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almost anything) that used expertise and machinery developed during the second world war for military applications. The many illustrations will be helpful to enthusiasts who can still buy these clocks quite cheaply to build up collections. Despite the 'rise and fall' of synchronous clocks, they are not dead yet, and it is hoped that a second edition can contain even more photographs and stray into the modern battery powered quartz synchronous clocks. In summary, a very useful book for the collector, although the price may put it out of the range of the very collectors it is aimed at.

Doug Bateman

JÜRGEN ERMERT, *Praezisionspendeluhren in Deutschland von 1730–1940 – Observatorien, Astronomen, Zeitdienststellen und ihre Uhren, Band 1 – Astronomische Pendeluhren in Deutschland von 1730–1840* [Precision Pendulum Clocks in Germany 1730–1940 – Observatories, Astronomers, Timeservices/Timestandards and their Clocks, Vol. 1]. Published by the author [JE Verlag], March 2015. No ISBN number stated. Hardcover, 608 pages, 21x31 cm. Price Euro 202 excl. p/p. Additional information and previews are found on the author's website www.ppu-buch.de. Sold exclusively directly by the author, e-mail: Juergen.Ermert@PPU-Buch.de. [Note: The first volume published – Vol. 3 of 4 – was reviewed in *Antiquarian Horology* in March 2014].

When the first in this four-volume epic series documenting the history of the precision pendulum clock in Germanic Europe, labelled Vol. 3, was released in early 2014 there was serious concern if this encyclopedic venture would ever be completed. But the chances of it happening have recently shot up, as the author has not only released the second volume, but orders have been so brisk that the newly available part may soon be out of print.

The volume under review focuses on observatory-grade regulators in Germanic Europe made between 1730 and 1840, but also includes sections on their precursors, like Otto von Guericke (Magdeburg, c. 1660), and on the first examples in the UK by Graham, Mudge and Dutton (who inspired the Germans), and the pioneering role of the Leyden Observatory (van der Cloese, Willem

Snellen, van Ceulen, Knebel van Spanje and Hohwü (65 pages).

A significant section (45 pp.) deals with instruments at the observatories in Vienna and Prague. The early section (pre-1770) includes discussion on the Germanic copies of Graham and Shelton clocks, as well as the clock built in Vienna by Vötter around 1740, and a very unusual 1744 clock in Saxonia by Johann Gottfried Zimmer.

The second half moves on to the early nineteenth century and includes not only a comprehensive list (15 pp.) of timekeepers in service in German observatories between 1730 and 1840, but also a 50 page section on John Arnold's influence, and shorter chapters devoted to timekeepers procured into Germanic Europe from the UK workshops of Vuillamy and Molyneux. The next chapters are devoted to oddities of this era, such as clocks by makers from Freiburg and Eichstätt, a year running clock by Johann Michael Dermer (Ochsenhausen, c.1775), the precision clocks built by Kinzig in Neuwied starting 1778 and by Peter Bofenschen in Hanover since 1784.

Coverage of the mainstream and most prominent German precision clock makers of the 1800 to 1840 era will be covered in Vol. 2, the next book due, which should be available about a year from now. The second half of the nineteenth century, with a focus on clocks from Glashütte, was covered by Vol. 3.

The amount of detail documented on each clock is unprecedented. This volume closes with 120 pages of indices (names, locations, subjects), 840 endnotes and source data for the 1380 images (which are mostly large and in colour).

Jürgen Ermert does his own layout, most pictures are his own, he promotes the books himself and schlepps his book orders to the post office. This is truly a labour of love of near fanatical proportions for which aficionados of precision pendulum clocks owe him deep gratitude. This reviewer is convinced that the books will become sought after classics, as nobody in the future will approach the subject with as much determination and attention to details as Ermert. Vol. 1 may be of particular interest to British collectors as it contains many British made (and some 'British inspired') precision pendulum clocks virtually unknown in their country of origin.

Work on the next book of the series (Vol. 2, covering roughly the first half of the nineteenth century) has recently started, and it is expected to be available summer of 2016.

Fortunat Mueller-Maerki

RAY ESSEN, *The Birth of Atomic Time*, Fast-Print Publishing, 2015, 202 pp. 60 ills (12 in colour). £15.99, ISBN 978-178456-167-3

Atomic clocks will never be of conventional antiquarian interest but they are fundamental to the modern history of timekeeping because of the radical changes they brought about. It is sixty years since Louis Essen built the first atomic clock and an appropriate time to review that history. This book by his son-in-law Ray Essen, with the active support of the National Physical Laboratory where Louis Essen spent all his working life, brings to light previously unseen material from family and former associates.

The core of the book is the memoir Louis Essen wrote for his family, extracts of which were used by Ray Essen in articles in *Antiquarian Horology* in March 2010 and June 2013. Only a small part of the memoir is directly about the atomic clock and atomic time but sections on quartz clocks and measuring the speed of light describe earlier important work related to time measurement. Other sections describe his early life, and also his persistent criticism of the theory of relativity which did not enhance his reputation. Short explanatory notes by Ray Essen after each section mostly add little to the memoir.

Subsequent chapters describe the process that led to atomic time. Quartz clocks, in particular Essen's quartz ring design, proved so superior to pendulum clocks that they rapidly became the de-facto standards. They also showed up the irregularities in astronomical time at the increasingly high precision required for electronic communications, and it was this that led Essen and others to propose an atomic clock. Other work had priority at NPL but the clock was completed in 1955, well in advance of similar work in the USA, and was used almost immediately to set the NPL's quartz clocks. There followed a close collaboration with the Time Service at the United States Naval Observatory to set atomic time as close

as possible to astronomical time, and high-level negotiation before the atomic second finally replaced the astronomical second as the basis of all time measurement in 1967.

The strengths of this book are Louis Essen's memoir and Ray Essen's use of NPL records and information from contemporaries to record the process of building the atomic clock and getting it accepted. These practical aspects of history are all too often lost. Brief contributions from colleagues about life at NPL are fascinating but most add little to the main story. Some basic technical explanation is given as to why atomic time is needed and the consequences of adopting it, but that is done better elsewhere, for example in Tony Jones's *Splitting the Second* (IoP Publishing, 2000). The story is also tightly focussed on the first atomic clock and does not mention Essen's other atomic clocks, although they are included in the June 2013 article. The list of Essen's published papers is welcome, but the lack of an index will irritate some. More regrettable is the lack of references for the many quotations, as this limits the utility of an informative read that should also be a valuable source for historians.

Neil Brown

Forthcoming reviews

In the next issue we hope to publish reviews of the following books:

Richard Garnier and Jonathan Carter, *The Golden Age of English Horology. Masterpieces from the Tom Scott Collection* (2015)

Chris McKay, *Longitude's Legacy. James Harrison of Hull, 1792–1875. The last of the Harrison clockmakers* (2015)

J.M.R. Knudsen, *The Jürgensen Dynasty. Four centuries of watchmaking in two countries* (2013)

Rebekah Higgitt, ed., *Maskelyne: Astronomer Royal* (2014)

J. Bonnin, *La mesure du temps dans l'Antiquité* (2015)