

W. E. Frodsham No.1. Another chronometer identified from *HMS Beagle's* second voyage

Simon C. Davidson* and Peter Linstead-Smith**

The second voyage of the Beagle, 1831–36, commanded by Robert Fitzroy, besides being famous for carrying Charles Darwin, was on an important surveying mission which necessitated the use of a large number of chronometers. Only a few of these are currently known to exist. Following extensive research, the authors can now reveal that Chronometer P is in fact W. E. Frodsham No.1 and this article shows its history between 1823 and the present day. It has been established that Fitzroy changed mid-voyage the alphabet sequence of some of his chronometers, something he had not revealed in his published works. This explains some anomalies that previously could not be reconciled.



Fig. 1. *HMS Beagle* in the Straits of Magellan, with Mount Sarmiento in the distance. Frontispiece from C. Darwin, *Journal of researches into the natural history and geology of the countries visited during the voyage round the world of HMS Beagle under the command of Captain Fitz Roy, RN, 1890.*

*Simon C. Davidson (simoncathlyn@hotmail.com) has had an interest in horology since he was seventeen with his first purchase of a Barwise pocket watch. He joined the AHS in June 1966 on completion of post graduate studies. For the last twenty years his interest has been specifically in box chronometers which have a history of use or ownership and also in turret clocks.

**Peter Linstead-Smith OBE (pls@rmg.co.uk) has had a lifelong interest in physics and astronomy, including horology. His interest in navigation arose following university and a career in the Royal Navy. Joined the AHS in 1992 and on leaving the navy went to West Dean College for the Conservation of Clocks Diploma in 1998. He has been a Volunteer since 2002 at the Royal Observatory Greenwich.



Fig. 2. Dial of W. E. Frodsham No.1.

It is well documented that Captain Robert Fitzroy had twenty-two chronometers, both boxed and pocket ones, aboard *HMS Beagle* (Fig. 1) on its second voyage to South America and the Pacific.¹ The Hydrographer to the Admiralty, Francis Beaufort, had given him the objectives of surveying the coasts and harbours of South America from Brazil to Peru and in addition to take meridian distances of longitude on his voyage around the globe. It was important to establish firm co-ordinates for major ports around the globe, which surprisingly were still imprecise in 1831.

He gave the twenty-two chronometers he had aboard letters, and identifies these in his

narrative published on his return (see appendix 2). It is interesting to note that in November 1831, seven weeks before departure, both Captain Fitzroy and the Hydrographer Captain Francis Beaufort were thinking that eighteen chronometers would be sufficient for the task.² Clearly either Fitzroy had second thoughts or, more likely, he was offered the loan of four extra chronometers from makers seeking publicity from the voyage.

The chronometers known to exist to date out of the twenty-two are:

- F - Arnold & Dent No.661 box 2 day, loaned by Arnold & Dent, now in private ownership.³

1. *HMS Beagle* was provided with twenty-two chronometers, kept in a special room low down in the ship sitting on saw-dust on wide partitioned shelves. They were looked after by Fitzroy's assistant George Stebbing. See R. Fitzroy, *Narrative of the Surveying Voyages of His Majesty's Ships Adventure and Beagle between the years 1825 and 1836*, Vol. II and Vol. IV the Appendix to Vol. II, 1839, *Chronometrical Observations*, Appendix No. 55, pp. 318–52.

2. UK Hydrographic Office, Taunton, Somerset [UKHO]: Letter Book No. 3 1830–32, Letter of Francis Beaufort to Fitzroy 11 November 1831, pp. 278–9

3. H. Staeger, *100 Years of Precision Timekeepers from John Arnold to Arnold & Frodsham 1763–1862* (1997), p. 495.



Fig. 3. Movement of W. E. Frodsham No.1.

- M - William E. Frodsham No.2 box 1 day, Government owned, now in private ownership.⁴
- N - Molyneux No.1175 box 2 day, owned by Fitzroy, now in private ownership.⁵
- O - Earnshaw No.705 box 1 day, Government owned, now in the Science Museum.
- V - Pennington No.426 pocket, owned by Lord Ashburnham, now in the British Museum.
- X - Earnshaw No.509 box 1 day, Government owned, now in the British Museum.

A seventh extant chronometer has now surfaced. This is chronometer P made by William Edward Frodsham No.1, a one day boxed chronometer (Figs 2 and 3). It was recently identified and acquired in the USA by the first named author.⁶ It had been in the ownership of the vendor's father for fifty years and kept in an attic. Here follows a description.

- Box: A three tier mahogany box of characteristic form, with brass carrying handles, key escutcheon and release button for the upper cover, the middle tier with a vacant circular brass inset to the front, probably inserted to replace an ivory disc perhaps damaged. The top of the lid has never had an inset.
- Dial: A 3 inch silvered Roman dial signed *Willm. Ed. Frodsham, Elève of Parkinson & Frodsham, Change Alley, London* with blued steel hands.
- Movement: Signed *Willm. E. Frodsham, Change Alley, London*. Unusually it is a quick train chronometer with 130 beats per minute instead of the much more common 120. It has an Earnshaw spring detent escapement, maintaining power, cut compensation balance with segmental weights and mean time adjusting screws and supported by a diamond endstone.

4. Bonhams, Bond Street, London, 9 July 2014, Lot 120.

5. Bonhams, Bond Street, London, 10 December 2014, Lot 26.

6. Skinners, Marlborough, USA 31 October 2015 Lot 209, also see advert in *AH* Sept 2015.

The helical spring has terminal curves at both ends. The movement plates are united by four pillars secured by blued screws. The movement has a bayonet fitted dust bowl and is provided with a measure of shock protection by means of three steel springs secured to a ledge machined on the interior of the bowl. The springs bear on the underside of the dial and the complete movement fits into the brass bowl, guided by three posts that pass through the brass edge and dial. Convex glass screw on bezel. The exterior bowl has a spring clip of P & F design for locking the bowl.

William Edward Frodsham

The history of this chronometer starts with William Edward Frodsham, the second son of William James Frodsham senior, one of the partners in the well-established firm of Parkinson & Frodsham (hereafter P & F) operating 1801–1947. William Edward was born in 1804 and apprenticed to his father on the same day as his elder brother Henry on 13 January 1823.⁷ William Edward was nineteen, his elder brother was twenty-one, slightly old to start an apprenticeship which would normally start at fourteen. This may indicate that the brothers were already working for their father and that the registering of the apprenticeship was a formality. Both brothers produced marine chronometers under their own name in 1823 at the beginning of their registered apprenticeships. On the dial of William Edward's under his name we read *Elève* (which would properly be spelled *Elève*) of Parkinson & Frodsham, meaning 'pupil of'.

At this time P & F had a policy of lending their chronometers to survey expeditions as a means of making known their excellences, and they published the details of their loans.⁸ William Edward must have started making his No.1 well ahead of the start of his apprenticeship

as it was lent to an expedition only four months after it had started (see below) and he would have needed time to rate his chronometer. He was clearly a very talented young man to be able to produce a marine chronometer at such a relatively young age. Tragically, William Edward died by drowning while bathing on 27 July 1825.

History of W. E. Frodsham No.1

W. E. Frodsham No.1 was supplied in 1823, with three others from P & F, to Captain Sabine, Royal Artillery, FRS, an astronomer conducting pendulum experiments in high latitudes approved by the Admiralty and the Board of Longitude. The ship *HMS Griper* sailed on 11 May 1823, under the command of Captain Clavering, to Spitsbergen and Greenland. *Griper* returned to London in December the same year.⁹ P & F reported that

Parkinson & Frodsham's three Chronometers accompanied this expedition, together with a Chronometer No.1, made by W. E. Frodsham, one of the junior branches of their house, which performed equally well with the others.¹⁰

In 1824, Captain Lyon, in command of *HMS Griper*, was lent W. E. Frodsham No.1, along with another P & F chronometer. The goal of his voyage was to discover a north-west passage starting in Repulse Bay, Canada and he was accompanied by Lieutenant Kendall, as assistant surveyor in charge of the chronometers.¹¹ Their performances are shown by this extract of the letter 4 January 1825 of Captain Lyon to P & F:

I have much pleasure in acquainting you of the admirable performance of your two Chronometers. A carefully registered table of their rates has been kept, with which I have requested Lieutenant Kendall to furnish you. ... I have to request you to

7. V. Mercer, *The Frodshams, The Story of a Family of Chronometer Makers* (1981), p. 52.

8. Parkinson & Frodsham, *A Brief Account of the Chronometer with remarks on those furnished by Parkinson and Frodsham to the Expeditions of Captains Ross, Parry, Sabine, King, Lyon, Foster and other Distinguished Navigators* (London, c.1832).

9. National Archives, Kew (hereafter NAK): Captain's Log ADM 51 / 3188.

10. Parkinson & Frodsham, *A Brief Account*, p. 5 and see Appendix III p. 14.

11. NAK: Captain's Log ADM 51 / 3188.

accept my best thanks for you having lent me two such valuable Chronometers, as those brought to me by Mr FRODSHAM, Jun.¹²

It is quite likely that of the two brothers it was William Edward who brought his chronometer No.1 and the other P & F chronometer to Captain Lyon aboard *HMS Griper* before they sailed, and that he heard the results of this trial before his unfortunate death on 27 July 1825.

The next record of W. E. Frodsham No.1 is when it was submitted for trial together with his No 2, after William Edward's death, for the Greenwich Trial starting in August 1828. It was probably entered by his proud father, Frodsham senior.

The next appearance of this chronometer in the records is in September 1829 when the Astronomer Royal, John Pond, turned down a request by Frodsham senior to have his son's two chronometers again entered in the Annual Trial for that year.¹³ A year later Pond, in a letter to 'their Lordships at the Admiralty', justified his refusal.¹⁴ We must assume that Frodsham senior, who had the attention of the Lords of the Admiralty owing to all the P & F loans without charge of marine chronometers to the many Arctic expeditions in the 1820s, had petitioned them as to what he saw was an injustice. Even Pond in his letter to the Admiralty admitted that Frodsham senior was only trying to obtain posthumous fame for his son.

Interestingly, Pond offered a compromise, namely to enter the two chronometers in a private trial, and their lordships could still consider their rates as though in a public trial. Private trials of chronometers were often carried out for foreign governments and were generally of three months duration. No record of this private trial is known, but it must have ended with favourable results, as on 23 January 1831, presumably at the end of the private trial, the Hydrographer Francis Beaufort wrote to the Astronomer Royal:

I am commanded by the Lords Commissioners of the Admiralty to inform you that they have directed W. E. Frodsham's Chronometers No.1 and 2, to be purchased for Government and delivered into your charge.¹⁵

On 30 March 1831 the Admiralty wrote to inform the Astronomer Royal that they had sent him funds to purchase W. E. Frodsham No.1 and 2 from Frodsham senior for £70 and £100 respectively.¹⁶

The chronometer ledgers at the Royal Observatory show that No.1 and No. 2 were both purchased in March 1831, and that No. 1 was sent to Captain Fitzroy at Devonport on 13 August 1831,¹⁷ and No. 2 was sent to Captain Fitzroy on 6 December 1831.¹⁸ The Ledger clerk at the Observatory was clearly confused about the two younger Frodshams and originally recorded the entries in both

12. Parkinson & Frodsham, *A Brief Account*, Appendix V p. 17. Cf. the following extract from Lieutenant Kendall's letter to P & F of 14 January 1825, also published on p. 17: *'I herewith inclose a table, drawn up by myself, of the daily comparisons, differences, and second differences of your Chronometers embarked on board HMS Griper in her voyage to Repulse Bay.....their performance was excellent. No chronometers, I believe, could have been exposed to a severer trial, except as relates to change of temperature. I cannot bring a stronger testimony in support of the equability with which their rates were maintained, than the fact of our having made the land with such surprising accuracy after so long an interval, during which it was not practicable to obtain observations to enable us to form a judgement of their going, and we therefore relied on the rates furnished by you on sending the Chronometers on board.'*

13. CUL, RGO 5/233 item 51: Letter of Pond, Astronomer Royal to Mr Frodsham 17 September 1829.

14. CUL, RGO 5/233 item 53: Letter of Pond, Astronomer Royal to the Admiralty 15 September 1830.

15. Royal Observatory Greenwich [ROG]: ARR 1135 / 4

16. ROG: ARR 1135 / 16

17. ROG: LP 281, which also records that it was left with the Peruvian Government when the *Beagle* was out on that coast; see Capt. Beeker's letter to the Astronomer Royal quoted below in n. 23.

18. ROG: LP 282, chronometer ledger has H. Frodsham No.2 with the H crossed out and written below "*alias W E Frodsham (on this Chron the name engraved to W E Frodsham)*".

at the UK Hydrographic Office, we were able to confirm the date and time. Chronometer P was sent to Lima at 4 pm on 28 August 1835.²⁴ (see Fig. 4).

In his *Narrative*, Captain Fitzroy mentions that, whilst at Callao in Peru in August 1835, the Hydrographer at Lima, Don Eduardo Carrasco, provided many copies of maps of the coast of Peru which were of invaluable assistance to *Beagle's* survey.²⁵ One can be almost certain that it was to Don Carrasco, Hydrographer to the Peruvian Navy, that W. E. Frodsham No. 1 was donated.

In the Appendix to his *Narrative*, Fitzroy gives results for the eleven stages on his outward journey and the survey of South America. Chronometer P was used on nine of the eleven stages on the outward journey before it left the ship in Peru. The two stages when it was not used it was on the tender *Adventure*.²⁶ There were twenty stages on the return journey from Peru.

It was not uncommon for up to six chronometers to be placed aboard either *Beagle's* whaler or yawl for periods up to three weeks while these boats were carrying out inshore surveying. When Fitzroy purchased two small schooners on the east coast of Argentina in October 1832, he assigned five chronometers to them for several months.²⁷ So although the *Beagle* carried twenty-two chronometers, on many occasions up to six could be off the ship and not being used for navigation and determining meridian distances.

The *Beagle's* Daily Chronometer Rates Book reveals that it was possible to have a chronometer cleaned in South America in the 1830s. In May 1833, when the ship was at Montevideo, Captain Fitzroy sent ashore Chronometers B, O and P to a Mr Bennett to be cleaned. They were returned on 6 July the same year whilst the ship was again off

Montevideo.²⁸ While at Valparaiso, chronometers H and K were sent ashore for four days each for attention by a Mr Croft.²⁹

W. E. Frodsham No. 1 has a Parkinson & Frodsham label inside the box lid (Fig. 5). The last date is that printed beside the address at the bottom, 1833. This is two years after the *Beagle* had set out on its second voyage, and seems to indicate that at some point after it was given to the Peruvian Government in 1835 it was returned to England for servicing by Parkinson & Frodsham, when this label would have been pasted in the lid. Little is known about the dating of this firm's printed labels, as few survive, nor for how long any one edition was used. However one can assume this could well have been used up to 1890 when they changed address from 4 Change Alley, Royal Exchange to 16 Queen Victoria Street. It is of course also possible that someone has taken a P & F label from another chronometer box and pasted it into this one.

What is known is that this chronometer was purchased by the previous owner in England in the 1960s. So we have an intriguing gap in its history from 1835 to circa 1960. More information may lie in the records, if they survive, in the Peruvian Hydrographic Office in Lima.

Captain Fitzroy changed his alphabet sequence for his chronometers

On examining the Chronometer Comparison Book closely, another entry of great significance was found. Captain Fitzroy and his chronometer attendant George Stebbing, who maintained and rated the chronometers, changed the designation of Chronometer M to Chronometer B on 1 July 1835 (Fig. 6).

It is known from records at the Royal Observatory that Gardner No. 24 (Chronometer B) was supposedly given by Captain Fitzroy to the Chilean Government

24. UKHO: OD 807 Chronometer Daily Comparison Book, 3 June 1834 to 6 November 1836, refer entry for 28 August 1835.

25. Fitzroy, *Narrative*, Vol. II, p. 484.

26. UKHO: OD 807, refer 5 July to 5 September 1834 Chronometers E K N P V Y on *Adventure*.

27. Fitzroy, *Narrative*, Vol. II, p. 295.

28. UKHO: OD 821, Daily Chronometer Rates Book 1 December 1831 to 6 November 1836, entries in May & July 1833.

29. UKHO: OD 807 entries for Chronometer H 22 & 27 June and for Chronometer K 16 & 22 June 1835.

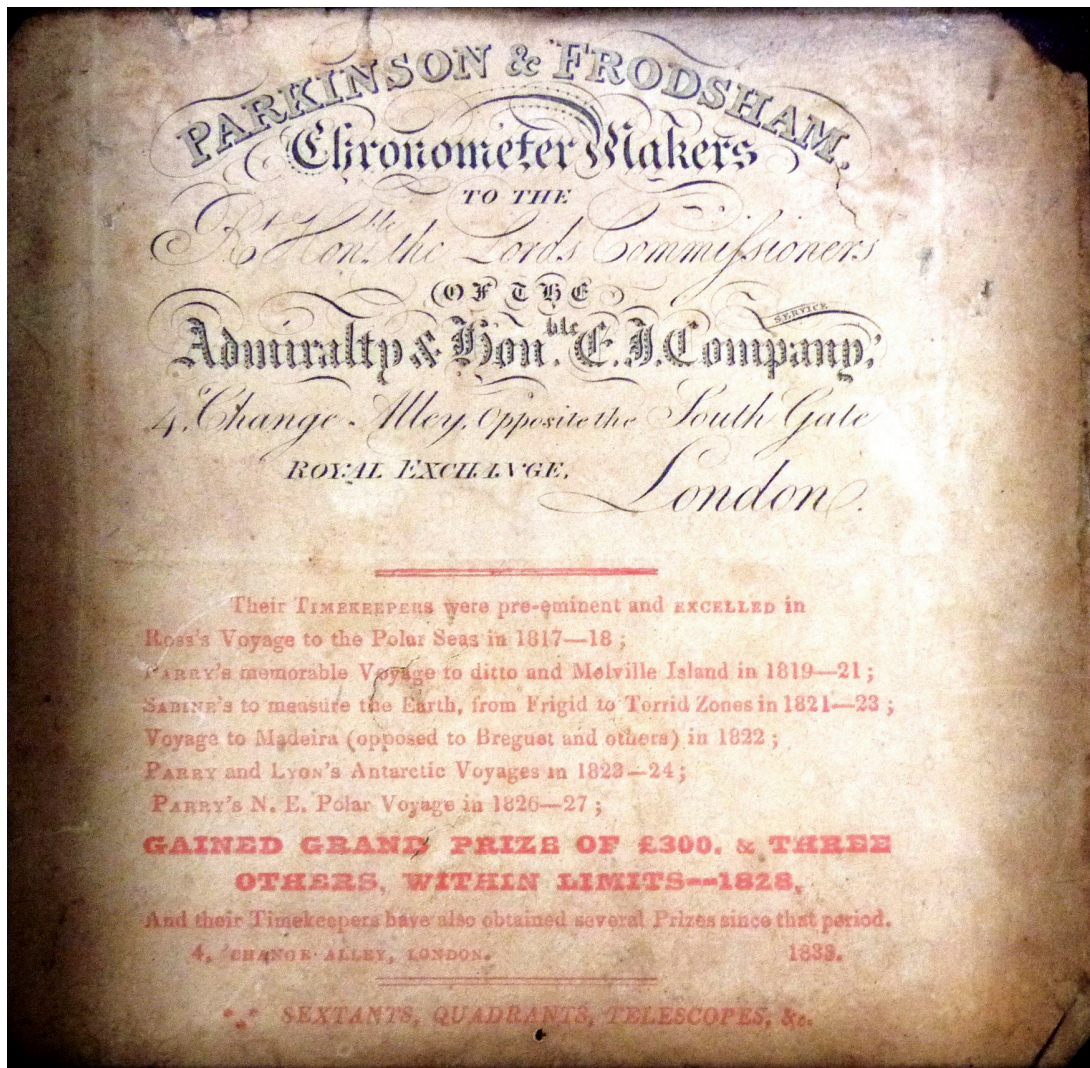


Fig. 5. Label inside the box lid of W. E. Frodsham No.1. The most recent year mentioned is 1833, two years after the *Beagle* had set out.

for the purposes of science.³⁰ The date of the gift to the Chilean Government can be derived from examining the Chronometer Comparison book, as the rating of Chronometer B ceases at Valdivia Harbour, Chile on 21 February 1835 and it had not been assigned to one of the *Beagle's* boats.³¹ Rating entries for Chronometer B only resume on 1 July 1835

when Chronometer M has its designation changed to B as above.³² Therefore one can assume that just after 21 February 1835, Gardner No. 24 or Chronometer B was given to the Chileans.

This also solves another conundrum which has existed ever since the *Beagle's* second voyage, namely why Chronometer M

30. Royal Observatory Greenwich [ROG]: Gardner No. 24; Hydrographer's letter 1 December 1875. LP 272, Taken off the books 26 June 1886, and UKHO: Incoming Letters Prior 1857, F 173, Fitzroy to Beaufort circa 24 November 1836.

31. UKHO: OD 807 no entry for this chronometer being assigned to a boat in February 1835.

32. UKHO: OD 807 refer entry for 30 June & 1 July 1835.

COMPARISONS.
1835

Date <i>30th June Tuesday at Sea</i>		Av. Temp. <i>62</i>	
Standards { <i>A 8-23</i> <i>74-30.17.0</i>		Difference Z + of A <i>8-15.17.0</i>	
A	<i>8-30</i>	Z	<i>4-55</i>
B	"	N	"
C	<i>12-30.31.5</i>	O	<i>1-55.59.9</i>
D	<i>2-32.58.7</i>	P	<i>7-13.43.2</i>
E	<i>6-20.32.7</i>	Q	"
F	<i>3-37.46.8</i>	R	<i>6-40.39.6</i>
G	<i>4-28.38.9</i>	S	<i>5-19.28.0</i>
H	<i>4-46.14.7</i>	T	<i>00-24.29.0</i>
I	"	V	"
K	<i>4-47.02.6</i>	W	<i>6-22.29.9</i>
L	<i>2-57.24.6</i>	X	<i>4-45.19.8</i>
M*	<i>4-18.06.9</i>	Y	"
Standards { <i>A 8-46.43.2</i> <i>75-02.00.0</i>		Difference Z + of A <i>8-15.16.0 -13.9</i>	
Date <i>1st July</i>		Av. Temp. <i>62 1/2</i>	
Standards { <i>A 8-20</i> <i>74-35.03.11</i>		Difference Z + of A <i>8-15.03.1</i>	
A	<i>8-25</i>	Z	<i>4-50</i>
B*	<i>4-12.48.2</i>	N	"
C	<i>12-33.24.3</i>	O	<i>1-57.08.3</i>
D	<i>2-27.41.0</i>	P	<i>7-08.53.0</i>
E	<i>6-15.25.2</i>	Q	<i>02-18.55.0</i>
F	<i>3-32.33.6</i>	R	<i>6-43.48.2</i>
G	<i>4-23.29.0</i>	S	<i>5-14.32.8</i>
H	<i>4-41.06.6</i>	T	<i>00-24.32.8</i>
I	"	V	"
K	<i>4-41.57.0</i>	W	<i>6-17.34.5</i>
L	<i>2-52.12.3</i>	X	<i>4-40.21.9</i>
M*	"	Y	"
Standards { <i>A 8-41.57.11</i> <i>74-57.00.0</i>		Difference Z + of A <i>8-15.02.9 -13.9</i>	
Date <i>2nd July at Sea</i>		Av. Temp. <i>61 1/2</i>	
Standards { <i>A 8-20</i> <i>74-34.49.2</i>		Difference Z + of A <i>8-14.49.2</i>	
A	<i>8-25</i>	Z	<i>4-50</i>
B	<i>4-12.29.8</i>	N	"
C	<i>12-33.17.1</i>	O	<i>1-51.17.1</i>
D	<i>2-27.23.2</i>	P	<i>7-09.06.7</i>
E	<i>6-15.17.5</i>	Q	<i>02-19.06.7</i>
F	<i>3-32.20.1</i>	R	<i>6-43.56.7</i>
G	<i>4-23.18.9</i>	S	<i>5-14.37.6</i>
H	<i>4-40.59.4</i>	T	<i>00-24.37.6</i>
I	"	V	"
K	<i>4-41.51.2</i>	W	<i>6-17.39.0</i>
L	<i>2-51.56.9</i>	X	<i>4-40.23.8</i>
M	"	Y	"
Standards { <i>A 8-37.11.10</i> <i>74-32.00.0</i>		Difference Z + of A <i>8-14.49.0 -13.9</i>	

7. 11. 48. 00. 0
8. 02. 50. 00. 0
9. 00. 00. 00. 0
10. 00. 00. 00. 0
11. 00. 00. 00. 0
12. 00. 00. 00. 0

Fig. 6. Entry for 1 July 1835 from daily Chronometer Comparisons on the left hand side: '* Changed M to B', with asterisks beside B on 1 July and beside M on 30 June and 1 July. Courtesy of UK Hydrographic Office

(Frodsham No. 2) disappears from the chronometer results reported by Fitzroy in his Narrative record in the last six months of 1835. It has been always assumed that it was placed aboard the Schooner *Constitucion* under the Master's Assistant Alexander Osborne to continue the survey of the coast of Peru when the *Beagle* sailed west across the Pacific. In fact the Chronometer Comparison Book clearly states in an entry for the 25 August 1835 that only Chronometers E F T and Y were placed aboard the schooner.

Conclusions

The *Beagle's* Chronometer Daily Comparisons Book and the Daily Chronometer Rates Book, lodged at the Hydrographic Office, have helped to confirm the hitherto obscure history of W. E. Frodsham No.1 Chronometer P. They have also revealed that Fitzroy reassigned his alphabet sequence for two chronometers in July 1835, which has solved a mystery surrounding the original Chronometer M.

Of the twenty-two chronometers that were on board the *Beagle* when it set out in 1831, twenty returned to England in 1836. The *Beagle* returned sixteen chronometers,³³ while Mr Osborne, Master's Assistant,

separately returned in 1836 after his survey of Peru by schooner with the other four.³⁴ The remaining two were donated to the Chilean and Peruvian governments in 1835.³⁵

Our findings have brought the number of chronometers with known whereabouts from six to seven. The remaining fifteen are listed in appendix 1. We know from the chronometer records at the Royal Observatory that three chronometers have been destroyed or lost at sea. One can only speculate how many of the remaining twelve may yet surface (See Appendix 1).

Acknowledgements

We would like to thank Ian Killick of the UKHO Archive at Taunton, Somerset for access to the *Beagle's* Chronometer Daily Comparisons Book 3 June 1834 to 6 November 1836 & Daily Chronometer Rates Book 1 December 1831 to 6 November 1836. The illustration of *HMS Beagle* was kindly supplied by Sergio Zagier. We would also like to thank Simon Keynes for directing us to an important reference concerning chronometer P in the RGO Archive at Cambridge University Library and Terence Camerer Cuss for access to the Usher & Cole day books.

33. A, B (now reassigned as W. E. Frodsham No.2), C, D, G, H, K, L, N, O, R, S, V, W, X, Z.

34. E, F, T, Y.

35. In February 1835 Gardner No.24, the original chronometer B, this alphabet letter reassigned on 1 July 1835 to the previous chronometer M – W. E. Frodsham No.2; on 28 August 1835 chronometer P – W. E. Frodsham No.1..

Appendix 1: Whereabouts of the chronometers that set out on the *Beagle's* second voyage

Chronometers identified as extant: F, M, N, O, P, V, X - see p. [2 and 3].

Chronometers yet to be identified as extant

- A - Molyneux No.1415 box 8 day, sold to Mr J E Morris 19 April 1929 (ROG: LP 3219)
- B - until February 1835 was Gardner No.24 box 1 day, left with Chilean government February 1835 (see note 29)
- C - Molyneux No.1081 box 1 day, sold to Messrs Turnbull 2 July 1920 (ROG: LP 1691)
- D - Murray No.542 box 8 day, returned to maker, no record after 1836.
- G - Arnold & Dent No.633 box 1 day, exchanged with Usher & Cole 2 October 1905 (ROG: LP 1654)
- H - Arnold & Dent No.261 pocket, no record after 1836.
- K - Parkinson & Frodsham No.1042 pocket, exchanged with E Dent & Co. 27 August 1906 (ROG: LP 2232)
- L - Arnold No.634 box 2 day, purchased from Fitzroy after voyage, exchanged with Usher & Cole, who in 1913 sold it to Matthews; has Arnold & Dent on the dial (Usher & Cole Notebook & ROG: LP 2014)
- S - Arnold No. 465 box 1 day, assessed not reparable part exchanged with Dent 1854 (ROG: LP 48)
- T - Molyneux No.1326 pocket, exchanged with E. Dent & Co. 27 August 1906 (ROG: LP 1532)
- W - Molyneux No.971 box 2 day, transferred to Mr Nowell 27 February 1929 (ROG: LP 3455)

- Y - Morrice No.6144 pocket, exchanged with Usher & Cole 11 April 1913 (ROG: LP 3358)

Chronometers known to have been destroyed

- E - Eiffe No. E box 1 day, destroyed 23 September 1892 (ROG: LP 1300 written off books not worth repair and destroyed 23. 9.1892).
- R - Murray No.584 box 1 day, purchased from Murray after voyage, wrecked in China aboard *HMS Racehorse* 1865 (ROG: LP 401 chronometer considered condemned 25. 8.1865)
- Z - French No. 4214 box 8 day, lost at sea in *HMS Erebus* 1845 (ROG: LP 198)

Appendix 2: Appraisals of the chronometers that set out on the Beagle's second voyage

In his *Narrative of the Surveying Voyages of His Majesty's Ships Adventure and Beagle between the years 1825 and 1836*, Captain Robert Fitzroy made brief remarks on each of the twenty-two chronometers that had been aboard. After an extensive review of Fitzroy's published data, Prof. A. Auwers, in 'Some Remarks on the Chain Meridian Distance measured around the Earth by HMS Beagle between the years 1831 and 1836', *Royal Astronomical Society Monthly Notices* Vol. XLIV No.6, pp. 303–46, gave relative weighting (see last column) to each chronometer, differing materially in some instances. His method is perhaps more methodical and rational than that of Fitzroy. Auwers reassessed the relative accuracy of Fitzroy's remarks as he thought they were not borne out by the results published in the tables in Fitzroy's Appendix No. 55. We must point out that Auwers did not have access to the two books in the UK Hydrographic Office, which reassigned the alphabet letters for two chronometer in 1835 referred to in notes 24 and 28.

Chronometer	Maker	No.	Owner	Type	Wind	Remarks	Weighting
A	Molyneux	1415	Fitzroy	box	8	Good	4
B	Gardner	24	Government	box	1	Bad	¼
C	Molyneux	1081	Molyneux	box	1	Rather Good	2
D	Murray	542	Murray	box	8	Rather Good	1
E	Eiffe	E	Government	box	1	Rather Good	½
F	Arnold & Dent	661	Arnold & Dent	box	2	Rather Good	½
G	Arnold & Dent	633	Fitzroy	box	1	Rather Good	1
H	Arnold & Dent	261	Fitzroy	pocket	1	Rather Good	½
K	Parkinson & Frodsham	1042	Government	pocket	1	Good	¼
L	Arnold	634	Fitzroy	box	2	Rather Good	¾
M	Frodsham	2	Government	box	1	Rather Good	½
N	Molyneux	1175	Fitzroy	box	2	Rather Good	1½
O	Earnshaw	705	Government	box	1	Rather Good	3
P	Frodsham	1	Government	box	1	Bad	1
R	Murray	584	Murray	box	1	Very Good	3
S	Arnold	465	Government	box	1	Rather Good	2
T	Molyneux	1326	Fitzroy	pocket	1	Indifferent	0
V	Pennington	426	Lord Ashburnham	pocket	1	Rather Good	½
W	Molyneux	971	Government	box	2	Good	1½
X	Earnshaw	509	Government	box	1	Rather Good	½
Y	Morrice	6144	Government	pocket	1	Rather Good	⅛
Z	French	4214	Government	box	8	Good	4