><br><br><br><br>01 00 00 | Ball dropped (by electricity from the Cape Observatory) at noon Cape mean time.<br><br><br><br><br>Gun fired (by electricity from the Cape Observatory) at 1h 0m p.m. Cape mean time. |
| 34° 11′ 30″ S.<br>18° 25′ 48″ E. | Simons Bay | Circular disc | Mast close to Simons Town Telegraph Office.<br><br>63 feet above high water<br>40 feet above ground.<br>(Drop 6 feet.) | 23 46 5 | 0 59 48.2 | Disc raised to a right angle with mast at 5 minutes before signal.<br>Disc falls (by electricity from the Cape Observatory) at moment of 1h 0m Cape mean time.<br><br>When signal fails in accuracy, the disc is kept up till 2 o'clock, then lowered. |
| 33° 57′ 43″ S.<br>25° 37′ 21″ E. | Port Elizabeth | Black disc | At the Lighthouse.<br><br>220 feet above high water<br>43 feet above ground.<br>(Drop 5 feet.) | 23 46 5 | 1 28 34.4. | Disc dropped (by electricity from the Cape Observatory) at moment of 1h 0m p.m. Cape Colony mean time.<br><br>When signal fails in accuracy, a chequered red and blue flag will be shown from the lighthouse, and ball dropped 5 minutes later, or at 1h 5m p.m. Cape mean time. |
| 33° 36′ 10″ S.<br>26° 54′ 10″ E. | Port Alfred | Ball | 54 feet above high water.<br>26 feet above ground.<br>(Drop 18 feet.) | 23 46 5 | 1 33 41.6 | Ball dropped (by electricity from the Cape Observatory) at 1h 0m p.m. Cape mean time. |


Figure 1: Time signal locations in 1880 (map modifications: Roger Kinns).

onds later: it was shown in the 1880 list as being 11.8 seconds earlier. This difference of 14 seconds results from the difference between Cape time and local astronomical time at the Table Bay signal location. Cape time corresponded to the longitude of the Observatory (Maclear, 1853). The time gun on the Imhoff Battery at Table Bay was fired one hour after the time ball was dropped: the longitude of the Observatory, rather than the unstated longitude of the gun, determined the time of firing. The local times at Simon's Bay, Port Elizabeth and Port Alfred corresponded to their stated longitudes East of Greenwich.

Lists of this type were expanded and modified over the years: time signals were introduced in different ports; there were changes in the location, type and timing of signals, and occasional corrections to latitude and longitude. In later editions, there was sometimes a statement of the dates when the signal was established and when it was last modified.

The locations of the time signals listed in 1880 are shown in Figure 1. The Port Elizabeth disc may actually have been a ball at the end of a lever arm (see later).

## 3 SOUTH AFRICA

There has been extensive previous research into the development of time signals in South Africa, especially those controlled by the Cape Observatory. The aim of this section is to establish the accuracy of information provided to navigators in international lists of signals and to identify the types of apparatus used in South Africa. Apparent contradictions between different sources have been resolved as far as possible.

Figure 2 shows the eventual locations of time signals in South Africa from Cape Town to Durban. This extends the 1880 list to include later time signals. They were established and withdrawn at different times.

### 3.1 Development of Time Signals Under Cape Observatory Control

Table 2 showing time signal development is derived from a summary by Evans (1993), with references to research by Harding (1971), Warner (1979) and Bisset (1984). The paper by Harding has not been found, but the entries have been checked using other sources. Evans referred to reports by H.M. Astronomer at the Cape of Good Hope, which are shown in the table as reports of HMA with the year to which they refer. There are a few references to time signals at the Royal Observatory in *Monthly Notices of the Royal Astronomical Society*. These are included separately in the main reference list at the end of this paper. Additional references are cited in the form used by Evans. Insertions in italics within square brackets are for clarification.

Developments after 1934 are not shown in Table 2. By that time, time balls and time discs had been withdrawn. Subsequent transmiss-

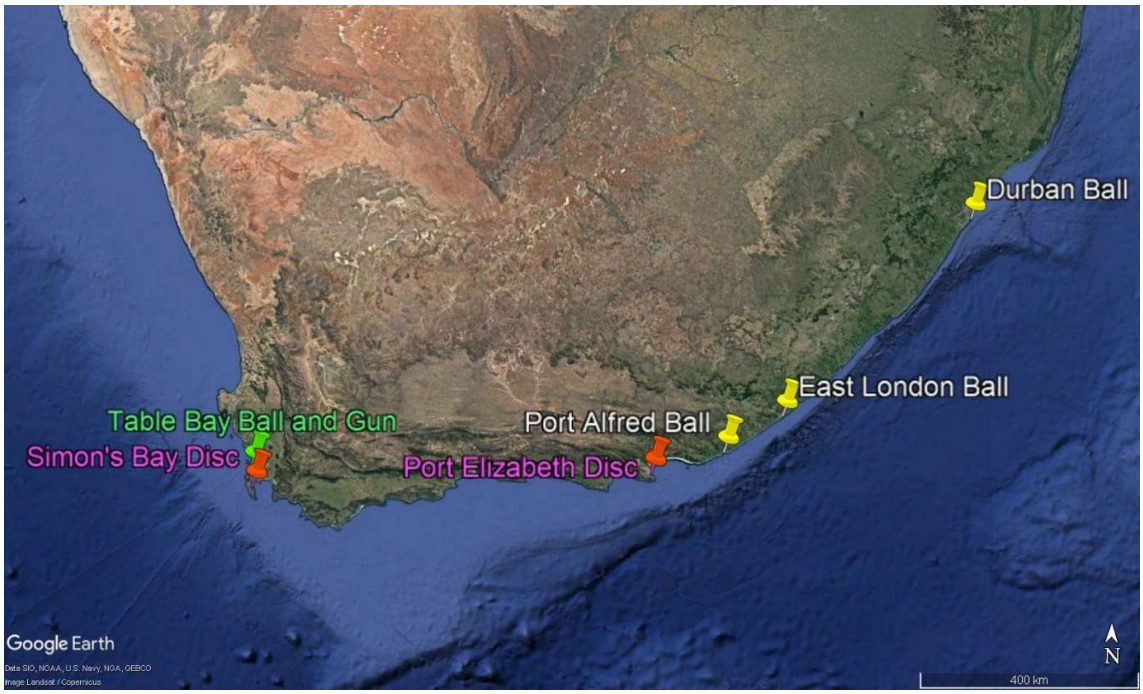


Figure 2: Locations of time signals in South Africa (map modifications: Roger Kinns).

Ions of time were by electric telegraph and wireless; only the gun remained to reflect earlier history. Some earlier entries that are not directly related to time signals for mariners have been excluded, but entries are otherwise those by Evans with minor adjustments.

There are mentions of return signals in 1873 and 1895. These indicated that the telegraph signal had released the time ball satisfactorily. The time ball at Deal on the south coast of Kent in England had been released by telegraph from Greenwich with a return signal to confirm the drop from 1 January 1855 (Howse, 1997: 102). Deal is about 100 km from Greenwich.

## 3.2 Noon Gun in Cape Town

By 1807 a noon gun was fired from the Imhoff Battery on the seaward side of the Castle in Cape Town. It was one of the means by which ships in Table Bay "… could determine the error and rate of their chronometers." (Warner, 1979: 47). Ideally, the flash of the gun or the puff of smoke would have been noted as the time signal: the delay in sound propagation to ships in Table Bay varied with atmospheric conditions and ship location. The accuracy of the gun signal is likely to have been modest in its early years of operation, as it was not controlled from an astronomical observatory. It would have had high precision from 1864 onwards, when it was fired electrically from the Observatory.

The history of time guns in Cape Town was explored by Bisset (1984), using Army records. There were various changes to the location and time of the gun signal during the nineteenth and twentieth centuries which have been summarised by Evans (1993).

Table 2: Development of Time Signals controlled by the Cape Observatory (after Evans, 1993).

| Date | Event | Reference |
|---|---|---|
| 1807 | Noon Gun fired from Imhoff Battery, Cape Town Castle. Used to rate ships chronometers. | Bisset, 1984. |
| 1821 | Instruments for time determination erected at the Observatory. [A temporary hut was used to house portable instruments that included a transit telescope. This allowed astronomical observations prior to erection of permanent observatory buildings. The new Observatory was operational in 1829.] | Harding, 1971 |
| 4 Jan. 1833 | Flash pistol and powder magazine purchased for visually signalling time. | Harding, 1971 |
| 30 Sep. 1836 | Time ball erected to SE of the Observatory | Warner, 1979 |
| Oct. 1853 | Observatory time ball not visible from whole of Table Bay. Repeating time ball on Lion's Rump | Warner, 1979 |
| 1857 | Time ball in Simons Town. A portable transit instrument determined the time at which to drop the time ball. | Warner, 1979 |
| 21 May 1860 | Observatory time ball hidden by trees, re-located N. | Warner, 1979 |

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|---|---|---|
| Sep. 1861 | Electric release of three time balls from Observatory. | Warner, 1979 |
| Jun. 1863 | Observatory time ball once again moved. | Warner, 1979 |
| 1864 | Gun fired electrically from Royal Observatory. | Bisset, 1984 |
| 1873 | Return signal from Port Elizabeth time ball 0.3 to 0.6 sec after trigger signal sent. [The return telegraph signal indicated that the ball had actually been released.] | Royal Observatory, 1873 |
| 1877 | Time distribution by telegraph. | Royal Observatory, 1877 |
| 1878 | Noon ball dropped at docks for shipping.<br>13:00:00: Time balls dropped at: - Observatory, Simons Town, Port Elizabeth, Kimberley. | Royal Observatory, 1878 |
| 21 Jul. 1889 | Electric time signals:<br>Noon signal drops time ball at docks.<br>13:00:00: Time ball dropped at Simon's Bay; time ball dropped at Port Elizabeth; time ball dropped at East London;<br>Gun fired at Imhoff battery.<br>Government telegraphic system distributed a time signal for use in the Cape colony, Orange Free State and Transvaal. | Report of H.M. Astronomer at the Cape of Good Hope for the period 26 May 1879 to 21 July 1889 |
| 7 Feb. 1892 | Arrangements made for changing civil time of colony. Previously Observatory mean time was used for telegraphic purposes throughout the colony and different railway systems used local time of their main station.<br>At junction of E and W railway systems it was decided to adopt 22.5 degrees E as longitude for all time purposes. This worked so well that that the uniform time of the Cape Colony was adopted by both the Transvaal and the Orange Free State. | Report of HMA, 1889 to 1892 |
| 8 Feb. 1892 | Time signals at Observatory mean time noon and 1pm discontinued in favour of a single signal at Greenwich mean noon which corresponds to 13 30 00 of Uniform South African time. | |
| 1893 | Daily signals from Observatory at GMT noon:<br>Disc dropped at Simon's Bay for shipping.<br>Gun fired at Imhoff Battery for shipping and town.<br>Time ball dropped at docks in Cape Town.<br>Disc dropped at Lighthouse in Port Elizabeth.<br>Ball dropped at East London.<br>Ball dropped at Port Alfred.<br>Signal to all telegraph offices in Cape, Orange Free State and Transvaal.<br>A clock in the Harbour Tower at the Cape Town docks is electrically controlled from the observatory. | Report of HMA, 1893 |
| 1894 | Daily signals from the Observatory at GMT noon: - Same as 1893.<br>New time ball erected in a conspicuous position near Resident Engineer's Office of the Cape Town Docks. | Report of HMA, 1894 |
| 1895 | Daily signals from the Observatory at GMT noon: - Same as 1894. | Report of HMA, 1895 |
| 20 Mar. 1895 | Two return signals from Cape Town time ball<br>at the instant the ball begins to fall<br>at the bottom of its drop.<br>[*The return telegraph signals indicated that the ball had been released and arrived at its rest position.*] | |
| 1896 | Daily signals from the Observatory at GMT noon: - Same as 1895.<br>Simon's Bay disc failed often from old age. | Report of HMA, 1896 |
| 1897 | Daily signals from the Observatory at GMT noon: - Same as 1896.<br>Simon's Bay disc dropped up to 11 Dec 1897 | Report of HMA, 1897 |
| 1 Jan. 1898 | Simon's Bay disc being replaced by time-ball. | |
| 2 Feb. 1898 to 9 Feb. 1898 | Cape Town gun under repair. | Report of HMA, 1898 |
| 14 Apr. 1898 | Simon's Bay time-ball operational. | |
| 1898 | Daily signals from the Observatory at GMT noon: - Same as 1897 except for the Port Alfred ball which was discontinued.<br>Telegraphic signals also go to Rhodesia [*now Zimbabwe*]. | |
| 18 Dec. 1900 | Cape Town time-ball position: -<br>74.83 ft above l.w.o.s.t. 30 ft above ground level (ball drops 10 ft)<br>Latitude 33° 54′ 24″ S. Longitude 18° 25′ 10.4″ E | SAAO Archives No A0035: Chronometers and Time Signals 1900-1906. |
| 1901 | Daily signals from the Observatory at GMT noon: - Same as 1898.<br>Failures at Port Elizabeth and East London partly due to interruption of the lines by the Boers. | Report of HMA, 1901 |
| 1 Nov. 1901 | Hourly signal sent to Wynberg station - set clocks every hour. | |
| 1902 | Daily signals from the Observatory at GMT noon: - Same as 1901. | Report of HMA, 1902 |
| 4 Aug. 1902 | Noon gun to Lion Battery on Signal Hill. Gun now fired from Signal Hill battery. | |
| 28 Feb. 1903 Midnight | The whole of South Africa adopts longitude 30 degrees E for time determination. That is 2 hrs ahead of Greenwich time. | Government Gazette, February 1903 |
| 1904 | Second floor added to time-ball building. | Government Gazette 27 August 1982 |
| 1914 | Daily signals from the Observatory at 10 00 00 GMT:<br>Ball dropped at Simon's Bay for shipping. | Report of HMA, 1914 |

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|---|---|---|
| | Gun fired from battery on Signal Hill.<br>Time ball dropped at docks in Cape Town.<br>Disc dropped at Lighthouse in Port Elizabeth.<br>Ball dropped at East London. | |
| 1 Sep.1914 | Daily transmission of wireless time signal for shipping on Union Government wireless station at Slangkop. | |
| 6 Feb.1925 | Broadcast of time but noon gun retained | Bisset, 1984 |
| 1925 | Daily signals from the Observatory at 10 00 00 GMT:<br>Ball dropped at Simonstown dockyard for shipping.<br>Gun fired from battery on Signal Hill.<br>Time ball dropped at docks in Cape Town.<br>Disc dropped at Lighthouse in Port Elizabeth.<br>Ball dropped at East London.<br>Time signal sent to telegraphic system and railway services.<br>A clock in the Harbour Tower at the Cape Town docks is electrically controlled from the observatory.<br>Daily transmission of wireless time signal for shipping on Union Government wireless station at Slangkop. | Report of HMA, 1925 |
| 6 Feb. 1925 | Time signal from the Observatory consisting of 4 dashes, the commencement of the last being on the hour, was transmitted by Local Broadcasting Association 3 times per day. | |
| 1926 | Daily signals from the Observatory at 10 00 00 GMT:<br>Ball dropped at Simonstown dockyard for shipping.<br>Gun fired from battery on Signal Hill.<br>Time ball dropped at docks in Cape Town.<br>Disc dropped at Lighthouse in Port Elizabeth.<br>Ball dropped at East London.<br>Time signal sent to telegraphic system and railway services.<br>A clock in the Harbour Tower at the Cape Town docks is electrically controlled from the observatory.<br>Daily transmission of wireless time signal for shipping on Union Government wireless station at Slangkop. | Report of HMA, 1926 |
| 1927 | Daily signals from the Observatory at 10 00 00 GMT: - Same as 1926. | Report of HMA, 1927 |
| 1928 | Daily signals from the Observatory at 10 00 00 GMT: - Same as 1927. | Report of HMA, 1928 |
| Aug. 1928 | Automatic control of clock in Harbour Tower discontinued as Harbour Administration considered it unnecessary. | |
| 15 Sep. 1928 | Belin apparatus to send international (ONOGO) time signals installed. Transmission from Slangkop once a day.<br>Local Broadcasting Association transmits last group of ONOGO signal (6-pips) at 1500 and 1800 GMT. Beginning of 6th pip is on the hour. | |
| 1929 | Daily signals from the Observatory at 10 00 00 GMT: - Same as 1928. | Report of HMA, 1929 |
| 8 Feb. 1929 | Simonstown time-ball dismantled. | |
| 30 Sep. 1930 | Disc in Port Elizabeth dismantled. | Report of HMA, 1930 |
| 1933 | Daily signals from the Observatory at 10 00 00 GMT:<br>Gun fired from battery on Signal Hill.<br>Time ball dropped at docks in Cape Town.<br>Time signal sent to telegraphic system and railway services.<br>Time signal also received at meteorological stations in Bulawayo and Salisbury.<br>Daily transmission of wireless time signal for shipping on Union Government wireless station at Slangkop. | Report of HMA, 1933 |
| 31 Oct. 1933 | 6-pip signal transmitted by African Broadcasting Company changed from 1700 and 2000 SAST to 1300, 1700, 1800, 1900, 2000, 2100 SAST. | |
| 1934 | Daily signals from the Observatory at 12 00 00 SAST:<br>Gun fired from battery on Signal Hill. | Report of HMA, 1934 |
| 1 Feb. 1934 | Time ball at docks in Cape Town discontinued.<br>Time signal sent to telegraphic system and railway services.<br>Time signal also received at meteorological stations in Bulawayo and Salisbury.<br>Daily transmission of wireless time signal for shipping on Union Government wireless station at Slangkop. | |
| 7 Sep. 1934 | Removal of the time ball at the Docks. The ball was made in 1932 from thin steel plate. | *The Cape Times*, 7 September 1934 |

In February 1892, time signals at noon and 1 pm were discontinued in favour of a single signal at noon, Greenwich mean time. The gun was moved from the Imhoff Battery to the Lion Battery on Signal Hill in August 1902. From midnight on 28 February 1903, the whole of South Africa adopted a time zone based on longitude 30° E, two hours ahead of Greenwich. The gun was then fired at noon, South African Standard Time. The gun signal "… was retained at the request of the Municipality of Cape Town." after time balls and time discs had been withdrawn (Bisset, 1984: 67; Warner, 1979: 115).

The noon gun is still operating in 2021 and

Figure 3: The Noon Gun being fired on Signal Hill in 1993 (photograph: Willie Koorts).

is a popular tourist attraction. Figure 3 shows the gun being fired on 4 November 1993 for the first time after the circuits had been modernised. The gun had been fired automatically since 1864, but the Lion Battery site was not open to the public until 1997, Evans (1993) noted that the report of the gun on Signal Hill can be heard at the Observatory about 18.5 seconds after detonation.

The guns are 18-pounder muzzle loaders bearing the monogram of King George III, cast in the Bahamas (Bisset, 1984: 69). Several guns of this type have been used for signalling time and two were later operated in parallel, with one acting in reserve should the other fail to fire.

## 3.3 The First Directors of the Cape Observatory

In *A History and Description of the Royal Observatory, Cape of Good Hope*, Gill (1913) gives biographies of the Directors who preceded him. The following short summaries are derived largely from that book. Sir David Gill (1843–1914) is highly regarded for his pioneering work in astronomy. He was Director of the Cape Observatory from 1877 to 1906 and was knighted in 1900 (Obituary,1914).

### 3.3.1 Fearon Fallows (1820 to 1831)

The Reverend Fearon Fallows (1788–1831) was appointed as the first Director of the Observatory by the British Board of Longitude in October 1820. His year of birth had been given as 1789, but this was corrected after research by Warner (1997). He served at the Cape from August 1821 until his premature death in July 1831 but never received timely support from the Board or Admiralty for development of his staff and facilities. Conditions were primitive and undoubtedly contributed to his early death. His life and work have been described by Cameron-Swan (1931).

Soon after his arrival at the Cape

> … whilst he hunted for a site in conformity with Admiralty requirements, Fallows obtained from the local Government a settler's wooden hut, which he converted into a temporary observatory for his portable instruments. (Cameron-Swan, 1931: 6).

The site for the new observatory was approved in July 1822, but he did not receive authority to implement his plans until December 1824. The Observatory buildings had been erected by the end of 1827 but the instruments were not fully operational until 1829.

### 3.3.2 Thomas Henderson (1831 to 1833)

Thomas Henderson (1798–1844) was appointed to succeed Fallows in October 1831 and arrived at the Cape in April 1832. He resigned in May 1833, in protest at the conditions under which he had to operate. He returned to Edin-

burgh, where he became the first Astronomer Royal for Scotland.

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### 3.3.3 Thomas Maclear (1833 to 1870)

Thomas Maclear (1794–1879) was appointed to succeed Henderson in July 1833 and arrived at the Cape in January 1834. Like Fallows and Henderson, he found that working conditions were primitive and he too suffered from lack of staff to support his work. During his long tenure, the Observatory was expanded with the erection of new buildings and additional instruments.

From 1834 to 1838 Maclear worked closely with Sir John Herschel at the Cape. Many of their exchanges are recorded in *Herschel at the Cape* (Evans et al., 1969), which contains Herschel's edited diaries and correspondence during an extraordinarily productive period. Captain Robert Wauchope, RN, inventor of the time ball, visited Maclear and Herschel on several occasions. Herschel also corresponded with John Augustus Lloyd in Mauritius. A diary entry on 12 March 1835 (Evans, 1969: 151) "Packed up & sent in Capt$^{n}$ Loyds (sic) papers." is probably a reference to the paper about the first observatory in Mauritius that was communicated to the Royal Astronomical Society by Herschel and presented in April 1836 (Herschel, 1836). Charles Piazzi Smyth (1819–1900), later to succeed Henderson as the second Astronomer Royal for Scotland, became Maclear's assistant in 1835 at the age of sixteen. Piazzi Smyth's descriptions of the Edinburgh time ball arrangement were rooted in his experience at the Cape (Kinns, 2011).

To quote Gill: "In the days of Maclear, a time ball was erected near the Observatory which was dropped in lieu of the pistol signal." (Gill, 1913: 143). This 1836 time ball was supplemented by a repeater ball on Lion's Rump (now called Signal Hill) in October 1853, moved a short distance in May 1860 and replaced by a new apparatus in June 1863. Other signals were distributed around the coast of South Africa during Maclear's tenure, with electrical control from the Cape Observatory.

## 3.4 The First Visual Signals at the Cape

*The Nautical Magazine* was first published in 1832. It used the longer title of *The Nautical Magazine and Naval Chronicle* between 1837 and 1870. It included various articles and notices about time signals for mariners from 1835 onwards. The following statement was written by the editor in 1835 as an introduction to the time ball service at St Helena that started in January 1834 (Editorial, 1835: 658). It provoked a reaction from Robert Wauchope that led to acceptance of his claim to invention of the time ball (Wauchope, 1836).

> The plan of communicating time by signal from observations, being coeval with the improvement of chronometers, is of recent date. The advantages of it are great to seamen, and it has been a matter of some surprise to us, that even within the few last years it has not been more generally adopted. We remember it to have been employed successfully by the Rev. Mr. Fallows, when he was astronomer at the Cape of Good Hope, about the year 1820. His plan was to eclipse a light at the moment of eight o'clock (mean time) by means of a shutter. The light was distinctly seen by the shipping in the roads, and the officers being on the look-out, were enabled to obtain a rate for the chronometers on board.

The article also mentioned rocket signals proposed by Captain Owen before going on to describe the St Helena arrangement. Wauchope's response did not contradict the statement about the shuttered lamp (Wauchope, 1836).

> I had pointed out the advantages to be derived from the plan for communicating time by means of telegraphs so far back as 1818, in my remark-book transmitted to the Admiralty when in command of the Eurydice, at that time on the Cape and St. Helena station. Sir Jahl. Brenton was then naval commissioner at the Cape, and an extract from a letter of his, dated 15th November, 1833, to Mrs. Wauchope, will, I think, establish my prior claim to the invention, before the Rev. Mr. Fallows, (who, it appears, was astronomer at the Cape in 1820,) or Captain William Owen, R.N.

It appears from this statement that Wauchope had never met Fallows, who arrived at the Cape in 1821 and died in 1831.

### 3.4.1 Fallows' Shuttered Lamp

The shuttered lamp was an important development. A key feature of the signal would have been the preparatory opening of a shutter to alert ships: closure, which made the lamp disappear, was the exact time signal. Fallows is likely to have used an Argand lamp, which was much brighter than an ordinary oil lamp but was still dim in relation to modern lighting. It was almost another century before electric lights could be used to provide a bright and accurate signal, again using the moment of extinction as the exact time. Its initial date of operation is likely to have been in 1823 (Bartky and Dick, 1981): Fallows did not arrive at the Cape until August 1821. Curiously, this lamp was not mentioned by Gill (1913), suggesting that early records at the Cape Observatory had been lost. The same applies to any discussion at the Cape concerning Robert Wauchope's ideas for visual

signals. Instead, Gill referred to a pistol signal and an unsophisticated time ball that is probably a myth.

### 3.4.2 Mythical Time Ball at the Cape

The following statement suggests that the very first time ball may have been at the Cape (Gill, 1913: 143):

> In the days of Fallows and Henderson, the Astronomer, a few minutes before the appointed hour, ascended to the roof of the Observatory, taking with him a chronometer (of which he had previously determined the error) and a large brass-barrelled pistol. This ungainly weapon is still preserved as an interesting relic. When the second hand of the chronometer reached the appointed instant the pistol was discharged and its flash was observed by a signalman provided with a telescope, and he, by means of a rope attached to his foot, dropped a time ball in the neighbourhood of the Bay.

Figure 4: The 1833 flash pistol used by Henderson in 1833 (courtesy; Ian Glass).

The same statement was repeated by Cameron-Swan (1931: 13). It does not undermine Wauchope's claim to time ball invention but suggests that a basic time ball may have been in operation at the Cape before the refined experimental version at Portsmouth in 1829 (Wauchope, 1830). There is, however, serious doubt about its veracity.

The signal would not have been possible until after the Observatory buildings had been erected in 1827 but could have preceded full operation of the Observatory in 1829. If the pistol was fired at night, a time ball would have been invisible to shipping. Another major weakness would have been the lack of a preparatory signal. Warner (1979) could not find explicit evidence to support Gill's statement and concluded that the time ball was a myth. Bartky and Dick (1981) concurred.

### 3.4.3 1833 Flash Pistol

There is a January 1833 note that "Flash pistol and powder magazine purchased for visually signalling time." (Harding, 1971). The date is after Fallows had died and not long before Henderson left the Cape:

> Early in 1833 Henderson started a new time service … a brass barrel percussion pistol for the making of night signals to vessels in Table Bay, for the regulation of their chronometers … with this gun and a pocket chronometer, Henderson each night climbed onto the roof of the Observatory and fired a charge of black powder at an advertised time. (Warner, 179: 32).

The 1833 pistol is shown in Figure 4.

## 3.5 Observatory Time Balls

### 3.5.1 1836 Observatory Time Ball

An Observatory time ball was in operation from October 1836 (Bartky and Dick, 1981), having been erected on 30 September. The apparatus was simpler than the 1833 Greenwich apparatus, but used the same basic principles.

An 1852 description of the first time ball is shown below (Maclear, 1852). According to this description, the location had not been changed since its erection in 1836 and high accuracy was achieved. The ball diameter was 5 feet, as at Greenwich. The 1852 notice suggested that it would have to be moved because of new construction that interrupted its line of sight from Table Bay. A 'repeater' time ball was constructed on Lion's Rump in July 1853. This repeater ball was initially under manual control and dropped when the Observatory time ball was seen to fall.

The Observatory time ball was relocated north on 21 May 1860 because it had become hidden by trees (Evans, 1993).

> THE OBSERVATORY TIME BALL – *Cape of Good Hope*
>
> The signal ball is five feet in diameter. It slides upon a rope attached to an arm projecting from the flag-staff at the height of 45 feet from the ground, and commands the outer anchorage in clear weather; but close in, particularly from the decks of small craft, the line of sight is interrupted by windmills and houses.
>
> No alteration has been made in the position of the flag-staff since it was first established; which position is the least objectionable to the sweep of the astronomical instruments, compatible with the command of the harbour. Otherwise, the staff might be placed to the north-west of the Observatory, so as to almost entirely clear the windmills and houses before-mentioned. The removal to the north-west is now under consideration; but it is proper to remark, that no arrangement at the Observatory can obviate the relative interruptions caused by the

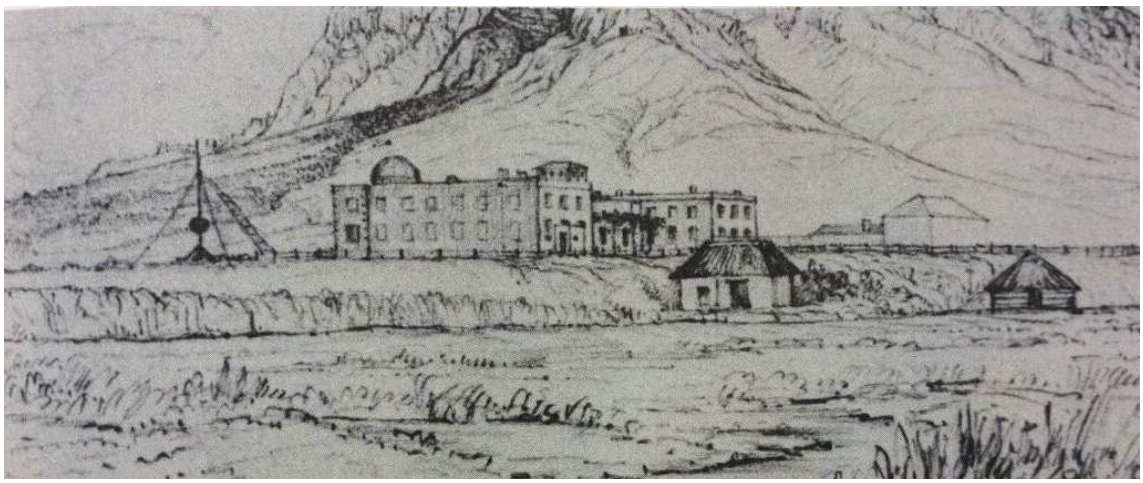


Figure 5: Detail from a January 1837 drawing by Sir John Herschel (courtesy: Willie Koorts).

> masts and rigging of a group of vessels at the anchorage. This could only be a met by a less distant, and particularly by a more elevated, position for the signal ball than the ground about the Observatory can furnish.
>
> The signal is made daily, Sundays and Good Fridays excepted, (and contingent exceptions that will be noticed presently,) at one o'clock, Cape mean time, corresponding to 11h. 46m. 5s. Greenwich time: and its precision is tested by an observer at the Normal mean time clock. An examination of the registered times of drop, since the beginning of this year, shows that the probable error has been reduced from about two-tenths of a second in time, to one-tenth part of a second in time. There is, therefore, an equal chance that the signal may happen one-tenth of a second too early or too late. This degree of accuracy is more than sufficient for the wants of the seaman, whose ordinary method of noting time signals admits of no such precision.
>
> Furthermore, with regard to the fountain from which the time for signal is derived, it may be well to record, that when the sky is clear, the error of the transit clock (which checks the Normal clock) is determined by astronomical observation as near the time of signal as is practicable.

The notice was extended with further observations concerning time ball reliability.

Figure 5 shows a detail from a camera lucida drawing that was made by Sir John Herschel in January 1837, not long after the time ball was first erected. The complete drawing is included in *Herschel at the Cape* (Evans et al., 1969: Plate 12). Herschel's diary entry for 2 January 1837 headed "Observatory" reads "Rose at 7.–Took sketch of the building from across the Salt River."

The time ball and mast can be seen to the left of the Observatory. The diameter of the ball appears to be larger than the 5 feet noted by Maclear (1852), but it is possible that the first time balls at the Observatory had a larger diameter than later. Large balls, probably made of wickerwork and covered in black-painted canvas, would have been difficult to manage in high winds and prone to damage. Piazzi Smyth (1853b) noted the frequent self-destruction of early time balls at the Cape.

Figure 6 is from an engraving published in *The Illustrated London News* (Cape Town Observatory, 1857), by an unknown artist. The black ball is in its raised position and is offset from the mast.

### 3.5.2 1853 Lion's Rump Time Ball

Details of the time ball at Lion's Rump were issued on 13 December 1853 (Maclear, 1853). The same notice was published in the 1854 Nautical Magazine and is transcribed below. It points out that the signal was available from 14 October 1853 and that observers should subtract one second from the time of ball release to give the exact time of 1 pm.

> ESTABLISHMENT OF AN ADDITIONAL TIME BALL AT THE CAPE OF GOOD HOPE. [153.] Mr Thomas Maclear, the Royal Astronomer at the Cape of Good Hope, has given notice, that the Time Ball attached to the Cape Observatory, not being generally visible by the Shipping on the eastern side of Table Bay, owing to the intervention of buildings, another has been established by the liberality of the Colonial Government, at the opposite side of the Bay. It stands on the Lions Rump, and commenced work on the 14th of last October.
>
> The Observer should note the time by his chronometer when this Ball *begins* to fall; and by subtracting one second from that time, he will have the moment of One o'clock p.m. by mean time at the Cape Ob-

Figure 6: Detail from an engraving published in *The Illustrated London News*, 21 March 1857.

servatory.

> The Cape Observatory stands in latitude 33° 56′ 3″ S., and longitude 18° 28′ 45″ or 1h 13m 55s E. of Greenwich.

In a letter to Airy, the Astronomer Royal at Greenwich, Maclear noted that "… an order for a trigger to drop the lever arm ball on the Lion's Rump was given by the Colonial Government." during 1861 (Maclear, 1863a). This suggests that the Lion's Rump ball was then dropped electrically. A 'lever arm ball' would be a possible description of the arrangement that was used at Port Elizabeth (see later).

### 3.5.3 Development of Time Ball Apparatus

In the early years of operation of the 1836 apparatus, the ball had to be replaced on several occasions. This would have been witnessed by Charles Piazzi Smyth, when he was assistant to Thomas Maclear at the Cape. The following comment relates to the selection of the time ball apparatus for Edinburgh (Smyth, 1853a).

> The earliest signal-balls which were made, though provided with ropes passing over pulleys by which they were enabled in their descent to raise a series of weights in order to check in a gradual manner the velocity of their fall, were yet invariably found, after a short time, to pull or to smash themselves to pieces. Steel springs were next tried to break the force of the concussion, but were pretty sure to be themselves snapped with a heavy ball, while a light one would not descend quick enough on a windy day. Recourse was finally had to compressed air, a spring of perfect temper never injured by time …

He made similar observations in a presentation to the Royal Society of Edinburgh, in December 1853, which referred specifically to his experience at the Cape (Smyth, 1853b).

> The author had several years' personal experience within 1837 and 1845 with this ball or balls, for several were made, and literally used up, so difficult was it found, with mere simple workmanship, to secure the perfect action, which Mr Field, of the firm of Maudslay and Field, had obtained by the adoption of a cylinder of compressed air to break the fall of the ball's descent.

Later in the same paper, probably to impress his audience, he grossly exaggerated the weight of the Edinburgh time ball as being 15 cwt (762 kg). Its real mass was less than 100 kg, but the myth persists in modern guidebooks (Kinns, 2014).

An arrangement using an air cylinder was more expensive than other alternatives, but its reliability benefits led it being used by many other manufacturers from the 1850s onwards. Many of these systems were imported from England.

Table 2 indicates that three time balls were released electrically from 1861. One was at the Observatory and one was at Simon's Bay. The third was probably the repeater ball at Lion's Rump but may have been at Port Elizabeth.

### 3.5.4 1863 Observatory Time Ball

The 1863 time ball apparatus was described in a notice published by Sir Thomas Maclear, which is reproduced in Figure 7. The notice pointed out that the new apparatus was erected about 45 m SW of the original. Its design was generally similar to that used at Edinburgh, Deal and Sydney, with a rack and pinion mechanism for hoisting and a cylinder of air to arrest the fall of the ball. The apparatus was supplied by Sandys & Co. in London, not by Maudslay,

NEW TIME-BALL AT THE ROYAL OBSERVATORY,
Cape of Good Hope

A new Time-ball, with elaborate machinery, has been erected at a spot distant about fifty yards south-west of the old signal-mast.

The Ball is five and a half feet in diameter, the upper and lower thirds of which are painted red, the middle third black. It slides upon a slotted Shaft, within which works a rack-edged gun-metal Rod, armed with a metallic Piston.

The Piston, when descending, plunges into an iron tube, where the contained air serves by its elasticity to break the shock of the fall.

The weight of the Ball, Rod, and Piston is about three hundred and sixty pounds. One hundred and sixty turns of the Windlass raises the Ball for signal, where it is supported by the catch of an Electro-magnetic Trigger, until the instant of one o'clock, Cape Observatory mean time, at which instant a Contact Lever attached to the train of the Mean Time Clock closes the galvanic circuit, and the Ball falls.

The Ball is raised ten feet above the top of the Tower at five minutes before one o'clock, where it rests about two minutes before raising it to the top of the Shaft. One o'clock, Cape mean time is coincident with $1^h\ 28^m\ 35^s$ Port Elizabeth time, and with $11^h\ 46^m\ 5^s$ a.m. Greenwich time.

The Port Elizabeth time is in terms of the meridian passing through the Elizabeth Monument on the hill, as determined by the triangulation of Captain Bailey, R.E.

THOS. MACLEAR.

Figure 7: Notice of a new time ball at the Cape in 1863 (Maclear. 1863c).

Sons & Field. It featured in two letters from Maclear to Airy, which pointed out defects in the delivered system that had to be rectified before the apparatus could be used and suggested that a similar apparatus for New Zealand should be inspected in London (Maclear, 1863a; 1863b). The other apparatus was erected at Wellington, New Zealand, and provided the first time ball service in New Zealand from 1864 (Kinns, 2017). It was designed to give a drop height of 18 feet, which was unusually large for a rack and pinion hoisting arrangement and required strengthening of the mast to allow operation in a windy environment (Maclear, 1863a).

The notice in Figure 7 shows that the time ball was raised by 10 feet at 5 minutes before the signal, paused there for about 2 minutes

Figure 8: The Observatory time ball after 1863 (courtesy: Ian Glass).

and then raised to its maximum height. The 1863 notice indicated that the ball was painted red with a black central band and had a diameter of 5½ feet.

Figure 8 shows the Observatory time ball after 1863. The locations of stays for the mast in Figure 8 suggest that it may have been decided to reduce the drop height from 18 feet to a more usual 10 feet after initial service. The mast cross-section differs from that described by Maclear (1863a), indicating that the hoisting arrangement had been changed in other respects. The original would have had the square cross-section used at Wellington, New Zealand

(see Kinns, 2017a: 74, Figure 2).

Neither the Observatory nor Lion's Rump time balls featured in the first (1880) or subsequent Admiralty lists. Table 2 shows that the time ball at the Observatory was still operating in 1878, or at least in 1877 when the report is likely to have been prepared (Royal Observatory, 1878). Time balls were also in operation at Simon's Town and Port Elizabeth, with an inland time ball at Kimberley. These were dropped at 1 pm, when the gun was fired. A ball at the Docks was dropped at noon, accompanied by a privately operated time ball. The latter and the Kimberley time ball are outside the scope of the research in this paper.

> Time-balls are dropped at one o'clock each day at the Observatory, Simon's Town, Port Elizabeth, and Kimberly, and a gun is fired in Cape Town. At noon a ball is dropped in the Cape Town Docks for the use of the shipping, and a private ball, erected by a Cape Town clockmaker, is dropped by a secondary current. A clock has been established at Port Elizabeth, which is regulated daily after a comparison with the mean solar clock of the Observatory. These arrangements have generally worked well, and through them accurate Cape mean time is distributed over a large portion of the Colony. In long circuits, like those in use, failures will occasionally take place through breakage or carelessness, but such failures are not frequent.

Port Elizabeth appears to have used a ball at the end of a lever arm (see later). It is sometimes described as a disc.

## 3.6 Cape Town Docks Time Ball

### 3.6.1 First Docks Time Ball

The time ball at the Docks is variously described as the Cape Town time ball, the Table Bay time ball and the Alfred Docks time ball. The first Admiralty list (List of Time Signals, 1880) gave the place as "Table Bay" and the location as "At Alfred Docks". The early history of this time ball is obscure and there are various inconsistencies in Admiralty descriptions.

The date of installation may have been in 1877 or earlier. There is a suggestion that the Docks time ball was installed in 1873 (Spencer-Jones, 1993). It might have been supplied by Siemens Brothers in London using a mechanical system manufactured by Maudslay, Sons & Field, which was thought to be destined for the Cape (Sells, 1883). However, there is strong evidence that the single apparatus built by Maudslays for Siemens Brothers in 1873 was a replica of the 1855 apparatus for Sydney and was installed at Lyttelton, New Zealand rather than at the Cape (Kinns, 2009; 2017). No details of the Docks arrangement before 1894 have been found.

### 3.6.2 Admiralty List Entries for Table Bay

Table 3 shows Admiralty list entries for Table Bay between 1880 and 1930. The local time anomaly in the 1880 list has been pointed out in Section 2.1. The ball drop time had been changed to local astronomical time by 1898. The local time is astronomical time in the lists from 1898 to 1908, based on zero hours at noon. This was changed to Standard time in the 1922 list, still based on zero hours at noon. It changed to civil time, based on zero hours at midnight, in the 1930 list. The local time given for the firing of the gun was incorrect in the lists for 1898, 1904 and 1908; it should have been the same as the time of the ball drop.

The 1880 list gave the location as 33° 54′ 27″ S., 18° 25′ 15″ E. From 1898, the time ball location was given as 33° 54′ 24″ S., 18° 25′ 15″ E. The small change in latitude between 1880 and 1898 suggests a relocation to the north of about 90 m, but this could be a correction. There were small changes in coordinates between 1922 and 1930, which are presumed to be further corrections as the location was unchanged. It is difficult to make sense of Admiralty list entries for Table Bay in several other respects. The time ball height above water changed by 30 feet between 1898 and 1922, with no significant change in the height above ground; they should change by the same amount if the tower height is changed. The 1922 and 1930 Admiralty lists both include a controlled clock in the tower, but automatic control from the Observatory had been discontinued in August 1928 (Evans, 1993). The drop height was recorded as 6 feet in the Admiralty lists, which was incorrect from 1894 onwards; it may have been correct for the first time ball at the Docks.

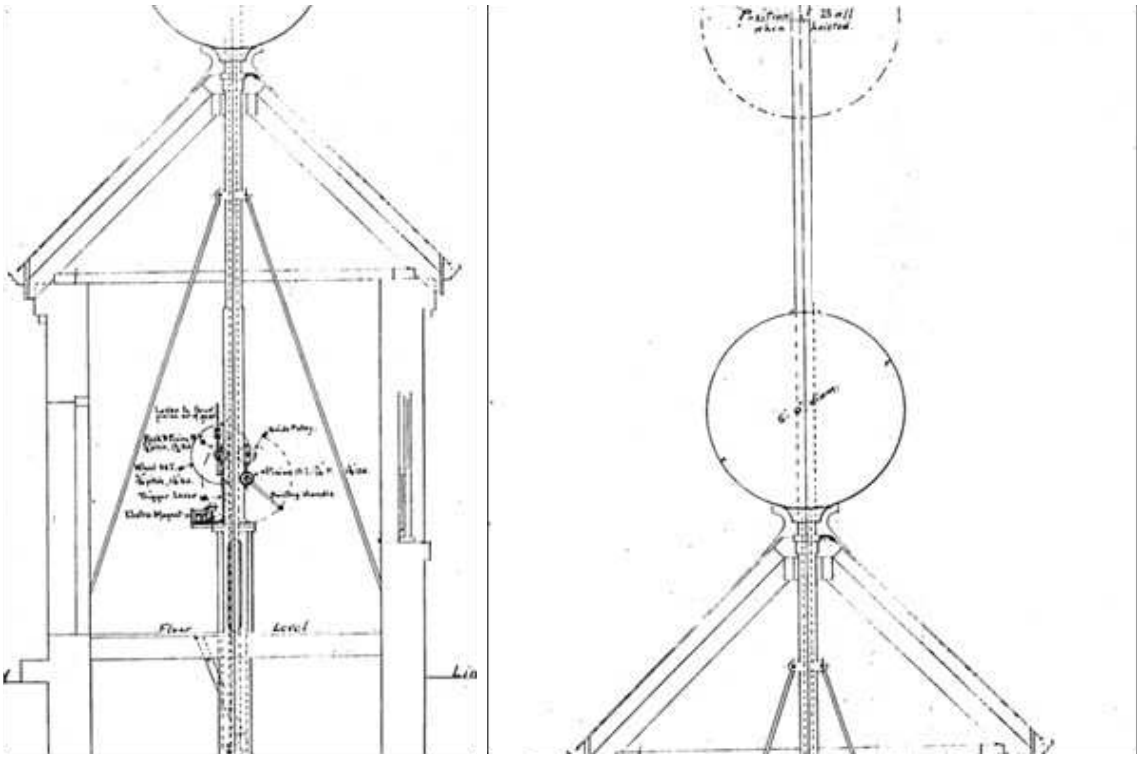
### 3.6.3 1894 Docks Time Ball

In 1894, a new time ball had been "… erected in a conspicuous position near Resident Engineer's Office of the Cape Town Docks." (Evans, 1993). Table 2 gives the time ball location in 1900 as 33° 54′ 24″ S., 18° 25′ 10.4″ E, about 100 m further west than in Admiralty lists. This is likely to be a longitude correction that had not been registered by the Admiralty. The ball was 30 feet above ground level and dropped 10 feet. From 18 April 1895, return signals to the Observatory confirmed that the ball had commenced and finished its drop. The Docks time ball was dropped at noon, rather than 1 pm as at other locations in South Africa.

Table 3: Admiralty list entries for Table Bay.

| Date | Latitude & Longitude | Signal | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h. m. s. | |
| 1880 | 33° 54′ 27″ S.<br>18° 25′ 15″ E. | Ball | At Alfred Docks.<br>47 feet above high water.<br>36 feet above ground.<br>(Drop 6 feet.) | 22 46 5 | 00 00 00 | Ball dropped (by electricity from the Cape Observatory) at noon Cape mean time. |
| | | Gun | On Imhoff battery. | 23 46 5 | 01 00 00 | Gun fired (by electricity from the Cape Observatory) at 1h 0m p.m. Cape mean time. |
| 1898 | 33° 54′ 24″ S.<br>18° 25′ 15″ E. | Ball | [As for 1880] | 0 00 00 | 01 13 41 | Ball dropped (by electricity from the Cape Observatory) at 1h 30m 00s Cape Colony mean time. |
| | | Gun | | 0 00 00 | 01 13 00 | Gun fired (by electricity from the Cape Observatory) at 1h 30m 00s Cape Colony mean time. |
| 1904 | 33° 54′ 24″ S.<br>18° 25′ 15″ E. | Ball | [As for 1880] | 22 00 00 | 23 13 41 | Ball dropped (by electricity from the Cape Observatory) at noon Cape Colony mean time. |
| | | Gun | | 22 00 00 | 23 13 00 | Gun fired (by electricity from the Cape Observatory) at noon Cape Colony mean time. |
| 1908 | 33° 54′ 24″ S.<br>18° 25′ 15″ E. | Ball | [As for 1880] | 22 00 00 | 23 13 41 | Ball dropped (by electricity from the Cape Observatory) at noon Cape Colony mean time. |
| | | Gun | | 22 00 00 | 23 13 00 | Gun fired (by electricity from the Cape Observatory) at noon Cape Colony mean time. |
| 1911 | | Ball<br>Gun | | | | |
| | | | | GMT h. m. s. | Standard Time h. m. s. | |
| 1922 | 33° 54′ 24″ S.<br>18° 25′ 15″ E. | Ball | At Alfred Docks.<br>77 feet above high water<br>37 feet above ground.<br>(Drop 6 feet.) | 22 00 00 | 0 00 00 | Ball dropped, electrically from the Cape Observatory, at Noon, Standard time.<br><br>A clock in the ground floor of the clock tower at the docks is controlled electrically from the observatory. If the clock is correct, the galvanometer on its face should show no deflection at the 50th and 60th seconds of each minute. Before comparing chronometers with this clock it should be ascertained that it is correct. |
| | | Gun | Battery on Signal Hill. | 22 00 00 | 12 00 00 | Fired, electrically from the Cape Observatory, at Noon, Standard time |
| | | | | GMT (Civil) h. m. s. | Standard Time (Civil) h. m. s. | |
| 1930 | 33° 54′ 21″ S.<br>18° 25′ 12″ E. | Ball | [As for 1922] | 10 00 00 | 12 00 00 | Ball dropped electrically from the Cape Observatory at Noon, Standard time.<br><br>[Clock as for 1922]. |
| | | Gun | | 10 00 00 | 12 00 00 | Fired electrically from the Cape Observatory at Noon, Standard time. |

Evans (1993) recorded that an extra storey was added to the tower in 1904, so this change should have been reflected in the 1908 list. The ball diameter and drop height were recorded by Evans as 5 feet and 10 feet in 1900. Extracts from drawings of the 1894 installation are repro-



1894 Mechanism 1894 Ball

Figure 9: The 1894 time ball at the Docks (courtesy: Gabriël Fagan).

duced in Figure 9, confirming these dimensions. The height of the signal was stated to be 30 feet above ground and 74 feet above low water in 1900. The 1894 drawing shows that the above-ground height of the centre of the ball in its raised position was indeed 30 feet. It was then a single-storey building, with part of the time ball apparatus in a deep basement. Its height was increased by adding another storey in 1904.

The Docks time ball was discontinued on 1 February 1934 and the ball itself was removed on 7 September (Evans, 1993). The tower remained in place.

### 3.6.4 Restored Docks Time Ball

The tower was declared a National Monument in 1982, but the time ball was then an immovable fibreglass replica. The Cape Town waterfront was redeveloped during the 1990s and it was decided to recreate the time ball that was withdrawn in 1934, using a replica of the original apparatus shown in Figure 9 (Glass et al., 1997). Restoration started in 1997 under the management of the late Gabriël Fagan (1925–2020), a renowned architect and conservation specialist. The original time ball apparatus had been lost, but the Department of Mechanical Engineering at the University of Cape Town built a working replica. The time ball could be dropped again at 1 pm under electrical control from the South African Astronomical Observatory. The GPS coordinates of the time ball are given as 33° 54′ 21.3″ S., 18° 25′ 09″ E., almost exactly those reported in 1900.

Figure 10 shows the Docks time ball after its restoration to the 1934 condition. The height of the centre of the raised time ball above ground is now about 14.5 m, 5.5 m higher than its 1894 elevation of 9 m.

## 3.7 Simon's Bay Time Balls and Discs

The Admiralty list entries referred to Simons bay and then Simon's Bay, rather than Simon's Town. A common spelling is now Simonstown. It is the home of the South African Navy's largest base.

The first time ball at Simon's Bay was erected in 1857. It was regulated using a portable transit telescope, as indicated in Table 2, until telegraph lines had been constructed between the Observatory and Simon's Bay. Electric operation was announced in *The Times* (Cape Town, 1861):

> The [telegraph] line from Cape Town to Simon's Bay is now made available for dropping the time-ball in the Admiralty-yard, thanks to Sir Thomas Maclean (*sic*), the Astronomer Royal …

The time ball had been replaced by a time disc

Figure 10: Docks time ball tower after restoration (photograph: Michael Peel).

before 1878, but the disc arrangement had become worn and failed frequently in 1896 and 1897, as shown in Table 2. A sketch of the arrangement is shown in Figure 11.

The disc was used for the last time on 11 December 1897 and replaced by a time ball which became operational on 14 April 1898.

### 3.7.1 Admiralty List Entries for Simon's Bay

The Admiralty list entries for Simon's Bay between 1880 and 1930 are shown in Table 4.

The 1880 Admiralty list included the circular disc. The list for 1898 was prepared before the change of signal type, so still included the disc

signal. There were small corrections to the latitude and longitude between 1880 and 1898, but no further changes afterwards. The list for 1904 indicated that the time ball was initially painted white, but this was changed to a chequered black and white paint scheme before 1908. There was no reported change in the signal location or the drop height with the change from a disc to a ball. Table 2 indicates that the time ball was dismantled on 8 February 1929. Inclusion in the 1930 Admiralty list was therefore incorrect.

The time ball arrangement may have been similar to those erected in Singapore in 1893 and Auckland in 1901, using weights, rather than an air cylinder, to control the descent (Kinns, 2021a). The small drop height is also consistent with installation of a lever arm ball, which appears to have been the arrangement at Port Elizabeth.

## 3.8 Port Elizabeth Time Balls and Discs

An electric telegraph link from the Cape may have been used to drop a time ball at Port Elizabeth as early as 1861 (see Table 2). It was certainly in operation by 26 August 1865 (Warner, 1979). The time ball provided a return signal to the Observatory in 1873, as shown in the following report (Royal Observatory, 1873):

> A return-signal has been arranged for after the drop of the Port Elizabeth time-ball. The distance over which the wires are carried is over 600 miles. The return-signal reaches the Observatory from $^{3}/_{10}$ to $^{6}/_{10}$ of a second after the current leaves the Observatory.

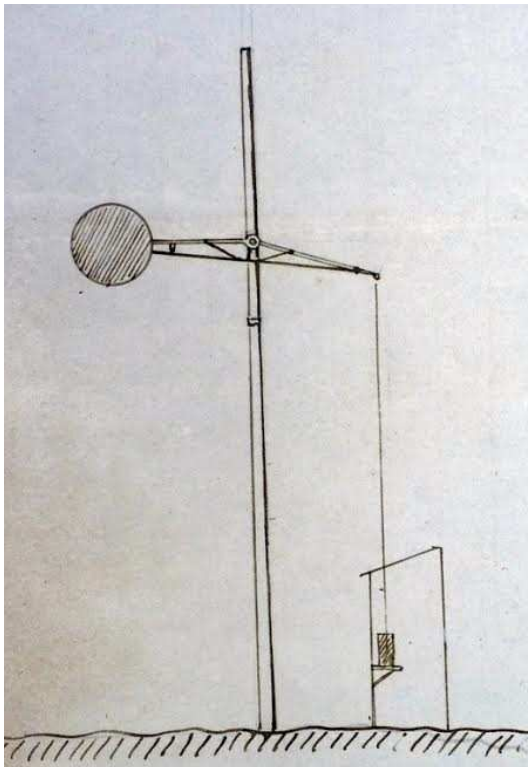


Figure 11: Sketch of the time disc at Simon's Bay (courtesy: David Erickson, Simonstown Historical Society, via Ian Glass).

Table 4: Admiralty list entries for Simon's Bay.

| Date | Latitude & Longitude | Signal | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h m s. | |
| 1880 | 34° 11′ 30″ S.<br>18° 25′ 48″ E. | Circular disc | Mast close to Simons Town Telegraph Office.<br><br>63 feet above high water.<br>40 feet above ground.<br>(Drop 6 feet.) | 23 46 5 | 0 59 48.2 | Disc raised to a right angle with mast at 5 minutes before signal. Disc dropped (by electricity from the Cape Observatory) at moment of 1h 0m p.m. Cape mean time.<br><br>When signal fails in accuracy, the disc is kept up till 2 o'clock, then lowered. |
| 1898 | 34° 11′ 35″ S.<br>18° 25′ 58″ E. | Circular disc | [As for 1880] | 0 00 00 | 1 13 43.9 | Disc raised to a right angle with mast at 5 minutes before signal. Disc dropped (by electricity from the Cape Observatory) at moment of 1h 0m p.m. Cape mean time.<br><br>When signal fails in accuracy, the disc is kept up till 2 o'clock, then lowered. |
| 1904 | 34° 11′ 35″ S.<br>18° 25′ 58″ E. | White ball | [As for 1880] | 22 00 00 | 23 13 43.9 | Ball hoisted 5 minutes before signal. Ball falls (by electricity from the Cape Observatory) at moment of noon Cape Colony mean time.<br><br>When signal fails in accuracy, the ball is kept up about 10 minutes and then lowered. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1908 | 34° 11′ 35″ S.<br>18° 25′ 58″ E. | Black and white chequered ball | [As for 1880] | 22 00 00 | 23 13 43.9 | [As for 1904] |
| 1911 | | Black and white chequered ball | | | | |
| | | | | GMT<br>h. m. s. | Standard Time<br>h. m. s. | |
| 1922 | 34° 11′ 35″ S.<br>18° 25′ 58″ E. | Black and white chequered ball | Mast near telegraph office.<br><br>63 feet above high water<br>40 feet above ground.<br>(Drop 6 feet.) | 22 00 00 | 0 00 00 | Ball hoisted at 5 minutes before the signal, and dropped, electrically from the Cape Observatory at Noon, Standard time.<br><br>Should the signal fail, the ball will be kept up for about 10 minutes, then slowly lowered. |
| | | | | GMT (Civil)<br>h. m. s. | Standard Time (Civil)<br>h. m. s. | |
| 1930 | 34° 11′ 35″ S.<br>18° 25′ 58″ E | Black and white chequered ball | [As for 1922] | 10 00 00 | 12 00 00 | [As for 1922] |

The linear separation is about 400 miles, so the cable was not routed directly. Table 2 indicates that a time ball was still in use during 1889, but the description had been changed to a time disc by 1894. This change of description is discussed later: there may not have been an actual change of signal type.

### 3.8.1 Admiralty List Entries for Port Elizabeth

The Admiralty list entries for Port Elizabeth are shown in Table 5. The entries for 1880 and 1898 refer to both a ball and a disc in the columns describing the signal and its location. The apparent contradiction is highlighted in red.

The following description was published in 1916 (Africa Pilot, 1916: 141–142):

> **Time signal**. — At Port Elizabeth Lighthouse, at an elevation of 220 feet above high water, a black ball is dropped by electricity from the Cape Observatory at 0 h. 0 m. 0 s. South Africa standard time, corresponding to 22 h. 0 m. 0 s. Greenwich mean time; but the signal is not made on Sundays or public holidays. Should the signal be inaccurate, a checkered red and blue flag will be hoisted at the lighthouse and the ball dropped 5 minutes later, or at 0 h. 5 m. 0 s. South Africa standard time.

The 1916 notice is consistent with the 1908 Admiralty list, both referring to a ball. Table 2 suggests that the ball had been changed to a disc by 1893 but this may be misleading. Figure 12 shows the disc in raised and lowered positions at the lighthouse. Although described as a disc, it appears that it was actually a ball attached to a lever arm, so that it could be observed from any direction. This would explain why the same location and drop height were given for both the ball and the disc and why the 1880 and 1898 lists of time signals referred to both: the change was a matter of description. Maclear had described the time ball at Lion's Rump as a lever arm ball in 1863. The essential difference from a conventional time ball was the dropping arrangement. The "disc" was dismantled on 30 September 1930.

## 3.9 Port Alfred

The relative locations of time signals at Port Elizabeth, Port Alfred and East London are shown in Figure 2. The Port Elizabeth signal was established first and remained in use longest of the three signals. It was followed by the Port Alfred signal and then the signal at East London.

The time balls at Port Alfred and East London did not appear in the report for 1878 (Royal Observatory, 1878). The ball at Port Alfred was, however, noted in the 1880 Admiralty list.

### 3.9.1 Admiralty List Entries for Port Alfred

The Admiralty list entries for Port Alfred are shown in Table 6. There was a small correction to the longitude between 1880 and 1898, corresponding to a change of 0.3 seconds in astronomical time. The corrected signal location was 1h 47m 36.3s fast on Greenwich. The drop time changed in combination with time zone modifications.

There was no description of the time ball arrangement in Admiralty lists, other than the elevation and drop height.

Table 5: Admiralty list entries for Port Elizabeth.

| Date | Latitude & Longitude | Signal | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h. m. s. | |
| 1880 | 33° 57′ 43″ S. 25° 37′ 21″ E.. | Black disc | At the Lighthouse. 220 feet above high water. 43 feet above ground. (Drop 5 feet.) | 23 46 5 | 1 28 34.4 | Disc dropped (by electricity from the Cape Observatory) at moment of 1h 0m p.m. Cape Colony mean time. When signal fails in accuracy, a chequered red and blue flag will be shown from the lighthouse, and ball dropped 5 minutes later, or at 1h 5m p.m. Cape mean time. |
| 1898 | 33° 57′ 43″ S. 25° 37′19″ E.. | Black ball | [As for 1880] | 0 00 00 | 1 42 29.3 | Disc dropped (by electricity from the Cape Observatory) at moment of 1h 30m 00s Cape Colony mean time. When signal fails in accuracy, a chequered red and blue flag will be shown from the lighthouse, and ball dropped 5 minutes later, or at 1h 35m 00s p.m. Cape Colony mean time. |
| 1904 | 33° 57′ 43″ S. 25° 37′ 19″ E.. | Black ball | [As for 1880] | 22 00 00 | 23 42 29.3 | Ball dropped (by electricity from the Cape Observatory) at moment of noon Cape Colony mean time. When signal fails in accuracy, a chequered red and blue flag will be shown from the lighthouse, and ball dropped 5 minutes later, or at 0h 5m 0s p.m. Cape Colony mean time. |
| 1908 | 33° 57′ 43″ S. 25° 37′ 19″ E. | Black ball | [As for 1880] | 22 00 00 | 23 42 29.3 | Ball dropped (by electricity from the Cape Observatory) at moment of noon Cape Colony mean time. When signal fails in accuracy, a chequered red and blue flag will be shown from the upper window of the lighthouse, and ball dropped 5 minutes later, or at 0h 5m 0s p.m. Cape Colony mean time. |
| 1911 | | Black ball | | | | |
| | | | | GMT h. m. s | Standard Time h. m. s | |
| 1922 | 33° 57′ 43″ S. 25° 37′ 19″ E.. | Black disc | [As for 1880] | 22 00 00 | 00 00 00 | Disc dropped, electrically from the Cape Observatory at Noon, Standard time. Should the signal be inaccurate, a red and blue chequered flag will be shown from the upper window of the lighthouse, and the signal repeated at 0h 05m 00s, Standard time. |
| | | | | GMT (Civil) h. m. s. | Standard Time (Civil) h. m. s. | |
| 1930 | 33° 57′ 43″ S. 25° 37′ 19″ E. | Black disc | [As for 1880] | 10 00 00 | 12 00 00 | Disc dropped electrically from the Cape Observatory at Noon, Standard time. Should the signal be inaccurate, a red and blue chequered flag will be shown from the upper window of the lighthouse, and the signal repeated at 12h 05m 00s, Standard time. |

Table 2 indicates that the Port Alfred time ball had been discontinued in 1898, but the following notice and Table 6 show that this was either incorrect or a temporary withdrawal. The signal was not discontinued until 1911 (Notices, 1911). The Admiralty notices appear to be correct.

Disc raised

Disc lowered

Figure 12: The semaphore disc or ball at Port Elizabeth (courtesy: Klaus Hülse collection).

Table 6: Admiralty list entries for Port Alfred.

| Date | Latitude & Longitude | Signal | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h. m. s. | |
| 1880 | 33° 36′ 10″ S. 26° 54′ 10″ E. | Ball | 54 feet above high water. 26 feet above ground. (Drop 18 feet.) | 23 46 05 | 01 33 41.6 | Ball dropped (by electricity from the Cape Observatory) at moment of 1h 0m p.m. Cape mean time. |
| 1898 | 33° 36′ 10″ S. 26° 54′ 05″ E. | Ball | [As for 1880] | 0 00 00 | 01 47 36.3 | Ball dropped (by electricity from the Cape Observatory) at moment of 1h 30m p.m. Cape Colony mean time. |
| 1904 | 33° 36′ 10″ S. 26° 54′ 05″ E. | Ball | [As for 1880] | 22 00 00 | 23 47 36.3 | Ball dropped (by electricity from the Cape Observatory) at moment of noon Cape Colony mean time. |
| 1908 | 33° 36′ 10″ S. 26° 54′ 05″ E. | Ball | [As for 1880] | 22 00 00 | 23 47 36.3 | Ball dropped (by electricity from the Cape Observatory) at moment of noon Cape Colony standard mean time. |
| 1911 1922 1930 | Port Alfred signal discontinued | | | | | |

**AFRICA -- Southeast coast – Port Alfred – Time signal discontinued.** The German Government has given notice that the time ball which has hitherto been dropped from a staff near the West Mole, Port Alfred, southeast coast of Africa, has been discontinued. (Notice to Mariners, 1911: No. 44).

The ball was dropped from a staff near the West Mole. Figure 13 shows the location of the time ball near the harbour entrance.

The drop height of 18 feet happens to be the same as that for the 1863 apparatus at the Cape Observatory. The evidence is circumstantial, but it is conceivable that the 1863 apparatus was re-used at Port Alfred, as the time ball at Alfred Docks had become the principal signal for Table Bay before 1880.

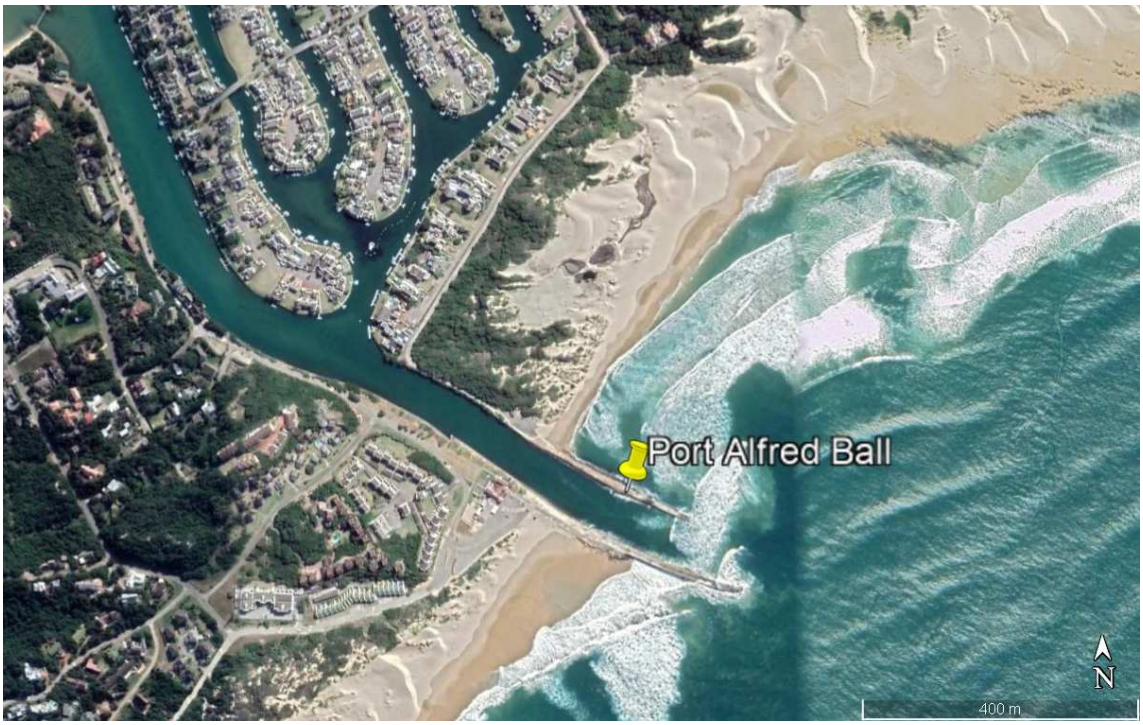



Figure 13: Location of the Port Alfred time ball (map modification: Roger Kinns).

## 3.10 East London

The East London ball was noted in the Table 2 entry for 1889 and in later entries up to 1929. It had been withdrawn by 1933.

### 3.10.1 Admiralty List Entries for East London

The Admiralty list entries for East London are shown in Table 7. Figure 3 shows that the Port Alfred and East London signals were not far apart.

The time ball was dropped from an iron frame at high elevation. The drop height was 15 feet. The apparatus would have been much simpler than those used at the Observatory in 1863 and at Alfred Docks after 1894. The time ball at East London probably used the 'Devonport Principle', which was developed in 1884–1885 by Admiral Wharton, then Hydrographer of the Navy. It was used at "Singapore, Portsmouth, Brisbane, Cairo, Port Said, Alexandria and other locations." (Lewis, 1910). This type of design reduced the cost of time ball installations and allowed a wide range of drop heights with electrical triggering.

Table 7: Admiralty list entries for East London.

| Date | Latitude & Longitude | Signal | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h. m. s. | |
| 1880 | No reported signal at East London | | | | | |
| 1898 | 33° 01′ 50″ S. 27° 54′ 55″ E. | Ball | Iron frame on Signal Hill. | 00 00 00 | 1 51 39.7 | Ball dropped (by electricity from the Cape Observatory) at 1h 30m 00s p.m. Cape Colony mean time.<br><br>Should the signal fail, a yellow flag is hoisted about 5 minutes after the ball has been dropped. Not visible from vessels alongside the wharves. |
| 1904 | 33° 01′ 50″ S. 27° 54′ 55″ E. | Ball | Iron frame on Signal Hill. | 22 00 00 | 23 51 39.7 | Ball dropped (by electricity from the Cape Observatory) at noon, Cape Colony mean time.<br><br>[Signal failure: As for 1898] |
| 1908 | 33° 01′ 50″ S. 27° 54′ 55″ E. | Ball | Iron frame on 149 feet hill. | 22 00 00 | 23 51 39.7 | Ball dropped (by electricity from the Cape Observatory) at noon, Cape Colony standard mean time. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 200 yards S.W. by S. from Signal Hill.<br><br>160 feet above high water. (Drop 15 feet.) | | | [Signal failure: As for 1898] |
| 1911 | | Ball | | | | |
| | | | | GMT<br>h. m. s. | Standard Time<br>h. m. s. | |
| 1922 | 33° 01′ 50″ S.<br>27° 54′ 55″ E. | Ball | Iron frame on hill near signal station.<br><br>160 feet above high water. (Drop 15 feet.) | 22 00 00 | 0 00 00 | Ball dropped electrically from the Cape Observatory, at Noon, Standard time.<br><br>Should the signal be inaccurate, a yellow flag will be hoisted about 5 minutes after. The ball falls slowly and is not to be relied on within one second. Not visible alongside the wharves.<br><br>Signal not made on Sundays or public holidays. |
| | | | | GMT (Civil)<br>h. m. s. | Standard Time (Civil)<br>h. m. s. | |
| 1930 | 33° 01′ 50″ S.<br>27° 54′ 55″ E. | Ball | [As for 1922] | 10 00 00 | 12 00 00 | [As for 1922] |

## 3.11 Durban, Natal

In 1882, David Gill, Director of the Cape Observatory, asked the Government of Natal to establish an astronomical observatory at Durban, in anticipation of the transit of Venus on 6 December that year. A site for the observatory was chosen in the southwest corner of the Natal Botanic Gardens. Initial equipment at the Natal Observatory included a 75-mm Troughton & Simms transit instrument and a sidereal clock by Dent (Natal Observatory).

It is believed that a time ball was established in 1883, controlled by Natal Observatory. Following the formation of the Union of South Africa in 1910 the post of Government Astronomer of Natal was abolished and the Observatory was closed in 1911.

### 3.11.1 Edmund Nevill *aka* Edmund Neison

Edmund Neville Nevill (1849–1940) was appointed Government Astronomer of Natal and Director of the Observatory. Nevill also used the name Edmund Neison. He is perhaps best known for his book *The Moon* (Nevill, 1940). The following extracts relating to his work in South Africa are from his obituary (Spencer Jones, 1941).

> EDMUND NEVILLE NEVILL was born at Beverley, Yorkshire, on 1849 August 27 … and was elected a Fellow of the [*Royal Astronomical*] Society in 1873 under the name of Edmund Neison, having the curious idea that it was derogatory to the holder of an ancient name to make a career in science.

Nevill had gone to South Africa as Government Astronomer for Natal. There had been under consideration for several years a proposal for the establishment of an observatory in Durban. The observatory was started in 1882, with the aid of sums voted by the Corporation of Durban and by the Legislative Council of Natal, a Grubb 8-inch equatorial being presented by Mr. Harry Escombe. Mr. (later Sir David) Gill, H.M. Astronomer at the Cape, had been consulted and Nevill received an urgent telegram from Gill, offering him the post of Government Astronomer. He sailed almost on twenty-four hours' notice on 1882 October 27, reached Durban on November 27 and, in accordance with instructions furnished by the Colonial Secretary, he took possession of the Observatory on December 1 as Astronomer to the Natal government. On December 6 he obtained successful observations of the transit of Venus, for which the conditions were exceedingly fine.

But lack of financial support soon made itself felt and work had more and more to be restricted to routine observations–determinations of time for the provision of a time-service, meteorological and tidal observations. In 1888 Nevill was appointed Government Chemist and Official Assayer for Natal, and combined this office with that of Government Astronomer until his retirement.

The Natal Observatory came to an end in 1911 and Nevill, who had been elected a Fellow of the Royal Society in 1908, returned to England to live in retirement at Eastbourne … Nevill reverted to his family name in 1888, in accordance with the conditions

of a will … He died on 1940 January 14 in his ninety-first year.

### 3.11.2 Admiralty List Entries for Durban

The Admiralty list entries for Durban are shown in Table 8. The place was given as Natal in 1898, as Port Natal (Durban) in lists up to 1911 and then as Durban in the lists for 1922 and 1930. The "local" time in early lists was Natal standard time defined by the Observatory location, not astronomical time at the signal location. The 1898 and 1904 lists show the initial location of the time ball.

The first time ball at Durban was included in the lists for 1898 and 1904. The time ball had been relocated in 1904, as indicated below (Notices, 1905: 22).

> **AFRICA - Southeast coast - Port Natal - Time ball - Position altered**. – The Government of Natal has given notice, dated November 3, 1904, that the time ball at port Natal bas been removed from the point to a position on the bluff, from which the Bluff lighthouse bears N. 59 ° E. true … distant 260 yards, and the south leading mark N. 22° W. true … The time ball will be dropped as before, on every day except

Table 8: Admiralty list entries for Durban.

| Date | Latitude & Longitude | Signal | Location of Time Signal | Time of Signal Being Made | | Additional Details |
|---|---|---|---|---|---|---|
| | | | | GMT h. m. s. | Local Time h. m. s. | |
| 1880 | No reported signal at Durban | | | | | |
| 1898 | 29° 52′ 30″ S. 31° 03′ 00″ E. | Ball | At 3 cables N.N.W. ½ W. from Sandy point, North side of Entrance to port. | 23 00 00 | 1 04 01 | Ball dropped at 1h 00m 00s p.m. Natal standard mean time.<br><br>When signal fails in accuracy, a blue flag with white centre is hoisted at the Time Ball staging about 1h 05m 00s p.m., as a Notice that the Signal cannot be relied on.<br>[Note: signal not made on Sundays.] |
| 1904 | 29° 52′ 30″ S. 31° 03′ 00″ E. | Ball | At 3 cables N.N.W. ½ W. from Sandy point, North side of Entrance to port. | 23 00 00 | 1 04 01 | [As for 1898] |
| 1908 | 29° 52′ 44″ S. 31° 03′ 42″ E. | Ball | On the Bluff 260 yards S. 83° W. from the Bluff lighthouse.<br><br>95 feet above high water. (Drop 8 feet) | 23 00 00 | 1 04 01 | Ball dropped at 1h 00m 00s p.m. Natal standard mean time.<br><br>[Signal failure as for 1898] |
| 1911 | | Ball | | | | |
| | | | | GMT h. m. s. | Standard Time h. m. s. | |
| 1922 | 29° 52′ 44″ S. 31° 03′ 42″ E. | Ball | On the Bluff, westward of the lighthouse.<br><br>283 feet above high water. (Drop 8 feet.) | 22 00 00 | 0 00 00 | Signal established or altered in 1916.<br><br>Ball dropped at 0h 00m 00s, Standard time.<br><br>Should the signal be inaccurate, the ball will be re-hoisted and again dropped at 3h 00m 00s Standard time.<br><br>Not made on Sundays.<br><br>Chronometers may be compared at the port office, where an electric signal is received every hour from the Observatory. |
| | | | | GMT (Civil) h. m. s | Standard Time (Civil) h. m. s. | |
| 1930 | 29° 52′ 44″ S. 31° 03′ 42″ E. | Ball | [As for 1922] | 10 00 00 | 12 00 00 | [As for 1922] |

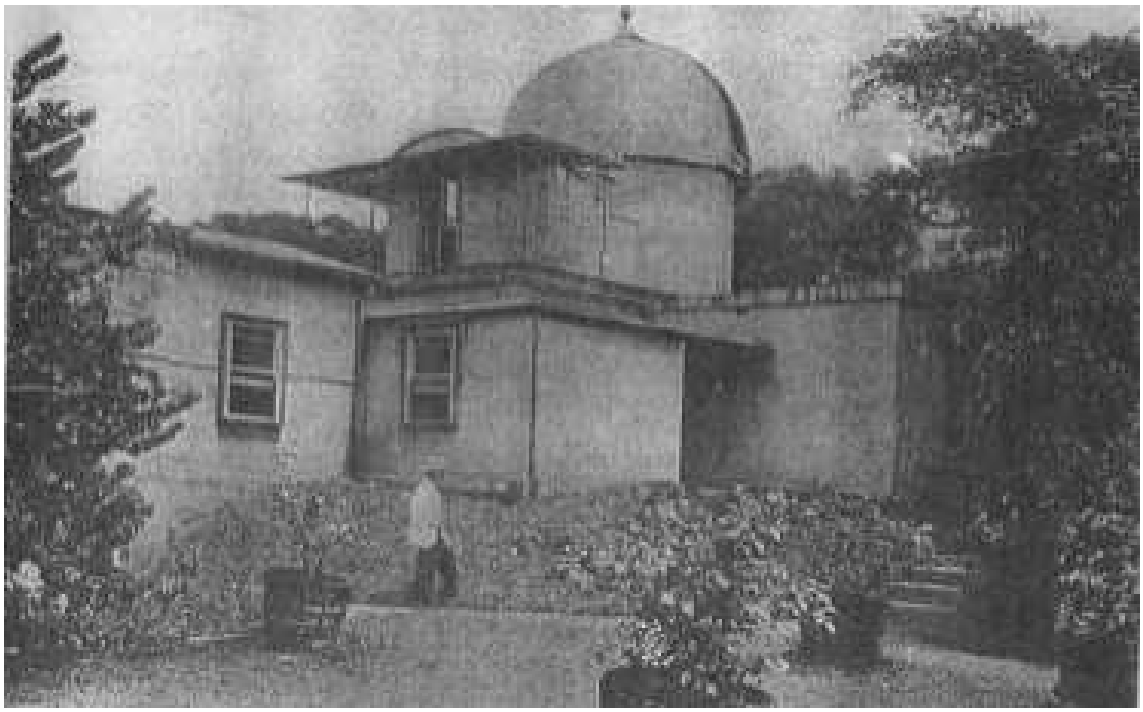


Figure 14: Natal Observatory in 1903 (Don Africana Library, Durban).

Sunday, at 1h. 00m. 00s. p.m. Natal standard mean time, corresponding to 23h. 00m. 00s. Greenwich mean time. Approx. position: Lat 29° 52′ 44″ S., Long. 31° 03′ 42″ E.


Figure 15: Durban lighthouse (Klaus Hülse collection).

The stated latitude and longitude were 29° 52′ 44″ S., 31° 03′ 42″ E., identical to those given in Admiralty lists. This suggests that the same time ball was used from 1904 until the signal was withdrawn. The drop height of 8 feet remained the same in all lists from 1908. There was a change in the location description between 1908 and 1922. “S. 83° W.” is an alternative to “westward”, but the change in signal elevation from 95 to a more plausible 283 feet above high water is probably a correction. The Bluff itself is 195 feet high (McCallum, 2014). The time of the drop was changed on 1 September 1912 from 1h. 00m. 00s. to noon South Africa standard time (Notices, 1912: 839).

Figure 14 shows a view of Natal Observatory from the North East. The small veranda was constructed around the Transit Room. Director Nevill appears in the foreground. The photograph was published in the Natal Illustrated Railway Guide of 1903 (Natal Observatory).

Figure 15 shows the lighthouse in a tinted photograph. The time ball may have been suspended from the signal mast, which was clearly used for a large number of different signals.

## 4 DISCUSSION AND CONCLUDING REMARKS

The aim of this paper is to establish the nature of time signals for mariners in South Africa. The research builds on previous work concerning the Royal Observatory at the Cape of Good

Hope, using Admiralty lists of time signals, notices to mariners and other sources to expose and resolve contradictions. It forms part of a description of visual time signals for mariners worldwide that is being developed by the author. South Africa played a key role in signal development.

Initial development of visual time signals for calibration of marine chronometers has been attributed to Captain, later Admiral, Robert Wauchope, who served at the Cape from 1818 and was later in command of ships that visited Cape Colony. Wauchope developed close relationships with Thomas Maclear, Director of the Cape Observatory from 1833 and Sir John Herschel, who worked at the Cape from 1834 to 1838 and was an active correspondent with other astronomers. A key feature of the successful visual arrangements was a preparatory signal to alert navigators that an exact signal was imminent. Fearon Fallows, the first Director of the Cape Observatory, had used an oil lamp from about 1823, lit several minutes before the signal and then hidden by a shutter at the designated time. It was to be almost another century before high-powered electric lights could be used for time signalling. Fallows had to work with severely limited facilities for many years and the Cape Observatory only became operational in 1829. Wauchope's ideas led eventually to the time ball, with successful experiments at Portsmouth in 1829–1830. The design concept was published widely and Wauchope tried to persuade various national authorities to adopt his ideas. The flash of a gun at the Cape had been used from 1807, but it only became a precise time signal under observatory control in 1864. A flash pistol was used as an evening signal at the Cape Observatory in 1833 by Henderson, who succeeded Fallows as Director.

The first operational time ball service was at Port Louis, Mauritius in April 1833, using a shuttered, stationary ball designed by John Augustus Lloyd without Wauchope's involvement. The system at Greenwich, designed by Maudslay, Sons & Field, was operational in October 1833 and became the model for later successful arrangements worldwide. A time ball in St. Helena was in use by the East India Company in January 1834, followed by another in Calcutta in January 1835. These systems were built locally, as was the next implementation at the Cape Observatory in September 1836.

The time ball at the Observatory had to be moved and supplemented by a repeater signal at Lion's Rump from 1853 when trees and buildings obscured it from Table Bay. The repeater signal was operated manually at first, using a lever arm ball. It was controlled by electric telegraph from 1861, together with the time ball at Simon's Bay, which had been established in 1857 and regulated initially using a portable transit telescope. The Observatory time ball was replaced in 1863 using an electric time ball supplied by Sandy's & Co. in London. Available descriptions and photographs indicate that the 1863 arrangement with a drop height of 18 feet was later modified to give a reduced drop height.

A time ball at Table Bay, also described as being at The Docks or at Alfred Docks, was erected in the 1870s, but its origins are obscure. It may have been erected as early as 1873. It featured in the Admiralty list of time signals from the first edition in 1880, which did not include the Observatory time balls. A new arrangement was used from 1894, whose details have been established from contemporary drawings. The tower height was increased by adding another story in 1904. Admiralty lists from 1898 onwards had not been altered as they should have been to reflect the modifications in 1894 and 1904. The Docks time ball was restored in 1997 using a working replica of the 1894 apparatus.

The first time ball at Simon's Bay was erected in 1857 and controlled by electric telegraph from 1861. It was described as a disc by the Astronomer in 1893, followed by announcements in 1896 and 1897 that the disc mechanism was failing to work reliably through old age. It was replaced by a new time ball, which became operational in April 1898. Admiralty lists described the signal as a disc in 1880, as a white ball in 1904 and as a black and white chequered ball in lists from 1908 to 1930. The stated location and drop height were unchanged throughout.

The time signal at Port Elizabeth has been variously described as a time ball or a time disc, occasionally with both descriptions in the same notice. It was described as a time ball in an 1873 announcement that a return telegraph signal was available to confirm the drop, and by the Astronomer in 1889. It was then described as a disc by the Astronomer in 1893. It was described as both a ball and a disc in Admiralty lists for 1880 and 1898; as a ball in 1904, 1908 and 1911; and as a disc in 1922 and 1930. A possible explanation is that the same signal was used throughout. Available photographs suggest that it was a lever arm ball, which dropped in a circular arc. The advantage over a simple disc was that it would appear as a circular object from any direction.

There were time balls at Port Alfred and East London, further east than Port Elizabeth but still within Cape Colony. The signal at Port Alfred was listed by the Admiralty in 1880, 1898,

1904 and 1908, but not in 1911 and later lists. This is consistent with a notice to mariners that the signal had been discontinued in 1911. The time ball at East London was in use by 1889 and was discontinued in 1933.

An Observatory was built in Durban to observe the 1882 Transit of Venus, with Edmund Nevill (*aka* Neison) as its Director. A time ball was erected soon afterwards, with regulation from the Observatory. The ball had been moved to a location near the Bluff lighthouse in 1904 and remained there until the service was withdrawn in 1930. The Observatory was closed in 1911. After that, the time ball was operated using telegraph signals from the Cape Observatory.

There are still some unknown features of several time signals in South Africa. The history of the time ball at the Docks in Cape Town before 1894 is uncertain and descriptions in later Admiralty lists have been shown to be inaccurate. The designs of the time ball apparatus used at Port Alfred, East London and Durban are uncertain. The Port Alfred time ball had a drop height of 18 feet and was located near the harbour entrance. It featured in the 1880 Admiralty list when no Observatory time ball was listed. 18 feet was the design drop height for the 1863 apparatus at the Cape Observatory, later limited to about 10 feet. It is possible that the 1863 apparatus was re-used at Port Alfred when it was no longer needed at the Observatory, but evidence is only circumstantial. The time ball at East London was dropped from an iron frame on top of a hill. This is likely to have used the "Devonport Principle", giving the stated 15 feet drop height at low cost with electrical triggering. This type of design is known to have been used for a high proportion of time balls supplied from England after 1885.

## 5 ACKNOWLEDGEMENTS

I am most grateful to Paul Fuller for sharing the results of his meticulous research into the life of Robert Wauchope, whose ideas on visual time signals had first developed at the Cape of Good Hope. This paper builds on historical studies by distinguished astronomers in South Africa, using international lists and notices to mariners. Dr Ian Glass, Willie Koorts and Chris de Coning, of the South African Astronomical Observatory, kindly provided additional illustrations and references. Willie Koorts and Chris de Coning have produced excellent videos concerning time signals at the Cape (see: https://youtu.be/BKU32cTe75o and https://youtu.be/nkBOkyl2hJw). The late Gabriël Fagan provided extensive information in 2009 about the 1894 time ball at the Docks. Various illustrations in this paper have come from the remarkable collection of post cards and photographs assembled by Klaus Hülse in Germany. I also thank referees for suggesting improvements to the original draft.

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**Dr Roger Kinns** was born in Winchester, England, in 1944. He read Mechanical Sciences as an undergraduate at Gonville and Caius College, Cambridge and then took an MASc degree in control engineering at the University of Waterloo in Ontario, Canada, before returning to Cambridge to complete a PhD on unsteady aerodynamics.

Roger was Maudslay Research Fellow of Pembroke College, Cambridge, from 1971 to 1975. He then joined YARD Ltd in Glasgow, Scotland to lead development and application of techniques for the acoustic design of ships and submarines. He has worked as an independent consultant since 1999 with principal research interests in underwater noise and vibration due to marine propulsion systems. Until 2019 he was a Senior Visiting Research Fellow in the School of Mechanical and Manufacturing Engineering at the University of New South Wales in Sydney, Australia. Presently, Roger is Treasurer of the Maudslay Society and Maudslay Scholarship Foundation.

The Maudslay connection led to an enduring fascination with the history of engineering and particularly time signals worldwide. Roger has published a succession of research papers on English, Scottish, Australian, New Zealand and Mauritius time balls and other time-signalling devices and techniques in a number of different journals, including *JAHH*, and he has a chapter on the time balls of Southeast Asia in *Exploring the History of Southeast Asian Astronomy: A Review in Current Projects and Future Prospects and Possibilities* (2021, Springer). Currently he is researching the time balls of Asia, Europe and the Americas, for further *JAHH* papers.