If the latitude is south, the T.B. can be derived in a similar way; thus, for heavenly body 'east',

$$\text{T.B.} = 180° - \text{A}$$

and, for 'west',

$$\text{T.B.} = 180° + \text{A}$$

7. *Schütte's Example* (p. 312). It is found, with the values of ϕ and w, the latter obtained from the charts, that $\phi + w < 90°$; hence, by 2 (II) of para. 6, the example belongs to Case II—as can also be seen easily from a figure. Then

$$\text{A} = 90° - a = 64°26'$$

so that

$$\text{T.B.} = 064°26'$$

Now, Azimuth is a term necessarily related to the celestial horizon as reference-plane and to some point on it as reference-point. According to Schütte's figure this reference-point is S, in which event the true bearing should be $180° - 64°26'$, which is wrong.

If, on the other hand, Schütte defines Azimuth as the angle RZX in the triangle RZX then his value of Az. is $64°26'$ and the true bearing is $064°26'$. But this definition depends on a particular construction (involving R) and it has no *general* significance in the ordinary problem associated with the fundamental spherical triangle PZX; such a definition inevitably leads to confusion.

The moral seems to be that there should be a consistent definition of the term Azimuth and this is achieved by defining it—as most textbooks do—as the angle PZX in the spherical triangle PZX; after all, this angle is *directly* connected with the usual formulae for a spherical triangle, and from it the corresponding true bearing can be very easily deduced.

REFERENCES

1 Schütte, K. (1955). *S*-diagrams for solving problems in astronomical navigation. This *Journal*, **8**, 310.

The English and the Dutchman's Log

from E. G. R. Taylor

IN his detailed and valuable account of the history of the Log (this *Journal*, **9**, 70) Commander Waters is surely at fault as regards the part he ascribes to the Gresham Professor, Gunter. This eminent mathematician delighted in designing instruments with engraved scales, and at first issued the customary *Description and Use* in Latin, a sufficient indication that he wrote only for fellow scholars. Importuned probably by the instrument-makers, he later published English versions of the tracts (in 1623), and among the numerous 'uses' included a couple of chapters on those for navigational purposes. Two and a half pages in the *Second Book of the Cross-staff* (Chapter VI, Section 1) are given to 'the ship's way', but there is no suggestion that any novelty of method is being

proposed, but merely a new way of arithmetical (or rather instrumental) computation. The Line of Numbers (logarithmic scale) was marked on the yard-long stem of this instrument (together with six other scales), and was figured from 0 to 1000 from Henry Briggs's recent Table. Used with a large pair of dividers this scale gave the direct answer to any problem that could be dealt with by the Golden Rule or Rule of Three, i.e. by simple proportion. This rule was the culminating one in the elementary arithmetic which sailors learned, and they learned, too, how to set it out, as, for example: 'As the time given is to the hour, so the way made to an hour's way'. The only seaman known to have used Gunter's new suggestion for the spacing of the knots (already undoubtedly on the line) was Captain Thomas James, who made an unusually 'bookish' approach to his Arctic voyage, and consulted various scholars. Champlain, who described as customary over here the English method and apparatus pictured by Commander Waters, had the opportunity for observation of the line knotted every seven fathoms when he was taken prisoner and brought to this country in 1629. But he may have known it much earlier, for the *Voyages* he describes took place near the beginning of the century, and he was an elderly man at the time of writing (1632). It is, indeed, impossible to imagine that within a few years a new practice (that of knotting the hitherto bare log-line) had been taken over from an academic text-book, the accompanying calculations (based on the strange centesme) being rejected, and new ones made. That moreover the new practice had become so widespread as to be observed by a foreigner as a usual one when he was carried on an unforeseen voyage to England. What we know is that Richard Norwood, a man bred to the sea, and a teacher of navigation on Tower Hill, introduced in 1636 a *re*-knotting of the line, based on his own actual measure of the length of the degree. But, said his contemporary, Henry Bond, 'many will hardly be drawn to alter their knots after their old forme'. How could there be an 'old forme' if the very idea of knots had only reached sailors well within the last thirteen years? Far into the eighteenth century conservative sailors were still obstinately clinging to the traditional line knotted every seven fathoms.

As to the Dutch log, Gunter is clearly only offering some new (and complicated) arithmetic, whereas pacing the deck beside some motionless object appears to be a very ancient practice. Such traditional methods the seaman takes for granted, and so they are unlikely to be described in print. The Dutch had, in fact, been active sailors and chart-makers long before they commenced to make official trans-oceanic voyages.

from A. H. W. Robinson

TOWARDS the end of his admirable article on the development of the English and Dutchman's Log, (*Journal*, 9, 70) Lieutenant-Commander D. W. Waters touches briefly on the introduction of the patent log, coupling with it the name of Saumarez. It is not correct, however, to say that the Saumarez log or 'Marine Surveyor' as he preferred to call it, was very successful as a means of measuring distance at sea. In a privately printed tract, a copy of which is in the British Museum, Saumarez traces the early history of his instrument. He first became interested in the problem of measuring the way of a ship at sea, so he tells us, 'when

the nation felt so great a loss as it did in the unhappy fate of Sir Clowdesley Shovell', wrecked in the Scillies in 1707. In its initial design, the log consisted of a paddle with four arms which rotated when dragged through the water from the stern of the vessel. The rotation of the paddle blades was transmitted to a vertical spindle and this in turn operated a dial which registered the number of revolutions. After calibration of the dial by tests over known measured distances, the Marine Surveyor would provide the long awaited solution to accurate distance measurement at sea, at least this is what Saumarez hoped. While the invention was still only a drawing, Saumarez wrote to the President of the Royal Society seeking his support. When this was not forthcoming, Saumarez, 'as a most loyal and trusted subject', decided to petition the king and this he did in December 1715. George I, somewhat naturally, referred the matter to the Admiralty and they in turn consulted Sir Isaac Newton for his advice. Newton, after examining the drawings of the instrument, although he 'was not yet satisfied that the reckoning will be so exact', decided that as he had no experience of sea affairs he was in no real position to judge and suggested that the machine should be referred to Trinity House. In due course this was done but after a considerable delay, during which time tests were made with wooden models, they too reported unfavourably on the Marine Surveyor.

Undismayed by this setback and obviously not convinced by the arguments of either Sir Isaac Newton or Trinity House, Saumarez set about making an actual instrument. When completed it was tested on the canal in St. James's Park and later a modified version of the machine was tested on the River Thames.[1] The modified Marine Surveyor, with a Y-shaped Fork in place of the four-armed paddle, was also taken on a voyage to Holland. From measurements made on this passage it was clear that the speed of the vessel and the depth to which the Fork was submerged, considerably affected the number of revolutions recorded on the dial. On his return Saumarez attempted to overcome this difficulty by preparing a set of tables to correct the dial reading for the different conditions likely to be encountered during a voyage, but clearly the end was in sight. Criticism of the instrument by members of the Royal Society finally sealed the fate of the Marine Surveyor, at least as far as Saumarez was concerned. Many years later, in 1754, John Smeaton revived the idea, redesigning the Fork of Saumarez's machine but even this modified version failed in tests at sea.[2]

The name 'Marine Surveyor' which Saumarez used to describe his machine is interesting when it is recalled that he did in fact carry out a survey of the Channel Islands in the years 1714 to 1727. A manuscript copy of the survey, in the form of two charts, one of the Channel Islands as a whole and the other a larger scale draught of the island of Alderney, is preserved in the archives of the Hydrographic Department and is at present on loan to the National Maritime Museum. On the same manuscript and bearing the date 1727 there is 'A representation of the use of the instrument called the Marine Surveyor', but as we know that the greater part of the Channel Islands survey was carried out before 1715, when the Marine Surveyor was still only on the drawing board, it seems unlikely that it was ever used for marine surveying. Certainly Saumarez, in his privately printed tract and in his papers published in the *Philosophical Transactions of the Royal Society*, never mentions its use for this purpose although secretly he may have had hopes in this direction, hence the name he used for the machine. It is clear that the Marine Surveyor was in no sense a forerunner of the station pointer, as has been suggested by Professor Taylor.[3]

REFERENCES

1 *Phil. Trans. Royal Society* (1725), 33 and (1729) 36.

2 *Phil Trans. Royal Society* (1754), 48.

3 Taylor, E. G. R. (1955). Biography of H. Saumarez in *The Mathematical Practitioners of Tudor and Stuart England.*

Lieutenant-Commander Waters writes:

I am grateful to Mr. Robinson for clarifying the principle of Saumarez's patent log and for his lively account of the abortive attempts to get the log to work.

H. R. Spencer, 'Sir Isaac Newton on Saumarez Patent Log', *American Neptune*, 14, 214, (1954), did not describe the principle upon which this log was based but quoted Sir Isaac Newton as reporting that he was

'of the opinion that by means of the Instrument . . . a Reckoning of the distance sailed by a Ship may be kept with less trouble than by the Logg-Line, but I am not yet satisfied that the Reckoning will be so exact . . . The instrument now proposed will keep a Reckoning of the Motion of the Ship with respect to the upper part of the Sea Water, but not of the driving of the Ship by Currents and Tides, and by the Motion of the upper surface of the sea caused by winds, and how far it will keep true Reckoning of the Motion of a Ship side Ways, occasioned by side Wind, doth not appear to me, and therefore the Logg-line is not to be laid aside until further experiments have been made.

J. B. Hewson, *A History of the Practice of Navigation*, (1954, pp. 166–7) states that both Foxon's and Russell's perpetual logs, tested by Captain Phipps in 1773 and reported upon favourably by him, 'were constructed upon the principle that a spiral in moving its own length in the direction of its axis, through a resisting medium, makes one revolution about its axis', and that the construction of Saumarez's *Marine Surveyor* 'was somewhat similar'.

As he also states that the *Marine Surveyor* was mentioned 'by a well-known writer, in a book on navigation as being in existence at this time' [1773 when, he states, Russell's and Foxon's perpetual logs were successfully tested] I erroneously concluded both that Saumarez's log was in principle similar to Russell's and Foxon's and that the tests on it recommended by Sir Isaac Newton had subsequently been passed successfully. My footnote referring to Saumarez's log was therefore misleading. The correction is both timely and valuable.

A New History of Navigation

from P. Collinder

PROFESSOR E. G. R. TAYLOR'S review, in the April 1955 issue of this *Journal*, of my book *A History of Marine Navigation* has passed unnoticed by me during a long absence, and I beg leave to offer a few comments.

The reviewer's introductory remark is indisputably correct; the title is not an adequate one. The Swedish title, literally translated, is *From Noah's Dove to*