

**NOTES ON THE MANAGEMENT
OF CHRONOMETERS AND
MEASUREMENT OF MERIDIAN
DISTANCES**

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Notes on the management of chronometers and measurement of meridian distances by Charles F. A. Shadwell

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ON THE

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MEASUREMENT OF MERIDIAN DISTANCES.

BY

CHARLES F. A. SHADWELL, Esq. C.B.

CAPTAIN, ROYAL NAVY.

New Edition, carefully revised.



LONDON:

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1861.



ADVERTISEMENT.

IN submitting to the notice of the naval profession a new edition of "Notes on the Management of Chronometers, and the Measurement of Meridian Distances," the Author has been desirous of rendering this work still more worthy of the favourable attention of students of nautical science.

The whole work has been carefully revised, and many small improvements introduced. The writings of recent French authors, Givry, De Cornulier, Lieussou, Mouchez, Vincendon Dumoulin, Coupvent Desbois, and Charles Ploix, have been carefully examined, and many valuable extracts from their works, taken chiefly from the pages of the "Recherches Chronométriques," a most useful publication, now in course of issue, under the auspices of the Minister of Marine at Paris, enrich the present volume both in the text and notes.

The important questions of the effects of change of temperature, and the influence of the acceleration, have been fully entered into. For this purpose a new chapter (chapter vi.) has been interpolated in this edition, in which the systems of De Cornulier, Lieussou, and Monchez have been amply discussed and commented on. The system proposed by Hartnup, of adopting a series of "tabulated rates," obtained by direct experiment, corresponding to the different degrees of the thermo-

metric scale, instead of a fixed daily rate, regardless of temperature, as usually employed, has also been introduced to the notice of the reader, and carefully examined.

The additional matter introduced by these changes, amounting to seventy pages of letterpress, has had the effect of altering the titles of the final chapters, chapters vii. viii. ix. and x. of this edition, respectively corresponding to chapters vi. vii. viii. and ix. of the original one. All the alterations in the work consist of additions; all the matter given formerly being still retained. Notwithstanding these changes, and consequent increase of expense in printing, the low price at which the book was originally offered to the public remains unchanged.

The Author trusts that the additions to his work, above alluded to, may prove useful to his professional brethren, and that in placing before British seamen the recent researches and analytical investigations of contemporary French writers, he may have rendered some essential service to the progressive improvement of nautical science.

Researches into the laws which regulate the changes caused by variations of temperature, and the influence of the acceleration, as a function of the time, seem to be the point towards which the improvement of chronometric science is at present tending; we trust that English navigators will take their share in contributing to the development of our knowledge on these important questions. With these hopes the Author submits his labours to the notice of the naval profession, and to the attention of students of chronometric science, trusting that they may be found worthy of their favourable consideration, and may be deemed a useful contribution to nautical knowledge.

Slough, March 1861.

PREFACE TO THE FIRST EDITION.

THE important services rendered by chronometers in the ordinary course of navigation at sea, by facilitating the daily determination of the ship's position in longitude, are well understood and fully appreciated by all intelligent seamen; but in addition to the useful ends to which, under ordinary circumstances, they are subservient in the daily conduct of the ship's affairs, they are susceptible, when placed in intelligent hands, of being applied to higher scientific uses, and when rightly employed, are capable of affording valuable contributions towards the gradual perfection of Maritime Geography.

The ordinary treatises on navigation, in use among seamen, contain ample rules and directions for the application of chronometers to the common purposes of determining the longitude at sea; but the information they afford relative to the accurate and systematic measurement of "chronometric differences of longitude," or "meridian distances," is for the most part of a very meagre and insufficient character.

The points involved in the discussion of meridian distances are not in themselves difficult or abstruse, and present but few impediments to those who are expert in computation and skilled in the ordinary processes of navigation; but at the

same time, in order to obtain from the use of chronometers all the precision of results of which they are susceptible, and in order to treat the measurement of meridian distances in a uniform, organised, and systematic manner, many minutiae must be attended to, and many points considered, on which the usual text-books are wholly silent, and on which the ordinary experience of the navigator throws but little light. It may thus happen that persons without much previous experience, who might be possessed of some good chronometers, and were desirous of employing them to the best advantage, would probably encounter many doubts and difficulties in the execution of their design, from the fragmentary, traditional, and irregular character of much of the knowledge at present existing on this subject.

Many scattered hints, and some valuable information relative to the application of chronometers to the accurate deduction of differences of longitude, exist in many detached works, but the subject seems to require condensation on some points, amplification on others, and systematic arrangement as a whole. The object of the Author in the following pages is to attempt to remedy this existing want, and to endeavour to supply naval officers, and others entrusted with the care of chronometers, with a manual of instruction how best to use them, and how to furnish systematic results in recording the meridian distances of the several places visited during their voyages.

With this end in view, the Author has freely considered, and availed himself of, several detached ideas on this subject, interspersed among various works by previous writers; among which may be enumerated,—

Forster's Voyage; Appendix by Tiarks.

Owen on Longitude.

Voyages of Adventure and Beagle; Appendix by Fitzroy.

Belcher on Nautical Surveying.

- Raper on Longitudes, "Nautical Magazine," 1839, &c.
 Raper's "Practice of Navigation."
 Nautical Magazine, various papers; Fisher, Bayfield, Bedford, &c.
 Memoirs Ast. Soc., Vols. III., XII., &c.
 Connaissance des Temps, Vols. 1835-6.
 Daussy sur la Marche des Chronomètres. Paris, 1840.
 Lieussou. Recherches sur les Variations de la Marche des Chronomètres, &c. Paris, 1854.
 &c. &c.

Blending the ideas derived from these various sources with the results of his own experience, the Author trusts that he has succeeded in producing a little work which, dealing with the questions relating to chronometers in a methodical and regular manner, may be found of some assistance to those who may hereafter be inclined to undertake the measurement of meridian distances.

In the execution of this design the Author has collected and arranged many detached precepts relative to the custody and management of chronometers, scattered at present among many books, or only existing in a traditional form. The questions of errors and rates, usually dismissed in books on navigation with a few brief remarks, next engage attention, and are discussed with an amplification of detail more commensurate, it is hoped, with their presumed importance. A method of combining observations for rate by the "*method of least squares*" is then explained, and it is hoped that, where extreme precision is sought for, the plan developed may be found useful in practice. A systematic arrangement of the formulæ for meridian distances is then undertaken, in which the method of correcting for the variation of the rate, proposed by Tiarks, and followed by Fitzroy, Bayfield, and other eminent navigators, has been amply developed and pursued to its legitimate consequences.