H. J. W. Shober

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VOYAGE

TOWARDS

THE NORTH POLE.

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VOYAGE

TOWARDS

THE NORTH POLE:

UNDERTAKEN

BY HIS MAJESTY'S COMMAND,

1773.

BY CONSTANTINE JOHN PHIPPS.

DUBLIN:
Printed for Messrs. SLEATER, WILLIAMS, WILSON,
HUSBAND, WALKER, and JENKIN.
MDCCLXXV.

1775

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TO

THE KING.

SIRE,

AS a Sea Officer addreſſing Your MAJESTY on a profeſſional ſubject, I might juſtly be accuſed of ſingular ingratitude, did I not avail myſelf of this opportunity of reminding the World, that the Voyage to

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to explore how far Navigation was practicable towards the North Pole was undertaken at a Period peculiarly distinguished by Your MAJESTY's gracious Attention to Your Navy.

In a Time of profound Peace Your MAJESTY, by a liberal Addition to the Half Pay of the Captains, relieved the Necessities of many, and gratified the Ambition of all, at once demonstrating Your MAJESTY's Regard to their Welfare, and the Remembrance of their Services.

The Armament which followed in a few Months, and Your MAJESTY's Review of that Armament, which, by the Dispatch of its Equipment, had prevented a War, afforded to Your Navy the most flattering and

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and diſtinguiſhed Mark of Royal Favour, and to Your Majesty an additional Proof of that Alacrity for Your Service, which had ſo recently received both its Reward and Encouragement from Your Majesty's Protection.

Permit me, Sire, to add, that Your Majesty's gracious Approbation of my Endeavours, and the Permiſſion I have been honoured with, of inſcribing the following Account of them to Your Majesty, are ſtrong Proofs of that Indulgence with which Your Majesty receives every Attempt to promote Your Service. —— An Indulgence, which, at the ſame Time that it cannot fail of animating the Zeal of others more worthy of Your Majesty's

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Majesty's Notice, has added to the most devoted Attachment, the warmest Gratitude of,

Sire,

Your Majesty's most dutiful

Subject and Servant,

CONSTANTINE JOHN PHIPPS.

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INTRODUCTION.

THE idea of a paſſage to the Eaſt Indies by the North Pole was ſuggeſted as early as the year 1527, by Robert Thorne, merchant, of Briſtol, as appears from two papers preſerved by Hackluit; the one addreſſed to king Henry VIII; the other to Dr. Ley, the king's ambaſſador to Charles V. In that addreſſed to the king he ſays, "I know it to be my bounden duty to manifeſt "this ſecret to your Grace, which hitherto, I ſup-"poſe, has been hid." This ſecret appears to be the honour and advantage which would be derived from the diſcovery of a paſſage by the North Pole. He repreſents in the ſtrongeſt terms the glory which the kings of Spain and Portugal had obtained by their diſcoveries Eaſt and Weſt, and exhorts the king to emulate their fame by undertaking diſcoveries towards the North. He ſtates in a very maſterly ſtyle the reputation that muſt attend the attempt, and the great benefits, ſhould it be crowned with ſucceſs, likely to accrue

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to the ſubjects of this country, from their advantageous ſituation; which, he obſerves, ſeems to make the exploring this, the only hitherto undiſcovered part, the King's peculiar duty.

To remove any objection to the undertaking which might be drawn from the ſuppoſed danger, he inſiſts upon "the great advantages of conſtant "day-light in ſeas, that, men ſay, without great "danger, difficulty, and peril, yea, rather, it is im-"poſſible to paſs; for they being paſt this little "way which they named ſo dangerous (which may "be two or three leagues before they come to the "Pole, and as much more after they paſs the Pole), "it is clear from thenceforth the ſeas and lands "are as temperate as in theſe parts."

In the paper addreſſed to Dr. Ley he enters more minutely into the advantages and practicability of the undertaking. Amongſt many other arguments to prove the value of the diſcovery, he urges, that by ſailing northward and paſſing the Pole, the navigation from England to the Spice Iſlands would be ſhorter, by more than two thouſand leagues, than either from Spain by the Straits of Magellan, or Portugal by the Cape of Good Hope; and to ſhew the likelihood of ſucceſs in the enterprize he ſays, it is as probable that the coſmographers ſhould be miſtaken in the opinion they entertain of the polar regions being impaſſable from extreme cold,

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cold, as, it has been found, they were, in ſuppoſing the countries under the Line to be uninhabitable from exceſſive heat. With all the ſpirit of a man convinced of the glory to be gained, and the probability of ſucceſs in the undertaking, he adds,—"God knoweth, that though by it I ſhould have "no great intereſt, yet I have had, and ſtill have, "no little mind of this buſineſs: ſo that if I had "faculty to my will, it ſhould be the firſt thing "that I would underſtand, even to attempt, *if our* "*ſeas Northward be navigable to the Pole or no.*" Notwithſtanding the many good arguments, with which he ſupported his propoſition, and the offer of his own ſervices, it does not appear that he prevailed ſo far as to procure an attempt to be made.

Borne, in his *Regiment of the Sea*, written about the year 1577, mentions this as one of the five ways to Cathay, and dwells chiefly on the mildneſs of climate which he imagines muſt be found near the Pole, from the conſtant preſence of the ſun during the ſummer. Theſe arguments, however, were ſoon after controverted by Blundeville, in his Treatiſe on Univerſal Maps.

In 1578, George Beſt, a gentleman who had been with Sir Martin Frobiſher in all his voyages for the diſcovery of the North Weſt paſſage, wrote a very ingenious diſcourſe, to prove all parts of the world habitable.

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No voyage, however, appears to have been undertaken to explore the circumpolar ſeas, till the year 1607, when "Henry Hudſon was ſet "forth, at the charge of certain worſhipful mer-"chants of London, to diſcover a paſſage by the "North Pole to Japan and China." He ſailed from Graveſend on the firſt of May, in a ſhip called the Hopewell, having with him ten men and a boy. I have taken great pains to find his original journal, as well as thoſe of ſome others of the adventurers who followed him; but without ſucceſs: the only account I have ſeen is an imperfect abridgment in Purchas, by which it is not poſſible to lay down his track; from which, however, I have drawn the following particulars:—He fell in with the land to the Weſtward in latitude 73°, on the twenty-firſt of June, which he named Hold-with-Hope. The twenty-ſeventh, he fell in with Spitſbergen, and met with much ice; he got to eighty degrees twenty-three minutes, which was the Northernmoſt latitude he obſerved in. Giving an account of the concluſion of his diſcoveries, he ſays, "On the ſixteenth of Auguſt I ſaw land, by "reaſon of the clearneſs of the weather, *ſtretching* "*far into eighty-two degrees*, and, by the bowing "and ſhewing of the ſky, much farther; which "when I firſt ſaw, I hoped to have had a free ſea "between the land and the ice, and meant to have "compaſſed this land by the North; but now find-

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"ing it was impoſſible, by means of the abundance "of ice compaſſing us about by the North, and "joining to the land; and ſeeing God did bleſs us "with a wind, we returned, bearing up the helm." He afterwards adds: "And this I can aſſure at "this preſent, that between ſeventy-eight degrees "and an half, and eighty-two degrees, by this "way there is no paſſage."—In conſequence of this opinion, he was the next year employed on the North Eaſt diſcovery.

In March 1609, old ſtyle, "A voyage was ſet "forth by the right worſhipful Sir Thomas Smith, "and the reſt of the Muſcovy Company, to Cherry "Iſland, and for a further diſcovery to be made "towards the North Pole, for the likelihood of a "trade or a paſſage that way, in the ſhip called the "Amity, of burthen ſeventy tuns, in which Jonas "Poole was maſter, having fourteen men and one "boy."—He weighed from Blackwall, March the firſt, old ſtyle; and after great ſeverity of weather, and much difficulty from the ice, he made the South part of Spitſbergen on the 16th of May. He ſailed along and ſounded the coaſt, giving names to ſeveral places, and making many very accurate obſervations. On the 26th, being near Fair Foreland, he ſent his mate on ſhore;—and ſpeaking of the account he gave at his return, ſays, "Moreover, I "was certified that all the ponds and lakes were "unfrozen, they being freſh water; which putteth

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" me in hope of a mild ſummer here, after ſo ſharp
" a beginning as I have had; and my opinion is
" ſuch, and I aſſure myſelf it is ſo, that a paſſage
" may be as ſoon attained this way by the Pole, as
" any unknown way whatſoever, by reaſon the ſun
" doth give a great heat in this climate, and the
" ice (I mean that freezeth here) is nothing ſo huge
" as I have ſeen in ſeventy-three degrees."

Theſe hopes, however, he was ſoon obliged to relinquiſh for that year, having twice attempted in vain to get beyond 79° 50'. On the 21ſt of June, he ſtood to the Southward, to get a loading of fiſh, and arrived in London the laſt of Auguſt. He was employed the following year (1611) in a ſmall bark called the Elizabeth, of 50 tuns. The inſtructions for this voyage, which may be found at length in Purchas, are excellently drawn up: They direct him, after having attended the fiſhery for ſome time, to attempt diſcoveries to the North Pole as long as the ſeaſon will permit; with a diſcretionary clauſe, to act in unforeſeen caſes as ſhall appear to him moſt for the advancement of the diſcovery, and intereſt of his employers. This however proved an unfortunate voyage: for having ſtaid in Croſs Road till the 16th of June, on account of the bad weather, and great quantity of ice, he ſailed from thence on that day, and ſteered W b N fourteen leagues, where he found a bank of ice: he returned to Croſs-Road; from whence

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when he ſailed, he found the ice to lie cloſe to the land about the latitude of 80°, and that it was impoſſible to paſs that way; and the ſtrong tides making it dangerous to deal with the ice, he determined to ſtand along it to the Southward, to try if he could find the ſea more open that way, and ſo get to the Weſtward, and proceed on his voyage. He found the ice to lie neareſt S W and S W b S and ran along it about an hundred and twenty leagues. He had no ground near the ice at 160, 180, or 200 fathoms: perceiving the ice ſtill to trend to the ſouthward, he determined to return to Spitſbergen for the fiſhery, where he loſt his ſhip.

In the year 1614, another voyage was undertaken, in which Baffin and Fotherby were employed. With much difficulty, and after repeated attempts in vain with the ſhip, they got with their boats to the firm ice, which joined to Red-Beach; they walked over the ice to that place, in hopes of finding whale-fins, &c. in which they were diſappointed. Fotherby adds, in his account: "Thus, "as we could not find what we deſired to ſee, ſo "did we behold that which we wiſhed had not "been there to be ſeen; which was great abun-"dance of ice, that lay cloſe to the ſhore, and "alſo off at ſea as far as we could diſcern." On the eleventh of Auguſt they ſailed from Fair-Haven, to try if the ice would let them paſs to the Northward, or Northeaſtward; they ſteered from

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Cape Barren, or Vogel Sang, N E b E eight leagues, where they met with the ice, which lay E b S and W b N. The fifteenth of August they saw ice frozen in the sea of above the thickness of an half-crown.

Fotherby was again fitted out the next year in a pinnace of twenty tons, called the Richard, with ten men. In this voyage he was prevented by the ice from getting farther than in his last. He refers to a chart, in which he had traced the ship's course on every traverse, to shew how far the state of that sea was discovered between eighty and seventy-one degrees of latitude, and for twenty-six degrees of longitude from Hackluit's headland. He concludes the account of his voyage in the following manner:

"Now, if any demand my opinion concerning "hope of a passage to be found in those seas, I "answer; that it is true, that I both hoped and "much desired to have passed further than I did, "but was hindered with ice; wherein although I "have not attained my desire, yet forasmuch as it "appears not yet to the contrary, but that there is "a spacious sea betwixt Groinland and king James "his new land [Spitsbergen] although much pes-"tered with ice; I will not seem to diswade this "worshipful company from the yearly adventuring "of

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"of 150 or 200 pounds at the moſt, till ſome fur-"ther diſcovery be made of the ſaid ſeas and lands "adjacent." It appears that the Ruſſia company, either ſatisfied with his endeavours and deſpairing of further ſucceſs, or tired of the expence of the undertaking, never employed any more ſhips on this diſcovery.

All theſe voyages having been fitted out by private adventurers, for the double purpoſe of diſcovery and preſent advantage; it was natural to ſuppoſe, that the attention of the navigators had been diverted from purſuing the more remote and leſs profitable object of the two, with all the attention that could have been wiſhed. I am happy, however, in an opportunity of doing juſtice to the memory of theſe men; which, without having traced their ſteps, and experienced their difficulties, it would have been impoſſible to have done. They appear to have encountered dangers, which at that period muſt have been particularly alarming from their novelty, with the greateſt fortitude and perſeverance; as well as to have ſhewn a degree of diligence and ſkill, not only in the ordinary and practical, but more ſcientific parts of their profeſſion, which might have done honour to modern ſeamen, with all their advantages of later improvements. This, when compared with the accounts given of the ſtate of navigation, even within theſe forty

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forty years, by the moſt eminent foreign authors, affords the moſt flattering and ſatisfactory proof of the very early exiſtence of that decided ſuperiority in naval affairs, which has carried the power of this country to the height it has now attained.

This great point of geography, perhaps the moſt important in its conſequences to a commercial nation and maritime power, but the only one which had never yet been the object of royal attention, was ſuffered to remain without further inveſtigation, from the year 1615 till 1773, when the Earl of Sandwich, in conſequence of an application which had been made to him by the Royal Society, laid before his Majeſty, about the beginning of February, a propoſal for an expedition to try how far navigation was practicable towards the North Pole; which his Majeſty was pleaſed to direct ſhould be immediately undertaken, with every encouragement that could countenance ſuch an enterprize, and every aſſiſtance that could contribute to its ſucceſs.

As ſoon as I heard of the deſign, I offered myſelf, and had the honour of being entruſted with the conduct of this undertaking. The nature of the voyage requiring particular care in the choice and equipment of the ſhips, the Racehorſe and Carcaſs bombs were fixed upon as the ſtrongeſt, and

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and therefore properest for the purpose. The probability that such an expedition could not be carried on without meeting with much ice, made some additional strengthening necessary : they were therefore immediately taken into dock, and fitted in the most compleat manner for the service. The complement for the Racehorse was fixed at ninety men, and the ordinary establishment departed from, by appointing an additional number of officers, and entering effective men instead of the usual number of boys.

I was allowed to recommend the officers; and was very happy to find, during the course of the voyage, by the great assistance I received on many occasions from their abilities and experience, that I had not been mistaken in the characters of those upon whom so much depended in the performance of this service. Two masters of Greenlandmen were employed as pilots for each ship. The Racehorse was also furnished with the new chain-pumps made by Mr. Cole according to Captain Bentinck's improvements, which were found to answer perfectly well. We also made use of Dr. Irving's apparatus for distilling fresh water from the sea, with the greatest success. Some small but useful alterations were made in the species of provisions usually supplied in the navy; an additional quantity of spirits was allowed for each ship, to be issued at the discretion of the commanders, when extraordinary fatigue

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fatigue or ſeverity of weather might make it expedient. A quantity of wine was alſo allotted for the uſe of the ſick. Additional clothing, adapted to that rigor of climate, which from the relations of former navigators we were taught to expect, was ordered to be put on board, to be given to the ſeamen when we arrived in the high latitudes. It was foreſeen that one or both of the ſhips might be ſacrificed in the proſecution of this undertaking; the boats for each ſhip were therefore calculated, in number and ſize, to be fit, on any emergency, to tranſport the whole crew. In ſhort, every thing which could tend to promote the ſucceſs of the undertaking, or contribute to the ſecurity, health, and convenience of the ſhips' companies, was granted.

The Board of Longitude agreed with Mr. Iſrael Lyons to embark in this voyage, to make aſtronomical obſervations. His reputation for mathematical knowledge was too well eſtabliſhed to receive any addition from the few opportunities which a voyage in ſuch unfavourable climates could afford. The ſame Board ſupplied him with ſuch inſtruments as they imagined might be uſeful for making obſervations and experiments. The Royal Society favoured me with ſuch information as they judged might ſerve to direct my enquiries, whenever the circumſtances of the voyage ſhould afford me leiſure and opportunity for making obſervations.

Beſides

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Besides these learned bodies, I was obliged to many individuals for hints; amongst whom it is with pleasure I mention Monsieur D'Alembert, who communicated to me a short paper, which, from the conciseness and elegance with which it was drawn up, as well as from the number of interesting objects that it recommended to my attention, would have done honour to any person whose reputation was not already established upon so solid a foundation as that learned philosopher's. To Mr. Banks I was indebted for very full instructions in the branch of natural history, as I have since been for his assistance in drawing up the account of the productions of that country; which I acknowledge with particular satisfaction, as instances of a very long friendship which I am happy in an opportunity of mentioning.

As a voyage of this kind would probably afford many opportunities of making experiments and observations in matters relative to navigation, I took care to provide myself with all the best instruments hitherto in use, as well as others which had been imperfectly, or never, tried.

The length of the Second Pendulum in so high a latitude as I was likely to reach, appearing to me an experiment too interesting to be neglected, I desired Mr. Cumming to make me such an instrument as he thought would best answer the purpose.
That

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That modesty and candour which always attend real merit, induced him to lend me the identical pendulum with which Mr. Graham had made his experiments, rather than furnish me with one of his own construction; but the judgment as well as skill with which the apparatus joined to it was contrived and executed, notwithstanding the shortness of the time, will, I am sure, do him credit.

The Board of Longitude sent two watch machines for keeping the longitude by difference of time; one constructed by Mr. Kendal, on Mr. Harrison's principles; the other by Mr. Arnold. I had also a pocket watch constructed by Mr. Arnold, by which I kept the longitude to a degree of exactitude much beyond what I could have expected; the watch having varied from its rate of going only 2′ 40″ in 128 days.

In the Journal which follows, I mean to confine myself to the occurrences of the voyage as they succeeded in order of time; which, for the convenience of the generality of readers, I have reduced from the nautical to the civil computation: to this I shall add, by way of Appendix, an account of all the experiments and observations under their respective heads, that those who interest themselves in any particular branch, may find whatever they want, unmixed with foreign matters; while those who may wish only to trace the whole

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whole progrefs of the voyage, as well as thofe who may be fatisfied with the general refults of the experiments, will find the account unincumbered with that detail which I wifh to fubmit to others, who may chufe to examine more minutely, and compare the facts with the conclufions.

A voyage of a few months to an uninhabited extremity of the world, the great object of which was to afcertain a very interefting point in geography, cannot be fuppofed to afford much matter for the gratification of mere curiofity. The experiments and obfervations may poffibly from their novelty, and the peculiar circumftances of the climate in which they were made, afford fome entertainment to philofophers; and might perhaps have been more numerous and fatisfactory, if the purfuit of the great object of the voyage had not rendered them, however interefting in themfelves, but a fecondary confideration.

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JOURNAL.

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JOURNAL.

APRIL 19th, 1773, I received my commiſſion for the Racehorſe, with an order to get her fitted with the greateſt diſpatch for a voyage of diſcovery towards the North Pole, and to proceed to the Nore for further orders.

23d. The ſhip was hauled out of dock.

May 21ſt. The ſhip being manned and rigged, and having got in all the proviſions and ſtores, except the Gunner's, we fell down to Galleons.

22d. We received on board the powder, with eight ſix-pounders, and all the gunner's ſtores. Lord Sandwich gave us the laſt mark of the obliging attention he had ſhewn during the whole progreſs of the equipment, by coming on board to ſatisfy himſelf, before our departure, that the whole had been compleated to the wiſh of thoſe who were embarked in the expedition. The Eaſterly

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winds prevented our going down the river till the 26th, when I received my inſtructions for the voyage, dated the 25th; directing me to fall down to the Nore in the Race-horſe, and there taking under my command the Carcaſs, to make the beſt of my way to the Northward, and proceed up to the North Pole, or as far towards it as poſſible, and as nearly upon a meridian as the ice or other obſtructions might admit; and, during the courſe of the voyage, to make ſuch obſervations of every kind as might be uſeful to navigation, or tend to the promotion of natural knowledge: in caſe of arriving at the Pole, and even finding free navigation on the oppoſite meridian, not to proceed any farther; and at all events to ſecure my return to the Nore before the winter ſhould ſet in. There was alſo a clauſe authorizing me to proceed, in unforeſeen caſes, according to my own diſcretion; and another clauſe directing me to proſecute the voyage on board the Carcaſs, in caſe the Racehorſe ſhould be loſt or diſabled.

27th. I anchored at the Nore, and was joined by Captain Lutwidge, in the Carcaſs, on the 30th: her equipment was to have been in all reſpects the ſame as that of the Racehorſe, but when fitted, Captain Lutwidge finding her too deep in the water to proceed to ſea with ſafety, obtained leave of the Admiralty to put ſix more guns on ſhore, to reduce the complement to eighty men, and return

a quantity

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a quantity of provisions proportionable to that reduction. The officers were recommended by Captain Lutwidge, and did justice to his penetration by their conduct in the course of the voyage. During our stay here, Mr. Lyons landed with the astronomical quadrant at Sheerness fort, and found the latitude to be 51° 31′ 30″, longitude 0° 30′ East. The Easterly winds prevented our moving this day and the following.

June 2d. Having the wind to the Westward of North, at five in the morning I made the signal to weigh; but in less than half an hour, the wind shifting to the Eastward and blowing fresh, I furled the topsails. The wind came in the afternnon to N b E; we weighed, but did not get far, the tide of flood making against us.

3d. The wind blowing fresh all day Easterly, we did not move.

4th. The wind coming round to the Westward at six in the morning, I weighed immediately, and sent the boat for Captain Lutwidge, to deliver him his orders. At 10 A. M. longitude by the watch 56′ E. At noon the latitude observed was 51° 37′ 36″ N. At eight in the evening we had got as far as Balsey Cliff, between Orford and Harwich. Little wind at night.

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5th. Anchored in Hoſeley Bay at half paſt ſeven in the evening, in five and an half fathom water. Orford Caſtle N E b N.

Angle between Aldborough Church and Orford Light Houſe,	7°	38′
Light Houſe and Orford Church, . . .	18	16
Orford Church and Caſtle, ...	2	20
Caſtle and Hoſeley Church, ...	100	59
Hoſeley and Balſey Church, ...	35	27

6th. At five in the morning, the wind at S S W, weighed, and ſtood out to ſea, finding I might loſe two tides by going through Yarmouth Roads. Examined the log line, which was marked forty-nine feet; the glaſs was found, by comparing it with the time-keeper, to run thirty ſeconds: at noon latitude obſerved 52° 16′ 54″, longitude by the watch 1° 30′ 15″ E.

Angle between Southwold and Walderſwick, ...	10°	39′
Walderſwick and Dunwich, ...	20	21
Dunwich and Aldborough, ...	46	53

Southwold N W ½ N, ſuppoſed diſtance three leagues. We concluded the latitude of Southwould to be 52° 22′, and longitude 1° 18′ 15″ E. The dip was 73° 22′.

7th.

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7th. The wind was Northerly all day, and blew fresh in the morning. We had stood far out in the night and the day before, to clear the Lemon and Ower.

8th. Little wind most part of the day, with a very heavy swell. Stood in for the land. At half past ten longitude by the watch 0° 41′ 15″ E. At noon the latitude was 53° 38′ 37″. We saw the high land near the Spurn, in the evening.

9th. About noon Flamborough Head bore N W b N distant about six miles: we were by observation in latitude 54° 4′ 54″, longitude 0° 27′ 15″ E; which makes Flamborough Head, in latitude 54° 9′, longitude 0° 19′ 15″ E. In the afternoon we were off Scarborough. Almost calm in the evening.

10th. Anchored in the morning for the tide in Robin Hood's Bay, with little wind at N W: worked up to Whitby Road next tide, and anchored there at four in the afternoon, in fifteen fathom, with very little wind.

11th. Calm in the morning; compleated our water, live stock and vegetables. At nine in the morning longitude observed by the watch 1° 55′ 30″ W; Whitby Abbey bore S ½ W. Weighed

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with the wind at S E, and ſteered N E b N to get ſo far into the mid-channel as to make the wind fair Eaſterly or Weſterly, without being too near either ſhore, before we were clear of Shetland and the coaſt of Norway.

12th. The wind at S E, and the ſhip well advanced, I ordered the allowance of liquor to be altered, ſerving the ſhip's company one-fourth of their allowance in beer, and the other three-fourths in brandy; by which means the beer was made to laſt the whole voyage, and the water conſiderably ſaved. One half of this allowance was ſerved immediately after dinner, and the other half in the evening. It was now light enough all night to read upon deck.

13th. The weather ſtill fine, but conſiderably leſs wind than the day before, and in the afternoon more Northerly. The longitude at ten in the morning was found by my watch 0° 6′ W. We took three obſervations of the moon and ſun for the longitude; the extremes differed from one another near two degrees: the mean of the three gave the longitude 1° 37′ E. At noon the latitude obſerved was 59° 32′ 31″. We found a difference of 36′ between the latitude by dead reckoning and obſervation, the ſhip being ſo much more Northerly than the reckoning. The diſtance by this log was too

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too ſhort by forty-three miles. A log marked forty-five feet, according to the old method, would have agreed with the obſervation within two miles in the two days' run. The circumſtance of ſteering upon a meridian, which afforded me ſuch frequent opportunities of detecting the errors of the log, induced me to obſerve with care the comparative accuracy of the different methods of dividing the line, recommended by mathematicians, or practiſed by ſeamen. In the afternoon I went on board the Carcaſs to compare the time-keepers by my watch. At ſix in the evening the longitude by my watch 0° 4′ E. This evening the ſun ſet at twenty-four minutes paſt nine, and bore about N N W by the compaſs. The clouds made a beautiful appearance long after to the Northward, from the reflection of the ſun below the horizon. It was quite light all night: the Carcaſs made the ſignal for ſeeing the land in the evening.

14th. Little wind, or calm, all day; but very clear and fine weather. Made ſeveral different obſervations for the longitude by the ſun and moon, and by my watch. The longitude of the ſhip was found by my watch, at ten in the morning, to be 1° 11′ 45″ W. The longitude by the lunar obſervations differed near two degrees from one another. By the mean of them the ſhip was in longitue 2° 57′ 45″ W. Some Shetland boats came on board with fiſh. At noon the latitude by obſervation

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tion was 60° 16′ 45″. At one in the afternoon the dip was obſerved to be 73° 30′; and at eight, 75° 18′: the evening calm, and very fine; the appearance of the ſky to the Northward very beautiful. Variation, by the mean of ſeveral obſervations, 22° 25′ W.

15th. By an obſervation at eight in the morning, the longitude of the Dip was by the watch 0° 39′ W: Dip 74° 52′. At half paſt ten in the morning, the longitude, from ſeveral obſervations of the ſun and moon, was 0° 17′ W; at noon being in latitude 60° 19′ 8″, by obſervation, I took the diſtance between the two ſhips by the Megameter; and from that baſe determined the poſition of Hangcliff, which had never before been aſcertained, though it is a very remarkable point, and frequently made by ſhips. According to theſe obſervations it is in latitude 60° 9′, and longitude 0° 56′ 30″ W. In the Appendix I ſhall give an account of the manner of taking ſurveys by this inſtrument, which I believe never to have been practiſed before. At one, obſerved the dip to be 75°. A thick fog came on in the afternoon, with a flat calm; we could not ſee the Carcaſs, but heard her anſwer the ſignals for keeping company. Variation, from the mean of ſeveral obſervations, 25° 1′ W.

16th.

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16th. A very thick fog in the morning; latitude obſerved at noon 60° 29′ 17″: the dip was obſerved at nine in the evening to be 76° 45′. In the afternoon, the weather clear, and the wind fair, ſteered N N E: ſent Captain Lutwidge his further orders and places of rendezvous.

17th. Wind fair, and blowing freſh at S S W, continued the courſe N N E: ordered the people a part of the additional clothing: ſaw an Engliſh ſloop, but had no opportunity of ſending letters on board, the ſea running high. At ten in the morning, longitude by the watch 0° 19′ 45″ W: at noon, the latitude obſerved was 62° 59′ 27″. The ſhip had out-run the reckoning eleven miles. I tried Bouguer's log twice this day, and found it give more than the common log. Variation 19° 22′ W.

18th. Little wind all day, but fair, from S S W to S E: ſtill ſteering N N E: latitude obſerved at noon 65° 18′ 17″. At three in the afternoon, ſounded with 300 fathom of line, but got no ground. Longitude by the watch 1° 0′ 30″ W.

19th. Wind to the N W. Took the meridian obſervation at midnight for the firſt time: the ſun's lower limb 0° 37′ 30″ above the horizon; from which

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which the latitude was found 66° 54′ 39″ N: at four in the afternoon, longitude by the watch 0° 58′ 45″ W: at fix the variation 19° 11′ W.

20th. Almoft calm all day. The water being perfectly fmooth, I took this opportunity of trying to get foundings at much greater depths than I believe had ever been attempted before. I founded with a very heavy lead the depth of 780 fathom, without getting ground; and by a thermometer invented by lord Charles Cavendifh for this purpofe, found the temperature of the water at that depth to be 26° of Fahrenheit's thermometer; the temperature of the air being 48° ½.

We began this day to make ufe of Doctor Irving's apparatus for diftilling frefh water from the fea: repeated trials gave us the moft fatisfactory proof of its utility: the water produced from it was perfectly free from falt, and wholefome, being ufed for boiling the fhip's provifions; which convenience would alone be a defirable object in all voyages, independent of the benefit of fo ufeful a refource in cafe of diftrefs for water. The quantity produced every day varied from accidental circumftances, but was generally from thirty-four to forty gallons, without any great addition of fuel. Twice indeed the quantity produced was only twenty-three gallons on each diftillation; this amounts to more than

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than a quart for each man, which, though not a plentiful allowance, is much more than what is neceſſary for ſubſiſtence. In caſes of real neceſſity I have no reaſon to doubt that a much greater quantity might be produced without an inconvenient expence of fuel.

21ſt. A freſh gale at S E all day; ſteered NNE. At four in the morning we ſpoke with a ſnow from the ſeal fiſhery, bound to Hamburgh, by which we ſent ſome letters. At ſix in the morning the variation, by the mean of ſeveral obſervations, was 23° 18′ W. Longitude by the watch at nine was 0° 34′ 30″ W. Latitude obſerved at noon 68° 5′.

22d. Calm moſt part of the day; rainy and rather cold in the evening. At noon obſerved the dip to be 77° 52′.

23d. Very foggy all day; the wind fair; altered the courſe and ſteered N E and E N E, to get more into the mid channel, and to avoid falling in with the Weſtern ice, which, from the increaſing coldneſs of the weather, we concluded to be near. At ſeven o'clock in the morning, being by our reckoning to the Northward of 72°, we ſaw a piece of drift wood, and a ſmall bird called a Redpoll. Dip obſerved at nine in the evening to be 81° 30′.

24th.

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24th. Very foggy all the morning; the wind came round to the Northward. The dip obſerved at noon was 80° 35′. In the afternoon, the air much colder than we had hitherto felt it; the thermometer at 34°. A fire made in the cabin for the firſt time, in latitude 73° 40°.

25th. Wind Northerly, with a great ſwell; ſome ſnow, but in general clear. At eight in the morning, the longitude obſerved by the watch was 7° 15′ E. Made ſeveral obſervations on the variation, which we found, by thoſe taken at ſeven in the morning, to be 17° 9′ W; by others at three in the afternoon, only 7° 47′ W. I could not account for this very ſudden and extraordinary decreaſe, as there were ſeveral different obſervations taken both in the morning and evening, which agreed perfectly well with each other, without any apparent cauſe which could produce an error affecting all the obſervations of either ſet. At eight in the evening the longitude by the moon was 12° 57′ 30″ E, which differed 2° 35′ from that by the watch. Little wind at night.

26th. Little wind all day; the weather very fine and moderate. The latitude obſerved at noon was 74° 25′. The thermometer expoſed to the ſun, which ſhone very bright, roſe from 41° to 61° in twenty

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twenty minutes. By each of two lunar obſervations which I took with a ſextant of four inches radius, at half paſt one, the longitude was 9° 57′ 30″ E; which agreed within thirty-ſeven minutes with an obſervation made by the watch at half an hour after three, when the longitude was 8° 52′ 30″ E. Dip 79° 22′.

27th. At midnight the latitude obſerved was 74° 26″. The wind came to the S W, and continued ſo all day, with a little rain and ſnow. The cold did not increaſe. We ſteered N b E. At ſeven in the morning the variation, by a mean of ſeveral obſervations, was found to be 20° 38′ W. We were in the evening, by all our reckonings, in the latitude of the South part of Spitſbergen, without any appearance of ice or ſight of land, and with a fair wind.

28th. Leſs wind in the morning than the day before, with rain and ſleet: continued ſteering to the Northward. At five in the afternoon picked up a piece of drift wood, which was fir, and not worm-eaten: ſounded in 290 fathom; no ground. At ſix the longitude by the watch was 7° 50′ E: between ten and eleven at night, ſaw the land to the Eaſtward at ten or twelve leagues diſtance. At midnight, dip 81° 7′.

29th.

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29th. The wind Northerly; ſtood cloſe in with the land. The coaſt appeared to be neither habitable nor acceſſible; it was formed by high, barren, black rocks, without the leaſt marks of vegetation; in many places bare and pointed, in other parts covered with ſnow, appearing even above the clouds: the vallies between the high cliffs were filled with ſnow or ice. This proſpect would have ſuggeſted the idea of perpetual winter, had not the mildneſs of the weather, the ſmooth water, bright ſunſhine, and conſtant day-light, given a chearfulneſs and novelty to the whole of this ſtriking and romantick ſcene.

I had an opportunity of making many obſervations near the Black Point. Latitude obſerved at noon 77° 59′ 11″. The difference of latitude, from the laſt obſervation on the 27th at midnight to this day at noon, would according to the old method of marking the log have been two hundred and thirteen miles; which agrees exactly with the obſervation. At three in the afternoon, brought to and ſounded 110 fathom; ſoft muddy ground: hoiſted out the boat and tried the ſtream; found it, both by the common and Bouguer's log (which agreed exactly) to run half a knot North; Black Point bearing E N E. At four the longitude by the watch was 9° 31′ E: at eight the variation, by the mean of nineteen obſervations, 11° 53′ W.

I could

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I could not account from any apparent cause for this great change in the variation: the weather was fine, the water smooth, and every precaution we could think of used to make the observations accurate. The dip was 80° 26′. Plying to the Northward.

30th. At midnight the latitude by observation was 78° 0′ 50″. At four in the morning, by Lord Charles Cavendish's thermometer the temperature of the water at the depth of 118 fathoms was 31° of Fahrenheit's; that of the air was at the same time 40° ¼. At nine in the morning we saw a ship in the N W, standing in for the land. Having little wind this morning, and that Northerly, I stood in for the land, with an intention to have watered the ship, and got out immediately, but was prevented by the calm which followed. At noon the latitude observed was 78° 8′; the dip 79° 30′. At two in the afternoon we sounded in 115 fathom; muddy bottom: at the same time we sent down Lord Charles Cavendish's thermometer, by which we found the temperature of the water at that depth to be 33°; that of the water at the surface was at the same time 40°, and in the air 44° ¾. Fahrenheit's thermometer plunged in water brought up from the same depth, stood at 38° ½. This evening the master of a Greenland Ship came on board, who told me, that he was just come out of the ice which lay to the

D Westward

Weſtward about fixteen leagues off, and that three ſhips had been loſt this year, two Engliſh, and one Dutch. The weather fine, and rather warm. At ſix in the evening the longitude by my watch was 9° 28′ 45″ E.

July 1ſt. Little wind Northerly, or calm, all day: the weather very fine, and ſo warm that we ſat without a fire, and with one of the ports open in the cabin. At noon the latitude obſerved was 78° 13′ 36″; Black Point bearing S 78° E; which makes the latitude of that point nearly the ſame as that of the ſhip, and agrees very well with the chart of this coaſt in Purchas.

2d. Little wind, and calms, all day; the weather very fine. At ſix in the morning five ſail of Greenlandmen in ſight. At noon the latitude obſerved was 78° 22′ 41″. I took a ſurvey of the coaſt, as far as we could ſee: I took alſo with the megameter the altitudes of ſeveral of the mountains: but as there is nothing particularly intereſting to navigators in this part of the coaſt, I ſhall only mention the height of one mountain, which was fifteen hundred and three yards. This may ſerve to give ſome idea of the appearance and ſcale of the coaſt. At half paſt ſix the longitude by the watch was 9° 8′ 30″ E: Variation 14° 55′ W.

3. Latitude

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3. Latitude at midnight 78° 23′ 46″: Dip 80° 45′. The weather fine, and the wind fair all day. Running along by the coast of Spitsbergen all day: several Greenlandmen in sight. Between nine and ten in the evening we were abreast of the North Foreland, bearing E b S ½ S, distance 1 ½ mile. Sounded in twenty fathom; rocky ground.

4th. Very little wind in the morning. At noon the latitude by observation was 79° 31′. Magdalena Hook bore N 39° E distant about four miles; which gives the latitude of that place 79° 34′; the same as Fotherby observed it to be in 1614. Stood in to a small bay to the Southward of Magdalena and Hamburgher's Bay: anchored with the stream anchor, and sent the boat for water. About three in the afternoon, when the boat was sent on shore, it appeared to be high water, and ebbed about three feet. This makes high water full and change at half an hour past one, or with a S S W moon; which agrees exactly with Baffin's observation in 1613. The flood comes from the Southward. Went ashore with the astronomer, and instruments, to observe the variation. A thick fog came on before we had completed the observations. The ship driving, I weighed and stood out to sea under an easy sail, firing guns frequently to shew the Carcass where we were; and in leſs than two hours joined her. Soon after, (about four in the morning of the 5th) the Rockingham Greenland Ship ran under our ſtern, and the maſter told me he had juſt ſpoke with ſome ſhips from which he learnt, that the ice was within ten leagues of Hacluyt's Head Land, to the North Weſt. In conſequence of this intelligence, I gave orders for ſteering in towards the Head Land; and if it ſhould clear up, to ſteer directly for it; intending to go North from thence, till ſome circumſtance ſhould oblige me to alter my courſe.

5th. At five the officer informed me, that we were very near ſome iſlands off Dane's Gat, and that the pilot wiſhed to ſtand farther out; I ordered the ſhip to be kept N b W, and hauled farther in, when clear of the iſlands. At noon I ſteered North, ſeeing nothing of the land; ſoon after I was told that they ſaw the ice: I went upon deck, and perceived ſomething white upon the bow, and heard a noiſe like the ſurf upon the ſhore; I hauled down the ſtudding ſails, and hailed the Carcaſs to let them know that I ſhould ſtand for it to make what it was, having all hands upon deck ready to haul up at a moment's warning: I deſired that they would keep cloſe to us, the fog being ſo thick, and have every body up ready to follow our motions inſtantaneouſly, determining to ſtand on under ſuch ſail as ſhould enable us to keep the

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ſhips under command, and not riſk parting company. Soon after two ſmall pieces of ice not above three feet ſquare paſſed us, which we ſuppoſed to have floated from the ſhore. It was not long before we ſaw ſomething on the bow, part black and part covered with ſnow, which from the appearance we took to be iſlands, and thought that we had not ſtood far enough out; I hauled up immediately to the N N W and was ſoon undeceived, finding it to be ice which we could not clear upon that tack; we tacked immediately, but the wind and ſea both ſetting directly upon it, we neared it very faſt, and were within little more than a cable's length of the ice, whilſt in ſtays. The wind blowing freſh, the ſhips would have been in danger on the lee ice, had not the officers and men been very alert in working the ſhip. The ice, as far as we could then ſee, lay nearly E b N and W b S. At half paſt ſeven in the evening, the ſhip running entirely to the Southward, and the weather clearing a little, I tacked, and ſtood for the ice. When I ſaw it, I bore down to make it plain; at ten the ice lay from N W to Eaſt, and no opening. Very foggy, and little wind, all day; but not cold. At eleven came on a thick fog. At half paſt midnight, heard the ſurge of the ice, and hauled the wind to the Eaſtward.

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6th. Clear weather all day, and the wind Easterly off the ice. In the morning I stood in to make the land plain. At six, was within four miles of the ice, which bore from ENE to WNW: at ten near Vogel Sang: at noon, latitude observed 79° 56′ 39″; wind Easterly. Continued plying to windward between the land and the ice: was within a quarter of a mile of the ice, which lay from ENE to NNW, when I tacked at two in the afternoon; and within half a cable's length at midnight; the Carcass was a great way astern and to leeward all day. Being so near the last rendezvous, I did not chuse to bring to for her, but was very anxious to avail myself of this favourable opportunity, having the wind off the ice and clear weather, to see whether there was any opening to the NE of the Head Land. By all the accounts from the Greenlandmen this year, and particularly the last account from the Rockingham, as well as from what we had seen ourselves, the ice appeared to be quite close to the NW. We had seen it from ESE to WNW. It was probable that the sea, if open any where, would be so to the Eastward, where the Greenlandmen do not often venture, for fear of being prevented from returning by the ice joining to Spitsbergen. I determined therefore, should the wind continue in the same quarter next day, to find whether the ice joined to the

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the land, or was so detached as to afford me an opportunity of passing to the Eastward. In case of the ice being fast I could, with the wind Easterly, range close along the edge of it to the Westward. The weather exceedingly fine. At six in the afternoon, the longitude by the watch was 9° 43′ 30″ E.

7th. At five in the morning the wind was Northerly, and the weather remarkably clear. Being near the ice I ranged along it. It appeared to be close all round; but I was in hopes that some opening might be found to get through to a clear sea to the Northward. I ran in amongst the small ice, and kept as close as possible to the main body, not to miss any opening. At noon, Cloven Cliff W ½ S seven leagues. At one in the afternoon, being still amongst the loose ice, I sent the boat to one of the large pieces to fill water. At four we shoaled the water very suddenly to fourteen fathom: the outer part of Cloven Cliff bore W ½ N: Redcliff, S ¼ E. The loose ice being open to the E N E, we hauled up, and immediately deepened our water to twenty-eight fathom; muddy ground, with shells. At half past four, the ice setting very close, we ran between two pieces, and having little wind were stopped. The Carcass being very near, and not answering her helm well, was almost on board of us. After getting clear of her, we ran

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to the Eaſtward. Finding the pieces increaſe in number and ſize, and having got to a part leſs crowded with the drift ice, I brought to, at ſix in the evening, to ſee whether we could diſcover the leaſt appearance of an opening: but it being my own opinion, as well as that of the pilots and officers, that we could go no farther, nor even remain there without danger of being beſet, I ſent the boat on board the Carcaſs for her pilots, to hear their opinion; they both declared that it appeared to them impracticable to proceed that way, and that it was probable we ſhould ſoon be beſet where we were, and detained there. The ice ſet ſo faſt down, that before they got on board the Carcaſs we were faſt. Captain Lutwidge hoiſted our boat up, to prevent her being ſtove. We were obliged to heave the ſhip through for two hours, with ice anchors, from each quarter; nor were we quite out of the ice till midnight. This is about the place where moſt of the old diſcoverers were ſtopped. The people in both ſhips being much fatigued, and the Carcaſs not able to keep up with us, without carrying ſtudding-ſails, I ſhortened ſail as ſoon as we were quite out, and left orders to ſtand to the Northward under an eaſy ſail: I intended, having failed in this attempt, to range along the ice to the N W, in hopes of an opening that way, the wind being fair, and the weather clear; reſolving, if I found it all ſolid, to return to the Eaſtward,

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ward, where probably it might by that time be broken up, which the very mild weather encouraged me to expect.

8th. Little wind in the morning, and a ſwell ſetting on the ice, we were obliged to get the boats a-head, to tow the ſhip clear; which they effected with difficulty. A breeze ſpringing up when we were within two cables lengths of the main body of the ice, ſtood in for the land, and attacked at two, to ſtand to the N W for the ice; but the weather coming thick between five and ſix, I ſtood in again for the land. It clearing up ſoon after, I bore away again N W for the ice. At ten, ſpoke with a Greenland Ship which had juſt left the ice all cloſe to the N N W. Between eleven and twelve the wind came to the S W, with an heavy ſwell, and thick weather. Double-reefed the topſails, and tacked at twelve, to ſtand in for Hacluyt's Head Land, not thinking it proper to run in with the faſt ice to leeward in thick weather, without even the probability of an opening; and propoſing if that weather continued, to complete the ſhip's water, and be ready with the firſt wind, off or along the ice, to look out for an opening, and run in. To avoid any inconvenience which from the experience of the preceding day I perceived might happen, from too many running to one place on any ſudden order, I divided the people into gangs under the midſhipmen, and ſtationed them to the ice hooks, poles, crabs, and to go over upon the ice when wanted.

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9th. Having a fair opportunity, and SW wind, stood to the Westward; intending, when the weather was clear, to make the ice to the Northward, and run along it. About twelve, clearer; saw the fast ice to the Northward, and the appearance of loose ice to the NW: stood directly for it, and got amongst it between two and three; steering as much to the Northward as the situation of the ice would permit. At six observed the dip 81° 52′. At half past seven, found the ice quite fast to the West, being in longitude 2° 2′ E, by our reckoning, which was the farthest to the Westward of Spitsbergen that we got this voyage. At eight the fog was so very thick, that we could neither see which way to push for an opening, nor where the Carcass was, though very near us. That we might not risk parting company with her, I was obliged to ply to windward under the topsails, tacking every quarter of an hour to keep in the opening in which we were, and clear of the ice which surrounded us. At four in the afternoon we were in 80° 36′.

10th. We lost the Carcass twice in the night, from the very thick fog, and were working all night amongst the ice, making very short tacks; the opening being small, and the floating ice very thick about the ship. The situation of the people from the very fatiguing work and wet weather, made the most minute precautions necessary for the preservation of their health: we now found the advantage

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vantage of the spirits which had been allowed for extraordinary occasions; as well as the additional cloathing furnished by the Admiralty. Notwithstanding every attention, several of the men were confined with colds, which affected them with pains in their bones; but, from the careful attendance given them, few continued in the sick list above two days at a time. At nine in the morning, when it cleared a little, we saw the Carcass much to the Southward of us. I took the opportunity of the clear weather to run to the Westward, and found the ice quite solid there; I then stood through every opening to the Northward, but there also soon got to the edge of the solid ice. I was forced to haul up to weather a point which ran out from it. After I had weathered that, the ice closing fast upon me, obliged me to set the foresail, which, with the fresh wind and smooth water, gave the ship such way as to force through it with a violent stroke. At one in the afternoon, immediately on getting out into the open sea, we found a heavy swell setting to the Northward; though amongst the ice, the minute before, the water had been as smooth as a mill pond. The wind blew strong at SSW. The ice, as far as we could see from the mast head, lay ENE: we steered that course close to it, to look for an opening to the Northward. I now began to conceive that the ice was one compact impenetrable body, having run along it from East to West above ten degrees. I purposed however

ever to ſtand over to the Eaſtward, in order to aſcertain whether the body of ice joined to Spitſbergen. This the quantity of looſe ice had before rendered impracticable; but thinking the Weſterly winds might probably by this time have packed it all that way, I flattered myſelf with the hopes of meeting with no obſtruction till I ſhould come to where it joined the land; and in caſe of an opening, however ſmall, I was determined at all events to puſh through it. The weather clearer, and the land in ſight.

11th. At half paſt four in the morning the longitude by the lunar obſervation was 9° 42′ E. And at the ſame time by my watch 9° 2′ E. Cloven Cliff S S E, diſtant eight miles. This would make the longitude of Cloven Cliff 9° 38′ E; which is within twenty minutes of what it was determined by the obſervations and ſurvey taken in Fair Haven. At noon the latitude obſerved was 80° 4′; Vogel Sang W S W. Little wind and a great ſwell in the morning. Calm moſt part of the day.

12th. Calm all day, with a great ſwell from the SW, and the weather remarkably mild. At eight in the evening longitude by the watch 10° 54′ 30″ E: Cloven Cliff S W b S. The Carcaſs drove with the current ſo near the main body of the ice, as to be obliged to anchor; ſhe came to in twenty-ſix fathom water.

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13th. Calm till noon, the ſhip driving to the Weſtward with the current, which we obſerved to be very irregular, the Carcaſs being driven at the ſame time to the Eaſtward. Near the main body of the ice, the detached pieces probably affect the currents, and occaſion the great irregularity which we remarked. We had found an heavy ſwell from the S W theſe two days. At two in the afternoon it came on very ſuddenly to blow freſh from that quarter, with foggy weather; we worked into Vogel Sang, and anchored with the beſt bower in eleven fathom, ſoft clay.

The place where we anchored is a good roadſtead, open from the N E to the N W. The Northeaſternmoſt point is the Cloven Cliff, a bare rock ſo called from the top of it reſembling a cloven hoof, which appearance it has always worn, having been named by ſome of the firſt Dutch navigators who frequented theſe ſeas. This rock being entirely detached from the other mountains, and joined to the reſt of the iſland by a low narrow iſthmus, preſerves in all ſituations the ſame form; and being nearly perpendicular, it is never diſguiſed by ſnow. Theſe circumſtances render it one of the moſt remarkable points on the coaſt. The Northweſternmoſt land is an high bluff point, called by the Dutch, Vogel Sang. This ſound, though open to the Northward, is not liable to any inconvenience from that circumſtance, the main body

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body of the ice lying so near us to prevent any great sea; nor are ships in any danger from the loose ice setting in, as this road communicates with several others formed by different islands, between all which there are safe passages. To all the sounds and harbours formed by this knot of islands, the old English navigators had given the general name of Fair Haven; of which Fotherby took a *plot* in 1614: that in which the Racehorse and Carcass lay at this time they called the North Harbour; the harbour of Smeerenberg, distant about eleven miles, (in which we anchored in August) they named the South Harbour. Besides these, there are several others; particularly two, called, Cook's Hole, and the Norways, in both which several Dutch ships were lying at this time. Here the shore being steep-to, we completed our water with great ease, from the streams which fall in many places down the sides of the rocks, and are produced by the melting of the snow. I fixed upon a small flat island, or rock, about three miles from the ship, and almost in the center of those islands which form the many good roads here, as the properest place for erecting a tent, and making observations. The foggy weather on the 14th prevented us from using the instruments that day. I regretted this circumstance much, fearing it would deprive me of the only probable opportunity of making observations on shore in those high latitudes, as our water was nearly recruited: however,

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however, having little wind, with the weather very fair from the 15th to the 18th in the morning, I made the best use of that time. Even in the clearest weather here, the sky was never free from clouds, which prevented our seeing the moon during the whole of our stay, or even being sure of our solar observations, Mr. Lyons never having been able to get equal altitudes for settling the rates of going of the time-keepers. Once indeed we were fortunate enough to observe a revolution of the sun, of which I availed myself to determine the going of the pendulum adjusted to vibrate seconds at London. During the course of this experiment, a particular and constant attention was paid to the state of the thermometer, which I was surprised to find differ so little about noon and midnight; its greatest height was 58°½, at eleven in the forenoon; at midnight it was 51°.

On the 16th, at noon, the weather was remarkably fine and clear. The thermometer in the shade being at 49°, when exposed to the sun rose in a few minutes to 89°½, and remained so for some time, till a small breeze springing up, made it fall 10° almost instantly. The weather at this time was rather hot; so that I imagine, if a thermometer was to be graduated according to the feelings of people in these latitudes, the point of temperature would be about the 44th degree of Fahrenheit's scale. From this island I took a survey, to ascertain

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ascertain the situation of all the points and openings, and the height of the most remarkable mountains: the longest base the island would afford was only 618 feet, which I determined by a cross base, as well as actual measurement, and found the results not to differ above three feet. To try how far the accuracy of this survey might be depended upon, I took in a boat, with a small Hadley's sextant, the angles between seven objects, which intersected exactly when laid down upon the plan. I had a farther proof of its accuracy some days after, by taking the bearings of Vogel Sang and Hacluyt's Head Land in one, which corresponded exactly with their position on my chart.

On the 17th, the weather being very clear, I went up one of the hills, from which I could see several leagues to the N E: the ice appeared uniform and compact, as far as my view extended. During our stay here, we found the latitude of the island on which the observations were made, to be 79° 50′; longitude 10° 2′ 30″ E; variation 20° 38′ W; dip 82° 7′: latitude of Cloven Cliff 79° 53′; longitude 9° 59′ 30″ E: Hacluyt's Head Land 79° 47′; longitude 9° 11′ 30″ E. The tide rose about four feet, and flowed at half an hour after one, full and change. The tide set irregularly, from the number of islands between which it passed; but the flood appeared to come from the Southward.

18th.

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18th. The calm weather ſince the 14th had given us full time to finiſh the obſervations, and complete our water: a breeze ſpringing up in the morning, I went aſhore to get the inſtruments on board. Between one and two we weighed, with the wind Weſterly, and ſtood to the Northward. Between eleven and twelve at night, having run about eight leagues, we were prevented by the ice from getting farther. We ſtood along the edge of it to the Southward. At two in the morning, being embayed by the ice, I tacked, and left orders to ſtand to the Eaſtward along the edge of the ice, as ſoon as we could weather the point; hoping, if there ſhould be no opening between the land and the ice, that I ſhould at leaſt be able to aſcertain where they joined, and perhaps to diſcover from the land, whether there was any proſpect of a paſſage that way: At that time the ice was all ſolid as far as we could ſee, without the leaſt appearance of water to the Northward.

19th. At ſix in the morning we had got to the Eaſtward among the looſe ice which lay very thick in ſhore, the main body to the Northward and Eaſtward: the land near Deer Field not four miles off, and the water ſhoaled to twenty fathoms. Here we found ourſelves nearly in the ſame place where we had twice been ſtopped, the ice ſituated as before, locked with the land, without any paſſage either to the Eaſtward or Northward: I therefore

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ſtood back to the Weſtward. At noon the Northernmoſt part of Vogel Sang bore S W b S, diſtant about ſeven leagues. The weather being very fine, and the wind to the Eaſtward, we were enabled to coaſt along the ice to the Weſtward, hauling into all the bays, going round every point of ice in ſearch of an opening, and ſtanding cloſe along by the main body all day, generally within a ſhip's length.

20th. At half after three in the morning the land was out of ſight, and we imagined ourſelves in rather more than eighty degrees and an half; ſome of the openings being near two leagues deep, had flattered us with hopes of getting to the Northward; but theſe openings proved to be no more than bays in the main body of the ice. About one in the afternoon, we were by our reckoning in about 80° 34′, nearly in the ſame place where we had been on the 9th. About three we bore away for what appeared like an opening to the S W; we found the ice run far to the Southward.

21ſt. We ſtill continued to run along the edge of the ice, which trended to the Southward. At noon we were in the latitude of 79° 26′, by obſervation, which was twenty-five miles to the Southward of our reckoning. Finding that the direction of the ice led us to the Southward, and that the current ſet the ſame way, I ſtood to the Northward and Weſtward cloſe along the ice, to try whether the

ſea

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ſea was opened to the Northward by the wind from that quarter. At nine in the evening we had no ground with 200 fathom of line. At ten we got into a ſtream of looſe ice. The weather fine, but cool all day, and ſometimes foggy.

22d. At two in the morning we bore away to the N E, for the main body of the ice; the weather became foggy ſoon afterwards. At ſix we ſaw the ice; and the weather being ſtill foggy, we hauled up to the S S E, to avoid being embayed in it. The air very cold.

23d. At midnight, tacked for the body of the ice. Latitude obſerved 80° 13′ 38″. Rainy in the morning; fair in the afternoon: ſtill working up to the Northward and Eaſtward, with the wind Eaſterly. At ſix in the evening, the Cloven Cliff bearing South about ſix leagues, ſounded in 200 fathom, muddy ground; the lead appeared to to have ſunk one third of its length in the mud. At two in the morning, with little wind, and a ſwell from the South Weſt, I ſtood to the Northward amongſt the looſe ice: at half paſt two the main body of the ice a cable's length off, and the looſe ice ſo cloſe that we wore ſhip, not having room or way enough to tack; ſtruck very hard againſt the ice in getting the ſhip round, and got upon one piece, which lifted her in the water for near a minute, before her weight broke it. The ſhips had

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been ſo well ſtrengthened, that they received no damage from theſe ſtrokes; and I could with the more confidence puſh through the looſe ice, to try for openings. Hacluyt's Head Land bore S 50° W diſtant about ſeven leagues.

24th. By this ſituation of the ice we were diſappointed of getting directly to the Northward, without any proſpect after ſo many fruitleſs attempts of being able to ſucceed to the Weſtward; nor indeed, could I with an Eaſterly wind and heavy ſwell attempt it, as the wind from that quarter would not only pack the looſe ice cloſe to the Weſtward, but by ſetting the ſea on it, make it as improper to be approached as a rocky lee ſhore. To the Eaſtward on the contrary it would make ſmooth water, and detach all the looſe ice from the edges; perhaps break a ſtream open, and give us a fair trial to the Northward; at all events, with an Eaſterly wind we could run out again, if we did not find it practicable to proceed. Finding the ice ſo faſt to the Northward and Weſtward, it became a deſirable object to aſcertain how far it was poſſible to get to the Eaſtward, and by that means purſue the voyage to the Northward. Theſe conſiderations determined me to ply to the Eaſtward, and make another puſh to get through where I had been three times repulſed. In working to the Eaſtward, we kept as near the body of the ice as poſſible. At noon the Cloven Cliff bore S W b S about

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about ſeven leagues. At ſix we were working to the NE, and at nine we ſteered to the SE, the ice appearing more open that way: we had freſh gales and cloudy weather. The ſhip ſtruck very hard in endeavouring to force through the looſe ice. At midnight the wind freſhened, and we double reefed the topſails. It was probably owing to the freſh gales this day, as well as to the ſummer being more advanced, that we were enabled to get farther than in any of our former attempts this way. We continued coaſting the ice, and at two in the morning the north part of Vogel Sang and Hacluyt's Head Land in one bore S 65° W; Cloven Cliff S 52° W; the neareſt part of the ſhore about three leagues off. When I left the deck, at four in the morning, we were very near the ſpot where the ſhips had been faſt in the ice on the 7th in the evening, but rather farther to the Eaſtward; we had paſſed over the ſame ſhoal water we had met with that day, and were now in twenty fathom, rocky ground; ſtill amongſt looſe ice, but not ſo cloſe as we had hitherto found it.

25th. At ſeven in the morning we had deepened our water to fifty-five fathom, and were ſtill amongſt the looſe ice. At noon we had deepened our water to ſeventy fathom, with muddy bottom, at the diſtance of about three miles from the neareſt land. By two in the afternoon we had paſſed Deer Field, which we had ſo often before at-

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tempted without succefs; and finding the fea open to the NE, had the moft flattering profpect of getting to the Northward. From this part, all the way to the Eaftward, the coaft wears a different face; the mountains, though high, are neither fo fteep or fharp-pointed, nor of fo black a colour as to the Weftward. It was probably owing to this remarkable difference in the appearance of the fhore, that the old navigators gave to places hereabouts the names of *Red Beach*, *Red Hill*, and *Red Cliff.* One of them, fpeaking of this part, has defcribed the whole country in a few words: "Here "(fays he) I faw a more natural earth and clay than "any that I have feen in all the country, but nothing growing thereupon more than in other "places." At two in the afternoon we had little wind, and were in fight of Moffen Ifland, which is very low and flat.

The Carcafs being becalmed very near the ifland in the evening, Captain Lutwidge took that opportunity of obtaining the following exact account of its extent, which he communicated to me.

"At 10 P M, the body of Moffen Ifland bearing "E b S diftant two miles; founded thirteen fa-"thoms; rocky ground, with light brown mud, "and broken fhells. Sent the mafter on fhore, "who found the ifland to be nearly of a round "form, about two miles in diameter, with a lake

"of

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" or large pond of water in the middle, all frozen " over, except thirty or forty yards round the edge " of it, which was water, with loose pieces of " broken ice, and so shallow they walked through " it, and went over upon the firm solid ice. The " ground between the sea and the pond is from " half a cable's length to a quarter of a mile broad, " and the whole island covered with gravel and " small stones, without the least verdure or vege- " tation of any kind. They saw only one piece of " drift wood (about three fathom long, with a root " on it, and as thick as the Carcass's mizen mast) " which had been thrown up over the high part of " the land, and lay upon the declivity towards the " pond. They saw three bears, and a number of " wild ducks, geese, and other sea fowls, with " birds nests all over the island. There was an in- " scription over the grave of a Dutchman, who " was buried there in July 1771. It was low water " at eleven o'clock when the boat landed, and the " tide appeared to flow eight or nine feet; at that " time we found a current carrying the Ship to the " N W from the island, which before carried us to " the S E (at the rate of a mile an hour) towards " it. On the West side is a fine white sandy bottom, " from two fathoms, at a ship's length from the " beach, to five fathoms, at half a mile's distance " off."

The soundings all about this island, and to the Eastward, seem to partake of the nature of the

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coaſt. To the Weſtward the rocks were high, and the ſhores bold and ſteep too; here the land ſhelved more, and the ſoundings were ſhoal, from thirty to ten fathom. It appears extraordinary that none of the old navigators, who are ſo accurate and minute in their deſcriptions of the coaſt, have taken any notice of this iſland, ſo remarkable and different from every thing they had ſeen on the Weſtern coaſt; unleſs we ſhould ſuppoſe that it did not then exiſt, and that the ſtreams from the great ocean up the Weſt ſide of Spitſbergen, and through the Waygat's Straits, meeting here, have raiſed this bank, and occaſioned the quantity of ice that generally blocks up the coaſt hereabouts.—At four in the afternoon, hoiſted out the boat, and tried the current, which ſet N E b E, at the rate of three quarters of a mile an hour. At midnight, Moffen Iſland bore from S E b S to S b W, diſtant about five miles.

26th. About two in the morning, we had little wind, with fog; made the ſignals to the Carcaſs for keeping company. At half an hour after three in the afternoon, we were in longitude 12° 20′ 45″ E; variation, by the mean of five azimuths, 12° 47′ W. At nine we ſaw land to the Eaſtward; ſteering to the Northward with little wind, and no ice in ſight, except what we had paſſed.

27th.

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27th. Working ſtill to the N E, we met with ſome looſe ice; however from the openneſs of the ſea hitherto, ſince we had paſſed Deer Field, I had great hopes of getting far to the Northward; but about noon, being in the latitude of eighty and forty-eight, by our reckoning, we were ſtopped by the main body of the ice, which we found lying in a line, nearly Eaſt and Weſt, quite ſolid. Having tacked, I brought to, and ſounded cloſe to the edge of the ice, in 79 fathom, muddy bottom.

The wind being ſtill Eaſterly, I worked up cloſe to the edge of the ice, coaſting it all the way. At ſix in the evening we were in longitude 14° 59′ 30″ E, by obſervation.

28th. At midnight the latitude obſerved was 80° 37′. The main body of the ice ſtill lying in the ſame direction, we continued working to the Eaſtward, and found ſeveral openings to the Northward, of two or three miles deep; into every one of which we ran, forcing the ſhip, wherever we could, by a preſs of ſail, amongſt the looſe ice which we found here in much larger pieces than to the Weſtward. At ſix in the morning the variation, by the mean of ſix azimuths, was 11° 56′ W; the horizon remarkably clear. At noon, being cloſe to the main body of the ice, the latitude by obſervation was 80° 36′: we ſounded in 101 fathom, muddy ground. In the afternoon the wind blew freſh at N E, with a thick

fog;

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fog; the ice hung much about the rigging. The loose ice being thick and close, we found ourselves so much engaged in it, as to be obliged to run back a considerable distance to the Westward and Southward, before we could extricate ourselves: we afterwards had both the sea and the weather clear, and worked up to the North Eastward. At half past five the longitude of the ship was 15° 16′ 45″ E. At seven the Easternmost land bore E ½ N distant about seven or eight leagues, appearing like deep bays and islands, probably those called in the Dutch charts the *Seven Islands*; they seemed to be surrounded with ice. I stood to the Southward, in hopes of getting to the Southeastward round the ice, and between it and the land, where the water appeared more open.

29th. At midnight the latitude by observation was 80° 21′. At four, tacked close to the ice, hauled up the foresail and backed the mizen topsail, having too much way amongst the loose ice. At noon, latitude observed 80° 24′ 56″. An opening, which we supposed to be the entrance of Waygat's Straits, bore South; the Northernmost land N E b E; the nearest shore distant about four miles. In the afternoon the officer from the deck came down to tell me, we were very near a small rock even with the water's edge; on going up, I saw it within little more than a ship's length on the lee bow, and put the helm down: before the ship got

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got round, we were close to it, and perceived it to be a very small piece of ice, covered with gravel. In the evening, seeing the Northern part of the islands only over the ice, I was anxious to get round it, in hopes of finding an opening under the land. Being near a low flat island opposite the Waygat's Straits, not higher, but much larger than Moffen Island, we had an heavy swell from the Southward, with little wind, and from ten to twenty fathom: having got past this island, approaching to the high land to the Eastward, we deepened our water very suddenly to 117 fathom. Having little wind, and the weather very clear, two of the officers went with a boat in pursuit of some sea-horses, and afterwards to the low island. At midnight we found by observation the latitude 80° 27′ 3″, and the dip 82° 2′ ½. At four in the morning I found, by Bouguer's log, that the current set two fathom to the Eastward. At six in the morning the officers returned from the island; in their way back they had fired at, and wounded a sea-horse, which dived immediately, and brought up with it a number of others. They all joined in an attack upon the boat, wrested an oar from one of the men, and were with difficulty prevented from staving or oversetting her: but a boat from the Carcass joining ours, they dispersed. One of that ship's boats had before been attacked in the same manner off Moffen Island. From Dr. Irving, who went on this party, I had the following account of the low island.

"We

"We found ſeveral large fir trees lying on the "ſhore, ſixteen or eighteen feet above the level "of the ſea: ſome of theſe trees were ſeventy feet "long, and had been torn up by the roots; others "cut down by the axe, and notched for twelve "feet lengths: this timber was no ways decayed, "or the ſtrokes of the hatchet in the leaſt effaced. "There were likewiſe ſome pipe-ſtaves, and wood "faſhioned for uſe. The beach was formed of "old timber, ſand, and whale-bones.

"The iſland is about ſeven miles long, flat, and "formed chiefly of ſtones from eighteen to thirty "inches over, many of them hexagons, and com-"modiouſly placed for walking on: the middle "of the iſland is covered with moſs, ſcurvy graſs, "ſorrel, and a few ranunculuſes then in flower. "Two rein-deer were feeding on the moſs; one "we killed, and found it fat, and of high flavour. "We ſaw a light grey-coloured fox; and a creature "ſomewhat larger than a weaſel, with ſhort ears, "long tail, and ſkin ſpotted white and black. The "iſland abounds with ſmall ſnipes, ſimilar to the "jack-ſnipe in England. The Ducks were now "hatching their eggs, and many wild geeſe feeding "by the water ſide."

When I left the deck at ſix in the morning, the weather was remarkably clear, and quite calm. To the N E, amongſt the iſlands, I ſaw much ice, but alſo much water between the pieces; which gave

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gave me hopes that when a breeze ſprung up, I ſhould be able to get to the Northward by that way.

30th. Little winds, and calm all day; we got ſomething to the Northward and Eaſtward. At noon we were by obſervation in latitude 80° 31′. At three in the afternoon we were in longitude 18° 48′ E, being amongſt the iſlands, and in the ice, with no appearance of an opening for the ſhip. Between eleven and twelve at night I ſent the maſter, Mr. Crane, in the four-oared boat, amongſt the ice, to try whether he could get the boat through, and find any opening for the ſhip which might give us a proſpect of getting farther; with directions if he could reach the ſhore to go up one of the mountains, in order to diſcover the ſtate of the ice to the Eaſtward and Northward. At five in the morning, the ice being all round us, we got out our ice-anchors, and moored along-ſide a field. The maſter returned between ſeven and eight, and with him Captain Lutwidge, who had joined him on ſhore. They had aſcended an high mountain, from whence they commanded a proſpect extending to the Eaſt and North Eaſt ten or twelve leagues, over one continued plain of ſmooth unbroken ice, bounded only by the horizon: they alſo ſaw land ſtretching to the S E, laid down in the Dutch Charts as iſlands. The main body of ice, which we had traced from Weſt to Eaſt, they now perceived to join to theſe iſlands, and from them to what

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what is called the North East land. In returning, the ice having closed much since they went, they were frequently forced to haul the boat over it to other openings. The weather exceedingly fine and mild, and unusually clear. The scene was beautiful and picturesque; the two ships becalmed in a large bay, with three apparent openings between the islands which formed it, but every-where surrounded with ice as far as we could see, with some streams of water; not a breath of air; the water perfectly smooth; the ice covered with snow, low, and even, except a few broken pieces near the edges: the pools of water in the middle of the pieces were frozen over with young ice.

31st. At nine in the morning, having a light breeze to the Eastward, we cast off, and endeavoured to force through the ice. At noon the ice was so close, that being unable to proceed, we moored again to a field. In the afternoon we filled our cask with fresh water from the ice, which we found very pure and soft. The Carcass moved, and made fast to the same field with us. The ice measured eight yards ten inches in thickness at one end, and seven yards eleven inches at the other. At four in the afternoon the variation was 12° 24′ W: at the same time the longitude 19° 0′ 15″ E; by which we found that we had hardly moved to the Eastward since the day before. Calm most part of the day; the weather very fine; the ice closed

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closed fast, and was all round the ships; no opening to be seen any where, except an hole of about a mile and a half, where the ships lay fast to the ice with ice-anchors. We completed the water. The ship's company were playing on the ice all day. The pilots being much farther than they had ever been, and the season advancing, seemed alarmed at being beset.

August 1st. The ice pressed in fast; there was not now the smallest opening; the two ships were within less than two lengths of each other, separated by ice, and neither having room to turn. The ice, which had been all flat the day before, and almost level with the water's edge, was now in many places forced higher than the main yard, by the pieces squeezing together. Our latitude this day at noon, by the double altitude, was 80° 37′.

2d. Thick foggy wet weather, blowing fresh to the Westward; the ice immediately about the ships rather looser than the day before, but yet hourly setting in so fast upon us, that there seemed to be no probability of getting the ships out again, without a strong East, or North East wind. There was not the smallest appearance of open water, except a little towards the West point of the North East land. The seven islands and North East land, with the frozen sea, formed almost a bason, leaving but about four points opening for the ice to drift out, in case of a change of wind.

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3d. The weather very fine, clear, and calm; we perceived that the ſhips had been driven far to the Eaſtward; the ice was much cloſer than before, and the paſſage by which we had come in from the Weſtward cloſed up, no open water being in ſight, either in that or any other quarter. The pilots having expreſſed a wiſh to get if poſſible farther out, the ſhips companies were ſet to work at five in the morning, to cut a paſſage through the ice, and warp through the ſmall openings to the Weſtward. We found the ice very deep, having ſawed ſometimes through pieces twelve feet thick. This labour was continued the whole day, but without any ſucceſs; our utmoſt efforts not having moved the ſhips above three hundred yards to the Weſtward through the ice, at the ſame time that they had been driven (together with the ice itſelf, to which they were faſt) far to the N E and Eaſtward, by the current; which had alſo forced the looſe ice from the Weſtward, between the iſlands, where it became packed, and as firm as the main body.

4th. Quite calm till evening, when we were flattered with a light air to the Eaſtward, which did not laſt long, and had no favourable effect. The wind was now at N W, with a very thick fog, the ſhip driving to the Eaſtward. The pilots ſeemed to apprehend that the ice extended very far to the Southward and Weſtward.

5th.

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5th. The probability of getting the ſhips out appearing every hour leſs, and the ſeaſon being already far advanced, ſome ſpeedy reſolution became neceſſary as to the ſteps to be taken for the preſervation of the people. As the ſituation of the ſhips prevented us from ſeeing the ſtate of the ice to the Weſtward, by which our future proceedings muſt in a great meaſure be determined, I ſent Mr. Walden, one of the midſhipmen, with two pilots, to an iſland about twelve miles off, which I have diſtinguiſhed in the charts by the name of Walden's Iſland, to ſee where the open water lay.

6th. Mr. Walden and the pilots, who were ſent the day before to examine the ſtate of the ice from the iſland, returned this morning with an account, that the ice, though cloſe all about us, was open to the Weſtward, round the point by which we came in. They alſo told me, that when upon the iſland they had the wind very freſh to the Eaſtward, though where the ſhips lay it had been almoſt calm all day. This circumſtance conſiderably leſſened the hopes we had hitherto entertained of the immediate effect of an Eaſterly wind in clearing the bay. We had but one alternative; either patiently to wait the event of the weather upon the ſhips, in hopes of getting them out, or to betake ourſelves to the boats. The ſhips had driven into ſhoal water, having but fourteen fathom. Should they, or the ice to which they were faſt, take the

 ground,

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ground, they muſt be inevitably loſt, and probably overſet. The hopes of getting the ſhips out was not haſtily to be relinquiſhed, nor obſtinately adhered to, till all other means of retreat were cut off. Having no harbour to lodge them in, it would be impoſſible to winter them here, with any probability of their being again ſerviceable; our proviſions would be very ſhort for ſuch an undertaking, were it otherwiſe feaſible; and ſuppoſing, what appeared impoſſible, that we could get to the neareſt rocks, and make ſome conveniences for wintering, being now in an unfrequented part, where ſhips never even attempt to come, we ſhould have the ſame difficulties to encounter the next year, without the ſame reſources; the remains of the ſhip's company, in all probability, not in health; no proviſions; and the ſea not ſo open, this year having certainly been uncommonly clear. Indeed it could not have been expected that more than a very ſmall part ſhould ſurvive the hardſhips of ſuch a winter with every advantage; much leſs in our preſent ſituation. On the other hand, the undertaking to move ſo large a body for ſo conſiderable a diſtance by boats, was not without very ſerious difficulties. Should we remain much longer here, the bad weather muſt be expected to ſet in. The ſtay of the Dutchmen to the Northward is very doubtful: if the Northern harbours keep clear, they ſtay till the beginning of September; but when the looſe ice ſets in, they quit them immediately. I thought it proper

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proper to ſend for the officers of both ſhips, and informed them of my intention of preparing the boats for going away. I immediately hoiſted out the boats, and took every precaution in my power to make them ſecure and comfortable: the fitting would neceſſarily take up ſome days. The water ſhoaling, and the ſhips driving faſt towards the rocks to the N E, I ordered canvaſs bread-bags to be made, in caſe it ſhould be neceſſary very ſuddenly to betake ourſelves to the boats: I alſo ſent a man with a lead and line to the Northward, and another from the Carcaſs to the Eaſtward, to ſound wherever they found cracks in the ice, that we might have notice before either the ſhips, or the ice to which they were faſt, took the ground; as in that caſe, they muſt inſtantly have been cruſhed or overſet. The weather bad; moſt part of the day foggy, and rather cold.

7th. In the morning I ſet out with the Launch over the ice; ſhe hauled much eaſier than I could have expected; we got her about two miles. I then returned with the people for their dinner. Finding the ice rather more open near the ſhips, I was encouraged to attempt moving them. The wind being Eaſterly, though but little of it, we ſet the ſails, and got the ſhips about a mile to the Weſtward. They moved indeed, but very ſlowly, and were not now by a great deal ſo far to the Weſtward as where they were beſet. However, I

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kept all the ſail upon them, to force through whenever the ice ſlacked the leaſt. The people behaved very well in hauling the boat; they ſeemed reconciled to the idea of quitting the ſhips, and to have the fulleſt confidence in their officers. The boats could not with the greateſt diligence be got to the water ſide before the fourteenth; if the ſituation of the ſhips did not alter by that time, I ſhould not be juſtified in ſtaying longer by them. In the mean time I reſolved to carry on both attempts together, moving the boats conſtantly, but without omitting any opportunity of getting the ſhips through.

8th. At half paſt four, ſent two pilots with three men to ſee the ſtate of the ice to the Weſtward, that I might judge of the probability of getting the ſhips out. At nine they returned, and reported the ice to be very heavy and cloſe, conſiſting chiefly of large fields. Between nine and ten this morning, I ſet out with the people, and got the Launch above three miles. The weather being foggy, and the people having worked hard, I thought it beſt to return on board between ſix and ſeven. The ſhips had in the mean time moved ſomething through the ice, and the ice itſelf had drifted ſtill more to the Weſtward. At night there was little wind, and a thick fog, ſo that I could not judge preciſely of the advantage we had gained; but I ſtill feared that, however flattering, it was not ſuch as to juſtify my my giving up the idea of moving the boats, the ſeaſon advancing ſo faſt, the preſervation of the ſhips being ſo uncertain, and the ſituation of the people ſo critical.

9th. A thick fog in the morning: we moved the ſhip a little through ſome very ſmall openings. In the afternoon, upon its clearing up, we were agreeably ſurprized to find the ſhips had driven much more than we could have expected to the Weſtward. We worked hard all day, and got them ſomething more to the Weſtward through the ice; but nothing in compariſon to what the ice itſelf had drifted. We got paſt the Launches; I ſent a number of men for them, and got them on board. Between three and four in the morning the wind was Weſterly, and it ſnowed faſt. The people having been much fatigued, we were obliged to deſiſt from working for a few hours. The progreſs which the ſhips had made through the ice was, however, a very favourable event: the drift of the ice was an advantage that might be as ſuddenly loſt, as it had been unexpectedly gained, by a change in the current: we had experienced the inefficacy of an Eaſterly wind when far in the bay, and under the high land; but having now got through ſo much of the ice, we began again to conceive hopes that a briſk gale from that quarter would ſoon effectually clear us.

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10th. The wind ſpringing up to the NNE in the morning, we ſet all the ſail we could upon the ſhip, and forced her through a great deal of very heavy ice: ſhe ſtruck often very hard, and with one ſtroke broke the ſhank of the beſt bower anchor. About noon we had got her through all the ice, and out to ſea. I ſtood to the NW to make the ice, and found the main body juſt where we left it. At three in the morning, with a good breeze Eaſterly, we were ſtanding to the Weſtward, between the land and the ice, both in ſight; the weather hazy.

11th. Came to an anchor in the harbour of Smeerenberg, to refreſh the people after their fatigues. We found here four of the Dutch ſhips, which we had left in the Norways when we ſailed from Vogel Sang, and upon which I had depended for carrying the people home in caſe we had been obliged to quit the ſhips. In this Sound there is good anchorage in thirteen fathom, ſandy bottom, not far from the ſhore: it is well ſheltered from all winds. The iſland cloſe to which we lay is called Amſterdam Iſland, the Weſternmoſt point of which is Hacluyt's Head Land: here the Dutch uſed formerly to boil their whale-oil, and the remains of ſome conveniencies erected by them for that purpoſe are ſtill viſible. Once they attempted to make an eſtabliſhment, and left ſome people to winter here, who all periſhed. The Dutch ſhips ſtill

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the ICE, August 10th 1773.

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ſtill reſort to this place for the latter ſeaſon of the whale fiſhery.

12th. Got the inſtruments on ſhore, and the tent pitched; but could not make any obſervations this day or the next, from the badneſs of the weather.

13th. Rain, and blowing hard: two of the Dutch ſhips ſailed for Holland.

14th. The weather being fine and little wind, we began our obſervations.

18th. Completed the obſervations. Calm all day. During our ſtay, I again ſet up the pendulum, but was not ſo fortunate as before, never having been able to get an obſervation of a revolution of the ſun, or even equal altitudes for the time. We had an opportunity of determining the refraction at midnight, which anſwered within a few ſeconds to the calculation in Dr. Bradley's table, allowing for the barometer and thermometer. Being within ſight of Cloven Cliff, I took a ſurvey of this part of Fair Haven, to connect it with the plan of the other part. Dr. Irving climbed up a mountain, to take its height with the barometer, which I determined at the ſame time geometrically with great care. By repeated obſervations here we found the latitude to be 79° 44′, which by the ſurvey correſponded exactly with the latitude of Cloven Cliff, determined before; the longitude 9° 50′ 45″ E; dip 82° 8′ ¼; variation 18° 57′ W; which agrees alſo with the obſervation made on ſhore in July. The tide flowed here half paſt one, the ſame as in Vogel Sang harbour.

Oppoſite to the place where the inſtruments ſtood, was one of the moſt remarkable Icebergs in this country. Icebergs are large bodies of ice filling the vallies between the high mountains; the face towards the ſea is nearly perpendicular, and of a very lively light green colour. This was about three hundred feet high, with a caſcade of water iſſuing out of it. The black mountains, white ſnow, and beautiful colour of the ice, make a very romantick and uncommon picture. Large pieces frequently break off from the Icebergs, and fall with great noiſe into the water: we obſerved one piece which had floated out into the bay, and grounded in twenty-four fathom; it was fifty feet high above the ſurface of the water, and of the ſame beautiful colour as the Iceberg.

A particular deſcription of all the plants and animals will have a place in the Appendix. I ſhall here mention ſuch general obſervations as my ſhort ſtay enabled me to make. The ſtone we found was chiefly a kind of marble, which diſſolved eaſily in the marine acid. We perceived no marks of minerals of any kind, nor the leaſt appearance of preſent, or remains of former Volcanoes. Neither did we meet with inſects, or any ſpecies of reptiles; not even the common earthworm. We ſaw no ſprings or rivers, the water, which we found

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found in great plenty, being all produced by the melting of the ſnow from the mountains. During the whole time we were in theſe latitudes, there was no thunder or lightning. I muſt alſo add, that I never found what is mentioned by Marten (who is generally accurate in his obſervations, and faithful in his accounts) of the ſun at midnight reſembling in appearance the moon; I ſaw no difference in clear weather between the ſun at midnight and any other time, but what aroſe from a different degree of altitude; the brightneſs of the light appearing there, as well as elſewhere, to depend upon the obliquity of his rays. The ſky was in general loaded with hard white clouds; ſo that I do not remember to have ever ſeen the ſun and the horizon both free from them even in the cleareſt weather. We could always perceive when we were approaching the ice, long before we ſaw it, by a bright appearance near the horizon, which the pilots called the *blink of the ice*. Hudſon remarked, that the ſea where he met with ice was blue; but the green ſea was free from it. I was particularly attentive to obſerve this difference, but could never diſcern it.

The Driftwood in theſe ſeas has given riſe to various opinions and conjectures, both as to its nature and the place of its growth. All that which we ſaw (except the pipe-ſtaves taken notice of by Doctor Irving on the Low Iſland) was fir, and not worm-eaten. The place of its growth I had no opportunity of aſcertaining. The

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The nature of the ice was a principal object of attention in this climate. We found always a great ſwell near the edge of it; but whenever we got within the looſe ice, the water was conſtantly ſmooth. The looſe fields and flaws, as well as the interior part of the fixed ice, were flat, and low: with the wind blowing on the ice, the looſe parts were always, to uſe the phraſe of the Greenland-men, *packed*; the ice at the edges appearing rough and piled up; this roughneſs and height I imagine to proceed from the ſmaller pieces being thrown up by the force of the ſea on the ſolid part. During the time that we were faſt amongſt the Seven Iſlands, we had frequent opportunities of obſerving the irreſiſtible force of the large bodies of floating ice. We have often ſeen a piece of ſeveral acres ſquare lifted up between two much larger pieces, and as it were becoming one with them; and afterwards this piece ſo formed acting in the ſame manner upon a ſecond and third; which would probably have continued to be the effect, till the whole bay had been ſo filled with ice that the different pieces could have had no motion, had not the ſtream taken an unexpected turn, and ſet the ice out of the bay.

19th. Weighed in the morning with the wind at NNE. Before we got out of the bay it fell calm. I obſerved for theſe three or four days, about eleven in the evening, an appearance of duſk.

20th.

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20th. At midnight, being exactly in the latitude of Cloven Cliff, Mr. Harvey took an obſervation for the refraction; which we found to agree with the tables. The wind Southerly all day, blowing freſh in the afternoon. About noon fell in with a ſtream of looſe ice, and about four made the main ice near us. We ſtood to the W N W along it at night, and found it in the ſame ſituation as when we ſaw it before; the wind freſhened and the weather grew thick, ſo that we loſt ſight of it, and could not venture to ſtand nearer, the wind being S S W.

21ſt. At two in the morning we were cloſe in with the body of the Weſt ice, and obliged to tack for it; blowing freſh, with a very heavy ſea from the Southward. The wind abated in the afternoon, but the ſwell continued, with a thick fog.

22d. The wind ſprung up Northerly, with a thick fog; about noon moderate and clearer; but coming on to blow freſh again in the evening, with a great ſea, and thick fog, I was forced to haul more to the Eaſtward, leſt we ſhould be embayed, or run upon lee ice.

The ſeaſon was ſo very far advanced, and fogs as well as gales of wind ſo much to be expected, that nothing more could now have been done, had any thing been left untried. The ſummer appears to have been uncommonly favourable for our purpoſe,

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purpofe, and afforded us the fulleft opportunity of afcertaining repeatedly the fituation of that wall of ice, extending for more than twenty degrees between the latitudes of eighty and eighty-one, without the fmalleft appearance of any opening.

I fhould here conclude the account of the voyage, had not fome obfervations and experiments occurred on the paffage home.

In fteering to the Southward we foon found the weather grow more mild, or rather to our feelings warm. Auguft 24th, we faw Jupiter: the fight of a ftar was now become almoft as extraordinary a phenomenon, as the fun at midnight when we firft got within the Arctic circle. The weather was very fine for fome part of the voyage; on the 4th of September, the water being perfectly fmooth with a dead calm, I repeated with fuccefs the attempt I had made to get foundings in the main ocean at great depths, and ftruck ground in fix hundred and eighty-three fathoms, with circumftances (which will be mentioned in the Appendix) that convince me I was not miftaken in the depth; the bottom was a fine foft blue clay. From the 7th of September, when we were off Shetland, till the 24th, when we made Orfordnefs, we had very hard gales of wind with little intermiffion, which were conftantly indicated feveral hours before they came on by the fall of the barometer, and rife of the manometer: this proved to me the utility

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utility of thofe inftruments at fea. In one of thefe gales, the hardeft, I think, I ever was in, and with the greateft fea, we loft three of our boats, and were obliged to heave two of our guns overboard, and bear away for fome time, though near a lee fhore, to clear the fhip of water. I cannot omit this opportunity of repeating, that I had the greateft reafon on this, as well as every other critical occafion, to be fatisfied with the behaviour both of the officers and feamen. In one of thefe gales on the 12th of September, Dr. Irving tried the temperature of the fea in that ftate of agitation, and found it confiderably warmer than that of the atmofphere. This obfervation is the more interefting, as it agrees with a paffage in Plutarch's Natural Queftions, not (I believe) before taken notice of, or confirmed by experiment, in which he remarks, "that the fea "becomes warmer by being agitated in waves."

The frequent and very heavy gales at the latter end of the year, confirmed me in the opinion, that the time of our failing from England was the propereft that could have been chofen. Thefe gales are as common in the Spring as in the Autumn: there is every reafon to fuppofe therefore, that at an early feafon we fhould have met with the fame bad weather in going out as we did on our return. The unavoidable neceffity of carrying a quantity of additional ftores and provifions, rendered the fhips fo deep in the water, that in heavy gales the boats, with many of the ftores, muft probably

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bably have been thrown overboard; as we experienced on our way home, though the ſhips were then much lightened by the conſumption of proviſions, and expenditure of ſtores. Such accidents in the outſet muſt have defeated the voyage. At the time we ſailed, added to the fine weather, we had the further advantage of nearly reaching the latitude of eighty without ſeeing ice, which the Greenlandmen generally fall in with in the latitude of ſeventy-three or ſeventy-four. There was alſo moſt probability, if ever navigation ſhould be practicable to the Pole, of finding the ſea open to the Northward after the ſolſtice; the ſun having then exerted the full influence of his rays, though there was enough of the ſummer ſtill remaining for the purpoſe of exploring the ſeas to the Northward and Weſtward of Spitſbergen.

APPENDIX.

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APPENDIX.

Eſtabliſhment of OFFICERS and MEN for the RACEHORSE.

ONE Commander.
Three Lieutenants.
One Maſter.
One Boatſwain.
One Gunner.
One Carpenter.
One Purſer.
One Surgeon.
One Surgeon's Mate.
One Cook.
Three Maſter's Mates.
Six Midſhipmen.
One Captain's Clerk.
Two Quarter Maſters.
One Quarter Maſter's Mate.
Two Boatſwain's Mates.
One Coxſwain.
One Maſter Sail-maker.
One Sail-maker's Crew.
One Gunner's Mate.
One Yeoman of the Powder Room.
One Quarter Gunner.
One Armourer.
Two Carpenter's Mates.
Two Carpenter's Crew.
One Steward.
One Corporal.
Fifty Seamen.
Two Pilots.
In all Ninety-two.

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Comparative Table of the Latitudes and Longitudes of ſome remarkable Places.

Places.	By Sir Jonas Moore.		By the Atlas Maritimus.		By Robertſon's Navigation.		By Obſervations made this Voyage.	
	Latitude.	Longitude.	Latitude.	Longitude.	Latitude.	Longitude.	Latitude.	Longitude.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Queenborough,	51 30	0 37E	. .	. . .	. .	. . .	. .	. . .
Sheerneſs,	. .	0 37E	. .	. . .	. .	. . .	51 31	0 30E
Orfordneſs,	52 20	1 11E	52 14	1 36E	52 17	1 11E	. .	. . .
Southwold,	. .	. . .	. .	. . .	. .	. . .	. .	1 18E
Flamborough Head,	54 8	0 49W	54 9	0 10E	54 8	0 11E	54 9	0 19E
Whitby,	54 35	1 14W	54 28	0 22W	54 30	0 50W	. .	1 55W
Hangcliff,	. .	. . .	. .	. . .	. .	. . .	60 9	0 56W
Black Point,	78 32	13 10E	77 58	. . .	78 0	10 50E	78 13	10 33E
Hakluyt's Head Land,	. .	. . .	. .	. . .	79 55	12 0E	79 47	9 11E

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Works.

ig.	Magnetic Observations. Dip.		Variation Weſt.	
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OBSERVATIONS on different METHODS of measuring a SHIP'S WAY.

THE degree of accuracy with which the distance run by a ship can be measured, is a thing of great importance, but unfortunately not easily to be ascertained, from the great variety of circumstances which may occasion errors in the reckoning, and which, though not depending upon the measure of the ship's way, may in voyages not nearly upon a meridian be confounded with those that do. The circumstances of the present voyage gave me the fairest opportunity of trying this experiment, the weather being fine, and the course very nearly upon a meridian; so that an error of one point could not make more than the difference of one mile in fifty in the distance. When the difference of latitude is the same as the distance, it gives frequent opportunities of comparing the reckoning with the observation, and whatever error is found must be attributed to the imperfections in the manner of measuring the distance. Most of the writers on this subject have attributed the errors to a faulty division of the log-line.

Before Norwood measured a degree, the length of a minute had been erroneously supposed 5000 feet; in consequence of which, the log line, from the first use of that instrument about the year 1570, was invariably marked forty-two feet to thirty se-

 conds.

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conds. Norwood, when he publiſhed his Seaman's Practice, ſtated the true meaſure to be fifty-one feet to thirty ſeconds; but, as the ſhip would really run more than is given by the log, and it is right to have the reckoning ahead of the ſhip, he recommended marking the log line fifty feet to thirty ſeconds. It does not appear at what time an alteration either in the marking the log, or the length of the glaſs, took place in conſequence of theſe obſervations: Sir Jonas Moore in his Navigation which was publiſhed in the reign of Charles II. mentions, that the ſeamen, having found the old log not to anſwer, had ſhortened the glaſs to twenty-five ſeconds, which was equal to a line marked fifty feet with a glaſs of thirty ſeconds; but he rather recommends reſtoring the half minute glaſs, and making the correction on the line. Since that time the ſeamen, whether from finding the allowance of one foot in fifty not a ſufficient compenſation for the accidental errors to which the log is ſubject, or from a preference of a meaſure nearly equal to the ſtatute mile, have uſed a line of forty five feet to thirty ſeconds, or a glaſs of twenty-eight ſeconds to forty-two feet.

All the writers I have met with, who have treated of the log, except Wilſon, have complained of the ſeamen not having adhered to Norwood's meaſure. Norwood himſelf, however, ſeems to have been aware of the neceſſity of ſubmitting to the teſt of experiment the advantages of a new meaſurement

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furement derived from theory. In the preface to his *Seaman's Practice* he fays, "Becaufe I am per-"fuaded we have at this day as many excellent na-"vigators in this kingdom, and as great voyages "performed, as from any other place in the world, "I fhould be glad to hear of the experimental re-"folution of this problem by fome of them, though "it were but running eight or ten degrees near the "meridian; for fo I doubt not but what I have "here written thereof, would receive further con-"firmation and better entertainment than happily "it will now, being fo much different from the "common opinion."

Had the errors in the diftance arifen only from a fault in marking the line, nothing would have been more eafy than to have removed that difficulty, by comparing carefully the different meafures with the obfervations, and adhering to that which had been found to correfpond beft with them. But the diftance meafured by the log being rendered uncertain by many accidental circumftances, it becomes difficult, or rather impoffible, to find any length of line which will fhew invariably the diftance run by the fhip, or even to afcertain with precifion that meafure which will at all times come neareft the truth. Some of thefe circumftances are:

1. The effects of currents.

2. The yawning of the fhip going with the wind aft, or upon the quarter, when fhe is feldom

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ſteered within a point each way: this I mention as an error in the diſtance, and not in the courſe; ſince, though the ſhip by being yawed equally each way may make the intended courſe good upon the whole, yet the diſtance will be ſhortened as the verſed ſine of the angle between the line intended and that ſteered upon.

3. By the ſhip being driven on by the ſwell, or the log during the time of heaving being thrown up nearer the ſhip.

4. By the log *coming home*, or being drawn after the ſhip, by the friction of the reel and the lightneſs of the log. Norwood mentions theſe two laſt, and ſays, "For theſe cauſes, it is like, there may "ſometimes be allowed three or four fathoms more "than is veered out; but this, (as a thing mutable "and uncertain) being ſometimes more, ſometimes "leſs, cannot be brought to any certain rule, but "ſuch allowance may be made as a man in his ex"perience and diſcretion finds fit."

5. By the log being only a mean taken every hour, and conſequently liable to error from the variations in the force of the wind during the intervals, for which an arbitrary correction is made by the officer of the watch; and though men of ſkill and experience come near the truth, yet this allowance muſt, from its nature, be inaccurate.

Theſe

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These circumstances did not escape M. Bouguer's attention, and his ingenuity suggested to him an improvement of the common log, which would correct the errors likely to arise from the most material of these circumstances: a description of this improvement he published at large in the Memoirs of the Academy of Sciences for the year 1747; it has since been abridged in the edition of his Navigation by De la Caille. It appears extraordinary that this log should never have been made use of by others;—the great reputation of the author, as well as the very good reasons he offers in favour of his improvement, were sufficient inducements to me to try the experiment.

In the log which I made use of,

The length of the cone was —	12 inches.
The diameter of the base —	$5\frac{1}{10}$.
The weight of the cone — —	25 ounces.
The diagonal length of the diver	14 inches.
The length of each side — —	$9\frac{1}{4}$.
The weight of the diver —	$26\frac{1}{2}$ ounces.

The length of line from the diver to the cone, 50 feet; the log line 51 feet to a knot.

Whether M. Bouguer's log will (as he expected) correct the errors arising from currents in the common log, I had no opportunity of discovering in this voyage.

The second error, which no log will correct, cannot be attended with any bad effect, as it must make the reckoning, in whatever degree it takes place, ahead of the ſhip.

By obſerving M. Bouguer's rules in comparing it with the common log, which for that purpoſe muſt be reckoned at fifty-one feet, it will, I think, very fully correct the third and fourth, which are the moſt material errors; as the agitation of the ſea from winds does not exceed the depth to which the diver is let down, and the weight of the whole machine prevents the friction of the reel from having an effect in any degree equal to that which it has on the common log.

The fifth ariſes from the imperfection it has in common with the log generally uſed.

At firſt, on the paſſage out, I contented myſelf with having Bouguer's log occaſionally, to obſerve what precautions were neceſſary to be taken to prevent errors, as well as to find whether its variations from the common log were on the ſame ſide as the meridian obſervation required. I found that it was neceſſary to take care that the diver ſhould be of ſuch a weight as to let only the top of the cone ſwim; but not heavy enough to ſink it, as in that caſe it would be liable to an error in exceſs, by meaſuring the depth that the diver would ſink in addition to the ſhip's way. It was neceſſary to put a weight of lead to the bottom of the diver, to ſink it down to its place before the ſtray line was out,

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The line between the diver and the cone ſhould not be more than fifty feet, that being as great a depth as it will ſink to whilſt the ſtray line is running off the reel when the ſhip has much way through the water.

On the paſſage out, the longeſt period of my trying this log between two obſervations, was from the twenty-fifth to the thirtieth; in which time the ſhip had run four degrees, and the reckoning by Bouguer's log was eighteen miles aſtern of the ſhip: but as it appears that the ſhip on the twenty-ſixth, with the wind Northerly, and making barely an Eaſt courſe, was found by the obſervation to be twenty miles to the Northward of her reckoning, that diſtance muſt be attributed to a current; therefore if that current had not taken place, Bouguer's log would have been, inſtead of eighteen miles aſtern, two miles ahead of the ſhip.

On the paſſage home it was tried from the latitude of eighty degrees eleven minutes to ſixty-eight degrees eleven minutes; in which diſtance, though the ſhip was much yawed from the ſea being frequently upon the quarter, this log was only thirty-one miles ahead of the ſhip, which might be owing entirely to that circumſtance without any other cauſe.

The ſtate of the common log on the paſſage out, when the weather was remarkably fine and water in general ſmooth, was, from the latitude of ſixty degrees thirty-ſeven minutes to ſeventy-eight degrees eight minutes, with the line marked fifty-one feet to thirty ſeconds, one degree fifty-eight minutes aſtern of the ſhip, with the line marked forty-five feet to thirty ſeconds, four miles ahead of the ſhip. On the paſſage home, the log at fifty-one feet to thirty ſeconds, thirty-five miles aſtern of the ſhip; at forty-five to thirty ſeconds, one degree ſeven minutes ahead of the ſhip. As far therefore as the experience of this voyage extends, it appears that the errors of the log marked forty-five feet are always on the ſafe ſide, and that thoſe of the longer marked line are always ſhort of the run; but that Bouguer's is much more accurate than either.

It is not to be expected that the obſervations of a ſingle voyage can be ſufficient to determine the merit of any inſtrument, particularly one of ſo much conſequence as the log. I thought it right, however, to give an account of the trial I made of the different methods, and of ſuch remarks as occured to me.

In the following table the courſe is put down, in the firſt colum, for all the diſtances and latitudes; after the diſtance and latitude, according to each marking of the log, there is a column for the difference between that latitude, and the latitude obſerved. I thought it beſt to continue the reckonings without corrections, as if there had been no obſervation, in order to ſhew the difference upon the whole run, as well as from one obſervation to another.

TABLE

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Day of the Month.	Course.	By the Co… marke…	
		Diftance.	Latitude by Account.
	°		° ′
June 16	N 27 E	27	60 3
17	N 7 E	136	62 5
18	N 7 W	131	65
19	N 4 W	54	65 5
20	N 20 E	59	66 4

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I alſo tried two perpetual logs; one invented by Mr. Ruſſell, the other by Foxon, both conſtructed upon this principle, that a Spiral, in proceeding its own length in the direction of its axis through a reſiſting medium, makes one revolution round the axis; if therefore the revolutions of the ſpiral are regiſtered, the number of times it has gone its own length through the water will be known. In both theſe the motion of the ſpiral in the water is communicated to the clock-work within board, by means of a ſmall line, faſtened at one end to the ſpiral, which tows it after the ſhip, and at the other to a ſpindle which ſets the clock-work in motion. That invented by Mr. Ruſſell has a half ſpiral of two threads, made of copper, and a ſmall dial with clock-work, to regiſter the number of turns of the ſpiral. Foxon's has a whole ſpiral of wood with one thread, and a larger piece of clock-work, with three dials, two of them to mark the diſtance, and the other divided into knots and fathoms, to ſhew the rate by the half minute glaſs, for the convenience of comparing it with the log.

This log, like all others, is liable to the firſt error, as well as to the ſecond. The third it partakes of in a very ſmall degree, only affecting the reckoning by that quantity which the ſpiral is thrown towards the ſhip; whereas in the log the ſame circumſtance affects the whole rate for the hour. The fourth it is entirely free from, as well

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as the fifth. It will have the advantage of every other in ſmooth water and moderate weather, when it is neceſſary to ſtand on one courſe for any particular diſtance, eſpecially in the night, or a fog, as it meaſures exactly the diſtance run. It will alſo be very uſeful in finding the trim of a ſhip, when alone; as well as in ſurveying a coaſt in a ſingle ſhip, or in meaſuring diſtances in a boat between headlands or ſhoals, when a baſe is not otherwiſe to be obtained; both which it will do with the greateſt accuracy in ſmooth water, with a large wind, and no tide or current. But notwithſtanding theſe advantages, which will make it very uſeful and worth having, I doubt much whether it might ever be ſubſtituted entirely in the room of the common log. Machines eaſily repaired or replaced have advantages at ſea, which ſhould not lightly be given up for others more ſpecious.

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Observations on the Uſe of the Megameter in Marine Surveying.

THE greateſt difficulty in marine ſurveying is that of obtaining an accurate baſe, from the extremities of which the angles may be taken with preciſion, for aſcertaining the bearings and diſtance of headlands and ſhoals, when either want of time or other circumſtances make it impracticable to land and meaſure a baſe. The uſual way is, to eſtimate the diſtance by the log, and to take the angles by the compaſs. This method is liable to many errors, and affords no means of correcting or diſcovering them. The Megameter, conſtructed upon the principles of the object-glaſs micrometer, deſcribed by M. de Charniere and applied by him to find the longitude at ſea, I thought might be uſefully applied to marine ſurveying. That which I uſed was made by Ramſden, with ſome improvements. The advantages I imagined might be derived from this inſtrument were, a more correct and expeditious manner of determining the poſition of coaſts, and the diſtance of ſhoals or the ſhip from headlands. This inſtrument being divided to ten ſeconds, an angle may be taken by it with great accuracy to five ſeconds. The height of a ſhip's maſt-head above the water being known, it is eaſy to find with this inſtrument, by a ſingle obſervation, the diſtance between two ſhips, and con-

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consequently to determine a base. The angles being taken with an Hadley's quadrant from each of the ships, to the objects whose situations are designed to be ascertained, the distance may be found; and, consequently, their relative situations. If there is a megameter in each ship, the altitudes taken from both ships at one instant, and the angles of the different parts of the coast intended to be surveyed observed with an Hadley's quadrant at the same time, will give the situation with more accuracy and expedition than any method of surveying from ships hitherto practised; with the farther advantage of the certain means of detecting any error in the observation, so as to judge whether it is of sufficient importance to be attended to. The only precautions necessary are; to make the observations at the same instant, to prevent their being affected by any alteration in the relative position of the ships, as a very small one there would occasion a considerable error in the distance; and to be careful in chusing objects sufficiently defined and remarkable. This method of surveying has the further advantage of giving the scale of a coast; Seamen, though they judge very accurately of their distance from places upon coasts well known to them, are very often mistaken when they fall in with land they have never seen before; of which we had, at first, some instances in this voyage, the height of the mountains, before we knew the scale of the coast, making us always think ourselves nearer

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nearer the land than we really were. Where the coaſt is at all high, the megameter affords a very accurate and expeditious method of determining the height of all the points, when their diſtances are found; and thence, the heights being known, of aſcertaining immediately by a ſingle obſervation the ſituation of the ſhip, or the latitude of any point by the bearings at the time of a meridian obſervation: the direction and rate of currents or tides may alſo be found in this manner with great accuracy. I made ſeveral obſervations during this voyage with the megameter, ſome of which I ſhall give as examples; they were ſufficient to prove to me the great accuracy that may be attained with this inſtrument after ſome practice. The utility of ſuch a method of obtaining a ſurvey on an enemy's or undeſcribed coaſt, as well as that of being able to prove the truth of charts by a ſingle obſervation, is obvious.

June the fifteenth, the ſhip being in latitude 60° 19′, longitude 0° 39′ W, Hangcliff bore S 63° 00′ W; variation, 23° W.

The altitude of the Carcaſs's maſt, by the megameter, was 35′ 48″; height of the maſt, 102,75 feet; hence the diſtance between the Racehorſe and Carcaſs was 9861 feet: angle between the Carcaſs and Hangcliff, 85° 48′; between the Racehorſe and Hangcliff, 87° 00′; From whence the difference of latitude was found 10′ S; difference of

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of longitude 17′ W. Therefore, the latitude of Hangcliff is 60° 9′; longitude 0° 56′ W.

July the ſecond, to try how far the megameter could be depended upon, I obſerved the altitude of the Carcaſs's maſt 2° 23′ 48″; the angle between the main-yard and main-topſail yard, 0° 44′ 26″; hence the diſtance between the main-yard and main-topſail yard came out — 31,750 feet.
By meaſurement it was found 34,125 feet.

Difference 2,375 feet.

The diſtance between the two ſhips, deduced from the altitude of the maſt, was 2457 feet.
By the angle of the main and main-topſail yard, the diſtance between them being 34,125 feet, — — 2640 feet.

Difference 183 feet.

Which is not more than the ſhips might have changed their poſition in the time of reading off and ſetting down the firſt obſervation before taking the ſecond.

An error of ten ſeconds in the obſervation of the angle ſubtended by the maſt at this diſtance, would make an error of two feet and three quarters in the diſtance. At the diſtance of a nautical mile it would produce an error of ſixteen feet. At other diſtances the error decreaſes as the ſquares of the diſtances

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diſtances decreaſe; and at other heights it decreaſes as the heights decreaſe.

Whenever the diſtance of the object, whoſe angle is taken by the megameter, does not exceed that of the viſible horizon, the very ſmall portion of the earth's ſurface intercepted between the object and obſerver, may be conſidered as a plane, to which the object is perpendicular, and the diſtance may be concluded by reſolving the right-angled triangle, formed by the upright object, and lines drawn from the obſerver's ſtation to the top and bottom of it.

But in greater diſtances, the bottom of the object being concealed from the ſight of the obſerver, it becomes neceſſary to have recourſe to a different calculation.

The only caſes which can occur in practice are two; the one when the height is given to find the diſtance; the other when, the diſtance being known, the height of the object is to be deduced from the obſervation: both which are eaſily ſolved by the following practical rules.

To find the Diſtance.

To the apparent altitude of the object above the ſenſible horizon, add the complement of the dip anſwering to the height of the obſerver's eye above the ſea; the ſum is the angle B A E (fig. 1.); and ſay: As the ſemi-diameter of the earth increaſed by the height of the object, is to the ſemidiameter increaſed by the height of the eye; ſo is the ſine of B A E, BAE, to another ſine, which is that of the angle B; the difference between 180°, and the ſum of the two angles BAE and B, is the value, in degrees and minutes, of the arc GC of the earth's ſurface intercepted between the eye and object. Multiply the number of minutes and decimal parts of a minute in this arc by the value of one minute in miles, fathoms, or ſuch meaſure as may be moſt convenient, and you will have the diſtance in the like meaſure.

EXAMPLE.

The height of Snow Peak being 1503 yards, its apparent altitude above the horizon of the ſea was obſerved to be — — 1° 47′ 6″
The height of the eye being 16 feet,
the complement of the dip is 82° 56′ 11″

The ſum is EAB 91° 43′ 17″

To the ſemidiameter of the earth in yards	6966382	- -	6966382
Add the height of the object	1503	Add the height of the eye	5⅓
Semidiam. + height of the object	6667885	Semidiam. + height of the eye	6966387⅓

As

As 6967885		Co.	Ar.		3,1568990
To 6966387 ½					6,8430076
So is Sine E A B	90°	43′	17″		9,9998040
To fine B	87	54	30		19,9997106
	179	37	47		
Subtracted from	180	0	0		
	0	22	13	the distance.	

Therefore the distance is 22,22 minutes, or nautical miles.

This multiplied by - 2040 the number of yards in one minute,

The product 45328,8 is the distance in yards.

To find the Height.

To the apparent altitude of the object above the fensible horizon, add the complement of the dip anfwering to the height of the obferver's eye above the fea, the fum is the angle B A E; to this add the horizontal diftance of the eye and object in degrees and minutes, and fubtract the fum from 180°, the remainder is the angle B: then fay, as the fine of B is to the fine of B A E, fo is the femidiameter of the earth increafed by the height of the eye to a fourth number; from which fubtracting the femidiameter of the earth, the remainder is the height of the object.

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EXAMPLE.

July the second, the apparent altitude of Snow Peak was observed to be, at the distance of 37507 yards or 18′ 30″	2°	12′	20″
The height of the eye being 5 1/3 yards, the complement of the dip is - - - -	89	56	11
Hence the angle BAE	92	8	31
Horizontal distance		18	30
	92	27	1
Subtracted from	180		
Angle B	87	32	59

Semidiameter of the earth 6966382
Height of the Eye 5 1/3

Semidiameter + height of the eye 6966387 1/3

As sine B	87°	32′	59″ Co. Ar.	0,0003972
To sine BAE	92	8	31	9,9996965
So is semidiameter + height of the eye = 6966387 1/3 yards				6,8430076
To 6967888				16,8431013

Semidiameter 6966382

Height 1506 in yards.

DEMON-

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DEMONSTRATION.

Let GFC (plate I. fig. 1.) represent the surface of the earth, E its centre, BC the height of a hill or other object rising perpendicular from C; A is the place of the observer's eye, whose height above the level of the sea is AG. Draw AH perpendicular to AE, and AF touching the circle GFC in F. Then HAF is the dip, EAF its complement, DAB is the apparent altitude of the object above the sensible horizon; to this add EAD, the sum is EAB. In the triangle EAB, the side EA is the sum of the semidiameter EG and GA the height of the observer's eye; EB the sum of the semidiameter EC and CB the height of the object; the angle AEB is measured by GC the horizontal distance between the observer and object. Now in the first case there are given in the triangle EAB, the sides EA, EB, and the angle BAE, to find the angle AEB; and in the second there are given the angles BAE, AEB and the side EA, to find the side EB and consequently BC. The trigonometrical solutions of these cases are the above practical rules.

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OBSERVATIONS on the VARIATION.

THE Variation of the compaſs, always an intereſting object to navigators and philoſophers, became peculiarly ſo in this voyage from the near approach to the Pole. Many of the theories that had been propoſed on this ſubject, were to be brought to the teſt of obſervations made in high latitudes, by which alone their fallacy or utility could be diſcovered. They of courſe engaged much of my attention, and gave me the fulleſt opportunity of experiencing, with regret, the many imperfections of what is called the Azimuth compaſs. This inſtrument, though ſufficiently accurate to enable us to obſerve the variations ſo as to ſteer the ſhip without any material error, with the precaution of always uſing the ſame compaſs by which they are taken, is far from being of ſuch a conſtruction as to give the variation with that degree of preciſion, which ſhould attend experiments on which a theory is to be founded, or by which it is to be tried. The obſervations taken in this voyage will fully evince this, by their great variations from one another in very ſhort intervals of time; nor is this diſagreement of ſucceſſive obſervations peculiar to the higher latitudes, and to be imputed to a near approach to the Pole, as I found it to take place even upon the Engliſh coaſt.

As to the obſervations themſelves, they were taken with the greateſt care, and the moſt ſcrupulous attention to remove every circumſtance which

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which might be ſuppoſed to create an accidental error; the obſervations being taken ſometimes by different people with the ſame compaſs, in the ſame and different places; ſometimes with different compaſſes, changing the places and the obſervers repeatedly, to try whether there was any error to be imputed to local attraction, or the different mode of obſervation by different perſons. I have ſince my return tried the compaſſes by a meridian as well as by taking azimuths, and find them to agree with one another, though the ſame compaſs ſometimes differs from itſelf a degree in ſucceſſive obſervations.

That every perſon may (as far as is poſſible without having been preſent at the time) be enabled to judge of the degree of accuracy to be expected in ſuch obſervations, as well as the degree of attention paid to thoſe made by us, I have ſet down every circumſtance that I thought material, giving every part of each obſervation, with each ſeparate reſult, and the mean of every ſet, with the weather at the time. Whenever I mention its blowing freſh, it was only comparatively with reſpect to the reſt of the voyage, no obſervation having been made in any weather which might not generally ſpeaking be called fine.

Having ſaid ſo much of the inaccuracy of the inſtrument, I muſt add, that I think ſome general and rather curious inferences may ſafely be drawn from theſe obſervations. One is, that the variation

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near the latitude of eighty, if it alters at all with time, does not alter in any degree as it does in these latitudes: the variation having been found by Poole in 1610 to be 22° 30′ W in latitude 78° 37′; 18° 16′ W in Croſs Road in latitude 79° 15′ N; and 17° 00′ within the foreland in latitude 78° 24′. By Baffin in 1613, in Horne Sound, latitude 76° 55″, the variation from the meridian was 12° 14′ W; but by his compaſs 17°: his compaſs "was touched 5½ Eaſterly," that being the variation in London at that time: in Green Harbour, latitude 77° 40′, he obſerved the variation 13° 11′ W. Fotherby in 1614, made the variation in Magdalena Bay, latitude 79° 34′ N, 25° 00′ W; and in latitude 79° 8′, two points. Neither Poole nor Fotherby mention whether their variations are reckoned from the meridian, or whether their compaſſes, like Baffin's, were fitted to the variation at that time in London. If Fotherby's were taken with a compaſs in which a correction was made for the variation at London, his obſervation agrees exactly with thoſe made by me in Vogel Sang and Smeerenberg; and thoſe of Poole and Baffin differ ſo little from mine, that the difference need not be regarded. But the variation in London now differs from what it was at that time above twenty-ſix degrees.

The other inference is, that in going to the Eaſtward in the latitude of eighty, the Weſterly variation decreaſes very conſiderably from a difference in the longitude.

Table

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28 at 6 AM.	80 30	15 14				12 54 11 24 11 24 11 56 12 30	11 56	Light Breezes, and the Water ſmooth.
31 at 4 PM.	80 35	19 0				12 24		The Weather very fine, and the Water quite ſtill.
	79 44	9 51	At Smeerenberg.			18 57		
Aug. 31. at 4 PM.	68 46	3 24	15 3	N 87 59W	107 32	19 33		
			4 25	N 53 45W	70 40	25 4		

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ACCOUNT of the OBSERVATIONS made with the MARINE DIPPING NEEDLE, constructed for the Board of Longitude by Mr. Nairne.

"THE instrument, hanging by an universal "joint on a triangular stand, is adjusted so "as to hang in a plane perpendicular to the hori- "zon, by means of a plumb line, which is to be "suspended on a pin above the divided circle, and "the dovetail work, which alters the position of "the instrument, by turning a button. The two "90° on the divided circle, are adjusted so as to "be perpendicular to the horizon, by the same "plumb line and the adjusting screw: and at the "lowest 90°, when it is adjusted, the pointer is "fixed. The length of the magnetic needle is "twelve inches, and its axis (the ends of which "were of gold alloyed with copper) rested on fric- "tion wheels of four inches diameter, each end on "two friction wheels; which wheels were balanced "with great care. The ends of the *axes* of the "friction wheels were likewise of gold alloyed "with copper, and moved in small holes made in "bell metal; and opposite the ends of the *axes* of "the needle and the friction wheels, were flat "agates finely polished. The magnetic needle vi- "brated within a circle of bell metal, divided "from the lower 90° each way, as far as sixty-five "degrees, into degrees and half-degrees: the

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"other divisions were two degrees and a half; the "needle being very nearly balanced before it was "made magnetical: but by means of the cross, "fixed on the axis of the needle (on the arms of "which were cut very fine screws, to receive the "small buttons, that might be screwed nearer or "farther from the axis) the needle could be ad-"justed both ways to a great nicety, after it was "made magnetical, by changing the sides of the "needle, and reversing the Poles. As this needle "at sea could seldom remain at rest; to remedy "in a great measure this inconvenience, the di-"vided circle is made moveable by turning the "button; so that when it is used at sea, the di-"vided circle is moved till some principal division "is the mean of the vibrations: then that number "of degrees and half-degrees distant from the "pointer, subtracted from ninety, gives the dip, "if the needle is properly balanced: but lest it "should be somewhat out of balance, the most "certain way is, first, to take the dip with the "face of the divided circle to the East, and after-"wards to the West, and then changing the ends "of the needle by reversing the Poles, and taking "the dip as before, with the divided circle front-"ing the East and West: and the mean of those "four dips will be the most accurate. In each case, "when the dip is taken, the instrument must be "so placed that the needle vibrates in the magnetic "meridian."

The

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The obſervations on the dip of the needle, during this voyage, were made with great care: firſt the dip was obſerved with the divided arch to the Eaſt, the inſtrument being placed as near as poſſible in the magnetic meridian; it was then turned, and the obſervation made with the divided arch to the Weſt: the poles being changed, the obſervation was repeated in the ſame manner. The actual obſervations are expreſſed in the ſecond, third, fourth, and fifth columns; and the mean reſult in the ſixth. It appears by theſe obſervations that the dip increaſes in going North.

There is no reaſon at preſent to ſuppoſe that the dip is liable to any variation in the ſame place at different periods of time, it having been obſerved in London by Norman, who firſt diſcovered it in 1592, to be 71° 50'; and by Mr. Nairne, in 1772, about 72°. The difference between theſe obſervations, taken at ſuch diſtant periods, is ſmaller than that found between ſeveral of Mr. Nairne's obſervations compared with each other; and therefore we have no reaſon to conclude that the dip has altered ſince Norman's time: the care with which his inſtrument was conſtructed, and his obſervations made, leaves no room to doubt of their accuracy.

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TABLE of the OBSERVATIONS made with the Marine DIPPING-NEEDLE.

Day of the Month.	West.	East.	West.	East.	Mean Dip	Place of Observation.
	° ′	° ′	° ′	° ′	° ′	
June 2 P. M.	73 0	73 15	73 20	74 30	73 31	Latitude 51 35 near the Buoy of the Upper Middle.
2 P. M.	74 30	73 0	73 20	73 30	73 35	
5 P. M.	70 20	73 0	73 15	72 15	72 12	Off Harwich
6 P. M.	72 0	75 0	72 0	74 30	73 22	In Southwold Bay.
14 P. M.	72 30	73 30	74 0	74 0	73 30	Off Shetland
8 P. M.	75 15	75 30	74 0	76 30	75 18	° ′
15, 8 A. M.	74 30	74 30	75 0	75 30	74 52	Latitude 60 18
P. M.	74 30	75 30	75 0	75 0	75 0	
16 P. M.	77 0	76 30	76 30	77 0	76 45	
22 Noon	78 0	77 30	78 0	78 0	77 52	Latitude 70 45
23, 9 P. M.	81 30	80 0	83 0	81 30	81 30	Latitude 72 40
24 Noon	82 30	79 30	81 30	79 0	80 35	Latitude 73 22
P. M.	77 30	77 30	81 0	82 0	79 30	Latitude 73 36
26, 2 P. M.	77 30	80 0	82 0	78 0	79 22	Latitude 74 30
28 Mid.	83 30	80 0	82 0	79 0	81 7	Latitude 77 48
29, 2 P. M.	79 15	81 0	78 30	83 0	80 26	Latitude 78 2
30 Noon	76 45	79 30	82 30	79 45	79 30	Latitude 78 8
July 2, Mid.	80 30	82 30	80 30	79 30	80 45	Latitude 78 24
9, 6 P. M.	82 45	81 45	83 0	80 0	81 52	Latitude 80 12
15	81 45	81 15	82 0	82 30	81 52½	On Shore.
	82 45	81 15	82 50	81 10	82 7½	Latitude 79 50
29 Mid.	83 15	83 0	80 40	81 15	82 2¼	Latitude 80 27
August 14	83 0	83 0	81 15	81 20	82 8¾	At Smeerenberg. Latitude 79° 44′ on shore.
31 P. M.	79 30	77 45	80 0	79 0	79 4	Latitude 69° 2′

ACCOUNT

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Account of the Instruments made uſe of for keeping the Meteorological Journal.

THE Marine Barometer was made by Mr. Nairne, from whom I received the following deſcription:

"The bore of the upper part of the glaſs tube "of this barometer, is about three-tenths of an "inch in diameter, and four inches long. To "this is joined a glaſs tube, with a bore about "one-twentieth of an inch in diameter. The two "glaſs tubes being joined together, form the tube "of this barometer; and being filled with mercu-"ry, and inverted into a ciſtern of the ſame, the "mercury falls down in the tube till it is counter-"balanced by the atmoſphere.

"In a common barometer, the motion of the "mercury up and down in the tube is ſo great at "ſea, that it is not poſſible to meaſure its perpen-"dicular height; conſequently, cannot ſhew any "alteration in the weight of the atmoſphere: but "in this marine barometer, that defect is reme-"died. The inſtrument is fixed in gimmals, and "kept in a perpendicular poſition by a weight "faſtened to the bottom of it.

"The

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"The perpendicular rising or falling of the mer-"cury is measured by divisions, on a plate divided "into inches and tenths, and by a Vernier division "into hundredths of an inch, which is fixed to the "side of the tube."

The HYGROMETER I was favoured with by M. De Luc; and the following account is a literal translation of that which he gave me in French.

THE part of M. De Luc's Hygrometer which is affected by the impressions of the moisture of the air, is a hollow cylinder of ivory, two inches eight lines long, and internally two lines and a half in diameter. It is open only at one end; and the thickness of its sides, for the length of two inches six lines from the bottom, is but three-sixteenths of a line. It is this thin part which does the office of an hygrometer; the remaining part of the cylinder, towards its orifice, must be kept a little thicker, being destined for joining it to a tube of glass, thirteen or fourteen inches long. This junction is effected by means of a piece of brass, and the whole is cemented together with gum lac.

M. De Luc's reason for chusing ivory as the hygrometer, is, that this matter appeared to him more proper than any other for receiving the impressions of the moisture of the air, without suffering thereby any essential change. The cylinder made of it becomes more capacious, in proportion

as

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as it grows moifter. This is the fundamental principle of the inftrument. M. De Luc has fince found, that upon letting this cylinder lie fome time in water of an uniform temperature, it fwells to a certain point, after which it dilates no farther. This circumftance furnifhed him with a *maximum* of humidity; and, confequently, with one point of comparifon in the fcale of the hygrometer; and this point he has fixed at the temperature of melting ice. For meafuring the differences in the capacity of this ivory cylinder, and thereby difcovering its different degrees of moifture, M. De Luc makes ufe of quickfilver, with which he fills the cylinder, and a part of the communicating glafs tube. The more capacious this cylinder is, or, which is the the fame, the moifter it is, the lower does the mercury ftand in the glafs tube; and *vice verfa*. Now M. De Luc has found, that the loweft point to which it can fink, is that where it ftands when the ivory cylinder is foaked in melting ice: he therefore names this point *zero*, in the fcale of his hygrometer; and confequently, the degrees of this fcale are *degrees of drynefs*, counted from below upwards, as the quickfilver rifes in the glafs tube.

To give thefe degrees a determinate length, and thus render the hygrometers capable of being compared with each other, M. De Luc employs in conftructing them fuch glafs tubes as have been previoufly prepared, by being made into thermometers,

and

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and filled with mercury, ſo as to aſcertain upon them the points of melting ice and boiling water, and to take exactly the diſtance between thoſe points by any ſcale at pleaſure. That done, the bulb of this preparatory thermometer muſt be broken, and the quickſilver it contains exactly weighed. It is by knowing the weight of this, together with the diſtance between the fixed points of the thermometer, that the ſcale of the hygrometer is determined. For inſtance, let the weight of the quickſilver be one ounce, and the diſtance between the two abovementioned points, one thouſand parts of a certain ſcale: then ſuppoſe that the quickſilver in the hygrometer, to which this tube is to be applied, weighs only half an ounce; this will give a fundamental line, conſiſting of five hundred parts of the ſame ſcale. The fundamental line, thus found, is applied to the ſcale of the hygrometer, beginning at *zero*, and meaſuring it off about four times over, that the whole variation of the inſtrument may be comprehended. Each of thoſe ſpaces being afterwards divided into forty equal parts, gives ſuch degrees as M. de Luc has found moſt convenient. In general terms, the length of the fundamental line of the hygrometer, muſt be to the interval between the two fixed points of the preparatory thermometer, as the weight of the quickſilver in the hygrometer, is to the weight of the quickſilver in that thermometer.

This

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This proportion between the ſcale of the hygrometer and that of the preparatory thermometer, furniſhes an eaſy method of correcting in this inſtrument the effects of heat upon the mercury it contains.

It will eaſily be conceived, from the conſtruction of the ſcale of this hygrometer, that if its cylinder of ivory was ſuddenly changed into glaſs, the inſtrument would become a true thermometer, in which the interval between the points, anſwering to melting ice and boiling water, would be divided into forty parts. If, therefore, a thermometer, with a ſcale ſimilarly divided into forty parts between the fixed points, be placed near the hygrometer, it will ſhew immediately the correction to be made on that inſtrument for its variation as a thermometer; with ſome reſtrictions, however; of which M. De Luc has given an account in the paper he ſent to the Royal Society on the ſubject of this hygrometer.

That part of the frame of the inſtrument on which the ſcale is marked, is moveable; ſo that, before obſerving the points at which the mercury ſtands, it may be puſhed upwards or downwards, according as the thermometer has riſen or fallen with reſpect to the point of melting ice: and thus the indications of the hygrometer can at once be freed from the errors which would ariſe from the difference in the volume of the quickſilver, on account of the different degrees of heat.

Deſcription

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Defcription of the Manometer, conftructed by Mr. Ramfden.

The Manometer ufed in this voyage was compofed of a tube of a fmall bore, with a ball at the end; the barometer being at 29,7, a fmall quantity of quickfilver was put into the tube to take off the communication between the external air, and that confined in the ball and the part of the tube below this quickfilver. A fcale is placed on the fide of the tube, which marks the degrees of dilatation arifing from the increafe of heat in this ftate of the weight of the air, and has the fame graduation as that of Fahrenheit's thermometer, the point of freezing being marked 32. In this ftate therefore it will fhew the degrees of heat in the fame manner as a thermometer. But if the air becomes lighter, the bubble inclofed in the ball, being lefs compreffed, will dilate itfelf, and take up a fpace as much larger, as the compreffing force is lefs; therefore the changes arifing from the increafe of heat will be proportionably larger; and the inftrument will fhew the differences in the denfity of the air, arifing from the changes in its weight and heat. Mr. Ramfden found, that a heat, equal to that of boiling water, increafed the magnitude of the air from what it was at the freezing point $\frac{484}{1000}$ of the whole. From this it follows, that the ball and the part of the tube below the

beginning

beginning of the ſcale is of a magnitude equal to almoſt 414 degrees of the ſcale.

If we have the heihgt of both the manometer and thermometer, the height of the barometer may be thence deduced by this rule; as the height of the manometer increaſed by 414, is to the height of the thermometer increaſed by 414; ſo is 29,7, to the height of the barometer.

This inſtrument, though far from complete, having been conſtructed in a hurry for the purpoſe of a firſt experiment, and liable to ſome inaccuracies in the obſervations from not having the thermometer with which it was compared attached to it, ſeldom differed from the marine barometer $\frac{1}{10}$ of an inch. Should it be improved to that degree of accuracy of which it ſeems capable, it will be of great uſe in determining refractions for aſtronomical obſervations, as well as indicating an approaching gale of wind at ſea.

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21	Noon.	[illegible]	[illegible]	[illegible]	47	[illegible]	[illegible]	S. cloudy	
	Midnight.	41½							1
	Noon.	39½	29,66	. .	. .	79 57	0 37	fair.	
6	6 P. M.	41							

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6	[illegible]	59	29,13	39	60	62	27	1	12	E by S, hazy.	
	8 P. M.	56	. . .	.	54	. .	.	. .	.		
	Midnight.	56½	. . .	.	58	. .	.	. .	.		
7	8 A. M.	58	. . .	.	61	. .	.	. .	.	SE, hazy.	
	Noon.	61	29,02	36	64	60	1	2	35		
8	4 A. M.	54	. . .	33½	65	. .	.	. .	.	SW, ſmall rain.	
	8 A. M.	54½	. . .	33	64½	. .	.	. .	.	Squally and rain.	
	Noon.	56	28,71	30	66	59	35	1	9	SW by S, hazy.	Freſh gales.
9	Noon.	56	28,70	41	66½	59	9	0	37	WSW, hazy.	Freſh gales.
10	. . . .	. . .	. . .	.	.	. .	.	. .	.	. . . .	The weather was ſo bad, and the ſhip had ſo much motion, that the Barometer could not be obſerved this day.
11	Noon.	50	29,20	41	59	57	25	1	32 E.	SW, hazy.	Freſh gales.
25	8 A. M.	. . .	29,66	. .	. .	. .	.	. .	.	SW, } cloudy.	
	Noon.	61	29,66	44	. .	. .	.	. .	.	SW by W, } cloudy.	
	11 P. M.	. . .	29,80	. .	. .	. .	.	. .	.	WSW, } cloudy.	

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MISCELLANEOUS OBSERVATIONS.

Observations for determining the refraction in high latitudes.

JUNE the thirtieth, at midnight, the distance of the two opposite horizons, taken by me with Ramsden's sextant, was 179° 54′; the height of the eye being sixteen feet above the level of the sea.

August the fifteenth, at midnight, by the astronomical Quadrant, the altitude of the sun's upper limb 4° 16′ 55″ lower limb 3° 46′ 0″

Error of the Quadrant			32	—			— 32
	4	16	23	—	3	45	28
Semidiameter	—	15	51	—	+	15	51
App. Alt. Sun's center	4	0	32	—	4	1	19
Co. Declin.	75	56	13	—	75	56	13
App. Lat.	79	56	45	—	79	57	32
True Lat.	79	44	3	—	79	44	3
Refraction		12	42	—		13	29
Dr. Bradley's tables		11	18	—		12	27
Allow for therm.		11	53	—		13	2

Barometer, 29,6 Thermometer, 37°

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August the twentieth, at midnight, the sun's meridian altitude by Mr. Harvey,

	2°	25′	00″
Dip		3	49
	2	21	11
Semidiameter +		15	52
Altitude of the Sun's center	2	37	3
Co. Declin.	77	31	26
App. Latitude	80	8	29
Refr. by the tables		16	44
True Latitude	79	51	45

Hakluyt's Head-land SBE
Cloven Cliff - EBS ½ S
Variation - 19° 30′ S.

It may not be improper to mention here that Baffin, in 1613, made an observation of the refraction when the sun was in the horizon, in latitude 78° 46′, which also agrees exactly with Dr. Bradley's tables. It may therefore be presumed that the refractions in the higher latitudes follow the same law as in these.

Specific

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Specific Gravity of Ice, tried by Dr. Irving.

A piece of the moſt denſe ice he could find, being immerſed in ſnow water, thermometer thirty-four degrees,---fourteen fifteenth parts ſunk under the ſurface of the water.

In brandy juſt proof, it barely floated: in rectified ſpirits of wine it fell to the bottom at once, and diſſolved immediately.

September the fourth, at two in the afternoon, we ſounded with all the lines, above eight hundred fathom. Some time before the laſt line was out, we perceived a ſlack, and that it did not run off near ſo quick as before. When we got the lines in again, the firſt coil came in very eaſily, and twenty fathom of the next, after which it took a great ſtrain to move the lead; a mark was put on at the place where the weight was perceived, and the line meaſured, by which the depth was found to be ſix hundred and eighty-three fathoms. The lead weighed above one hundred and fifty pounds, and had ſunk, as appeared by the line, near ten feet into the ground, which was a very fine blue ſoft clay. A bottle fitted properly by Dr. Irving (none of thoſe ſent out having given ſatisfaction) was let down, faſtened to the line, about two fathom from the lead. A thermometer plunged into the

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the water from the bottom ſtood at forty degrees: in water from the ſurface at fifty-five degrees;---in the ſhade, the heat of the air was ſixty-ſix degrees.

Experiments to find the Temperature of the Water at different Depths, made with Lord Charles Cavendiſh's Thermometer.

Day of the Month.	Depth in Fathoms to which it was ſunk.	Temperature of the Water as ſhewn by the Inſtrument.	Correction for Compreſſion and unequal Expanſion of Spirits.	Temperature of the Sea at the greateſt Depth to which it was ſunk, corrected for Compreſſion and Expanſion.	Heat of the Air.
		°	°	°	°
June 20	780	15	11	26	48½
30 A.M.	118	30	1	31	40½
P.M.	115	33	0	33	44½
Auguſt 31	673	22	10	32	59½

It appears from the experiment of July 1ſt, in which the inſtrument was compared with Fahrenheit's thermometer at different heats, that the experiment cannot be depended on to leſs than two or three degrees, as the reſults drawn from the different compariſons would differ by about five degrees.

Experiments

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Experiments to determine the Temperature of the Water at different Depths of the Sea, and Quantity of Salt it contains; made with the Bottle fitted by Dr. Irving. A Measure, containing 29 Ounces 59 Grains of pure Snow-water, was used as a Standard; Thermometer 59°, Barometer 30,06.

Day of the Month.	Weight of the Water.	Depth in Fathoms.	Thermometer at the Surface.	Thermometer in Water from the Bottom.	Thermometer in the Air.	Weight of the Salt.	Latitude, &c.
1773	Oz. Grs.		°	°	°	Grs.	° ′
June 1	29 404				59	393	51 31 Nore
9	30 2					500	54 8 Off Flamborough Head.
11		32	51	49	55		
12 {	29 440	Surface.	50		50	490	60 Off Shetland.
	29 442	65		44		490	
26	29 462				36	496	74 At Sea.
July 3	29 454		40		44	500	78
19	29 369				44	476	80 Near the Ice.
Aug. 4	30 15	60	36	39	32	510	80 30 Under the Ice.
31	12 360	80	51		48	220	
Sept. 4 {	12 365	683	55	40	66½	192	75 At Sea.
	12 365					216	
7		56	53	40	60		60 14

Sea water taken up at the back of Yarmouth Sands, was in the following ratio to diftilled water;

	oz.	dwts.	grs.	
Sea-water	21	16	13,7	Thermometer,
Diftilled water	21	4	16	53°;

which is, as 10192 : 10477,7; or, as 1; 1,02803. The quantity of dry falt produced from the above water, was 13 dwts. 15 grs.; it appears, therefore, that fea-water contains more air than diftilled water.

The refults of the experiments made with Lord Charles Cavendifh's thermometer, and thofe with the bottle fitted by Dr. Irving, differ materially as to the temperature of the fea at great depths; I fhall give an account, therefore, of the precautions ufed by Dr. Irving to prevent the temperature from being altered, as well as of the allowance made by Mr. Cavendifh for compreffion, as they communicated them to me.

The following is the account of the precautions taken by Dr. Irving to prevent the temperature of the water being changed in bringing up from the bottom:

"The bottle had a coating of wool, three inches "thick, which was wrapped up in an oiled fkin, "and let into a leather purfe, and the whole inclofed "in a well-pitched canvafs-bag, firmly tied to the "mouth of the bottle, fo that not a drop of water

"could

"could penetrate to its surface. A bit of lead "shaped like a cone, with its base downwards and "a cord fixed to its small end, was put into the "bottle; and a piece of valve leather, with half a "dozen slips of thin bladder, were strung on the "cord, which, when pulled, effectually corked the "bottle in the inside."

The following is Mr. Cavendish's account of the corrections to be made for Lord Charles Cavendish's thermometer.

"The Thermometer used in these experiments "is fully described in the Philosophical Transactions, "Vol. L. Page 308; so that I imagine it is unnecessary "to mention it here. But since the publication "of that volume, the late Mr. Canton discovered, "that spirits of wine and other fluids are compressible; "which must make the thermometer appear "to have been colder than it really was, and renders "a correction necessary on that account. There is "another smaller correction necessary, owing to the "expansion of spirits of wine by any given number "of degrees of Fahrenheit's thermometer being "greater in the higher degrees than the lower. As "the method of computing these two corrections "is not explained in that paper, it may be proper "just to mention the rule which was made use of "in doing it.

"In adjusting the degrees on the scale of this "thermometer, the tube was intirely full of Mer-

"cury,

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" cury, or the Mercury ſtood at no degrees on the " ſcale, when its real heat was 65° of Fahrenheit. " Let the bulk of the Mercury contained at that " time in the cylinder be called M, and that of the " ſpirits, S; let the expanſion of ſpirits of wine " by 1° of Fahrenheit, about the heat of 65°, " be to its whole bulk at that heat, as s to " 1; and let its expanſion by one degree at any " other heat, as 65°— x, be to its bulk at 65°, " as $s \times \overline{1 - x}$ to 1; let the expanſion of Mercury " by one degree of heat be to its bulk at 65°, as m " to 1; and let $\frac{Ss + Mm}{Ss}$ be called G; let the com- " preſſion of ſpirits of wine by the preſſure of 100 " fathom of ſea-water, when the heat of the ſpirits is " nearly the ſame as that of the ſea at the depth to " which the thermometer was let down, be to its " bulk at 65°, as C to 1; the compreſſion of the " Mercury is ſo ſmall that it may be neglected; let " the thermometer be let down N hundred fathom, " and when brought up and put into water of 65° " —F degrees of heat let the Mercury in the tube " ſtand at E degrees; conſequently the heat, as " ſhewn by the thermometer, is 65°—F—E: and let " the real heat of the ſea at the depth to which it " was ſunk be 65 — x degrees; then 65° — x =

" $65° - F - E + \frac{CN}{sG} - \frac{Ed \times \overline{E + F + x}}{2G} + \frac{CNd \times \overline{F + x}}{2sG^2}$.

" In this thermometer S = 1160; M = 97; the " expanſion

"expansion of the spirits used in making it by 1° at "the heat of 65°, was found to be $\frac{1}{1786}$ of their "bulk at that heat; that is $s = \frac{1}{1786}$; $m = \frac{1}{11500}$; "therefore G = 1,013. From M. D Luc's experiments * it appears, that the expansion of spirits "of wine by 1° at any degree of heat, as 65° "— x, is to its expansion by 1° at 65°, nearly as "$1 - \frac{x}{315}$ to 1: therefore, $d = \frac{1}{315}$. The compressibility of the spirits used for this thermometer "at the heat of 58°, was found to be exactly the "same as Mr. Canton determines it to be at that "heat; and therefore its compressibility at all other "degrees of heat is supposed to be the same as he "makes it. According to his experiments †, the "compression of spirits of wine by the pressure of "29½ inches of Mercury at the heat of 32°, *id est*, "nearly the heat of the sea in these experiments, is "59¼ millionth parts of its bulk at that heat; "therefore $\frac{C}{sG} = 1,9$ and $65 - x = 65 - F - E$

"$+ N \times 1,9 - \frac{E \times \overline{E + F + x}}{638} + \frac{N \times 1,9 \times \overline{F + x}}{638}$.

* Modifications de l'Atmosphere, vol. I. pag. 252.

† Philosophical Transactions, Vol. LIV. page 261.

OBSERVATIONS

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Observations made by Dr. Irving of the heat of the ſea agitated by a gale of wind, and that of the atmoſphere.

September the twelfth, the thermometer plunged into a wave of the ſea, roſe to 62°; the heat of the atmoſphere 50°.

This experiment was frequently repeated during the gale, and it gave nearly the ſame difference. At night, when the weather became moderate, the heat of water 30 fathoms below the ſurface was 55°; the ſurface and the atmoſphere were 54°.

September the twenty-ſecond. The ſea-water was 60°; the atmoſphere, 59°: the wind at S W, a freſh gale.

Observations for determining the height of a Mountain in Latitude 79° 44′; by the Barometer, and Geometrical Meaſurement.

Obſervations taken by the Barometer, by Dr. Irving.

AUGUST the eighteenth, the day remarkably clear:

	Inches.
At 6h in the morning, the barometer by the ſea ſide ſtood at .	30,040
The Thermometer 50°	
On the ſummit of the mountain, about an hour and three quarters later than the firſt obſervation below, - -	28,266
Thermometer 42°	
About an hour later at the ſame place	28,258

Thermometer

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Thermometer 42°	inches.
By the fea fide, where the firft obfervation was made, and about three hours later	30,032
Thermometer 44°	

Height of the mountain calculated by M. De Luc

from the firft obfervation	-	1585 feet
From the fecond obfervation	-	1592
Mean - - -	-	1588½ feet

Means ufed to afcertain the Height of the Mountain Geometrically.

A point was fixed upon, in the moft convenient place the ground would admit of between the fummit of the mountain (a well-defined object) and the fea-fide; from hence, in a right line from the mountain, a ftaff was placed at the fea fide, by a Theodolite made by Ramfden, with two telefcopes and double Vernier divifions. The inftrument was carefully adjufted; firft, by levelling the ftand with a circular level, and afterwards the whole inftrument by the crofs levels. From hence (A) at right angles to the ftation at the fea fide (C) and the top of the mountain (E), a bafe was meafured each way to (B) and (D) of eight lines of feventeen fathom each; in all, five hundred and forty-four yards. The divifions of both the Verniers were carefully examined, both at fetting off the ftation by the fea fide, and thofe at the extremities of each bafe, the fixed telefcope

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telefcope being kept directed to the fummit of the mountain, and the moveable one directed at right angles each way, both divifions of the Vernier coinciding exactly. Station ftaves were fixed perpendicular by the vertical hair of the telefcope. The altitude of the mountain was then taken with the vertical arch, as a means of detecting any error in the obfervation, and was found to be 8° 50′. The diftance not enabling me to take the depreffion of any particular part of the ftaff by the fea fide under the land on the other fide accurately, I fent a man to ftand clofe before it, and took the depreffion nearly to his eye, which was found to be 1° 54′. The inftrument was then removed to the ftation on the right (B). The inftrument being adjufted with the fame precautions as before, and the fixed telefcope pointing to the center ftation (A); the angle to the mountain was 84° 58′, the angle to the ftation by the water fide (C) 294° 44′. The inftrument was then removed to the ftation by the fea fide (C), the fame precautions ufed in adjufting, and the fixed telefcope pointing to the center (A) in one with the mountain, the angle to the ftaff on the right (B) was 24° 44′. Intending to make the triangle B C D ifofceles, and imagining there might be fome little error from the unevennefs of the ground, I fet off the theodolite an angle equal to the laft, having a perfon ready with a ftaff on the bafe line to fix it where that angle fhould interfect on looking through the telefcope; I found it cut exactly

exactly at the staff D 335° 16', and from thence concluded the measure of the base to be exact. I then took the altitude of the mountain by the vertical arch 7° 44'. I then removed the instrument to the station (D) to take the third angle; but from the badness of the ground, I could not place the instrument exactly over the spot where the staff stood; from hence I took the third angle of the triangle; the fixed telescope pointing to (A) and the same precautions of adjustment being observed, the angle to C came out 65° 15'; less by one minute than it should have been. I then took from the same place the angle to the mountain (E) 275° 1'; more by one minute than the corresponding angle at the opposite station (B): but the errors correcting each other, the whole angle CDE = 150° 14' = the whole angle CBE.

		feet:
By the triangle ABC, AC comes out		1771,4
By the triangle ABE, AE comes out		9265,0
Therefore the distance CE is		11036,4 feet.
Angle of the mountain's elevation seen from C		7° 44':
Height of the mountain above C		1498,8 feet:
+ height of C above the water's edge		5:
Height of the mountain above the water's edge	- - -	1503,8 feet.

I prefer this observation to the others, because the three angles of the triangle ABC came out exactly 180 degrees by the observation. The distance AC found by the computation, differed only four feet from that by the measure; but, the ground being

being uneven, I did not depend upon the meaſure, but took it merely as a check upon the operation, to detect an error, in caſe of any great difference.

The diſtance found by the ſimilar triangles B C E and C D E comes out	11037 feet;
The angle of the mountain's elevation ſeen from A was - 8° 50′;	
Hence the height of the mountain above A was found -	1439,8 feet:
Depreſſion of C ſeen from A was 1° 54;	
Hence the height of A above C is	58,7
Height of the mountain above C	1498,5
+ height of C above water's edge	5;
Height of mountain above the level of the ſea - -	1503,5

which differs from that found by the ſingle angle three tenths of a foot.

I cannot account for the great difference between the geometrical meaſure and the barometrical one according to M. De Luc's calculation, which amounts to 84,7 feet. I have no reaſon to doubt the accuracy of Dr. Irving's obſervations, which were taken with great care. As to the geometrical meaſure, the agreement of ſo many triangles, each of which muſt have detected even the ſmalleſt error, is the moſt ſatisfactory proof of its correctneſs. Since my return, I have tried both the theodolite and barometer, to diſcover whether there was any fault in either, and find them upon trial, as I had always done before, very accurate.

OBSERVATIONS

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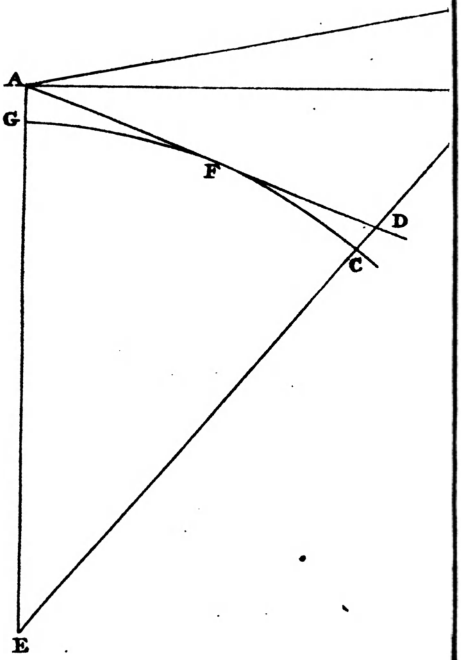
Fig. 1.



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Observations for determining the Acceleration of the Pendulum.

Description of the Pendulum with which the Observations were made, by Mr. Cumming.

"THE apparatus with which the following "experiments were made, was prepared for "the voyage with all the care which the shortness "of the time would admit, and particular atten-"tion was paid to its simplicity. The pendulum "was that which the late Mr. George Graham "had constructed, to ascertain the exact distance "between the center of motion and center of "oscillation of a pendulum to vibrate seconds at "London.

"The ball is a sphere of solid brass, whose dia-"meter is three inches and ninety two hundredth "parts of an inch; and whose weight is nine pounds "and one quarter.

"The rod is a round steel wire, one tenth of "an inch thick, and is so firmly screwed into the "ball, that it cannot be unscrewed by hand, nor "the length of the pendulum altered without the "application of proper instruments for that purpose, "there being no adjusting screw as in clock-pen-"dulums.

"The axis of the pendulum is of hard-tempered "steel, nearly two inches long, and moves on an-"gular, or knife-pivots, whose edges are formed

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" with great care, ſo as to lie exactly in the ſame " right line; the pivots are formed nearly to an " angle of thirty-eight degrees from the edge to " the back; the ſharpneſs of the edges is taken off, " and they are carefully rounded, ſo that the " lower parts of both (on which the pendulum " moves) form parts of one continued cylinder, " whoſe diameter is rather leſs than the two hun- " dredth part of an inch.

" Thoſe pivots move in angular notches made " in two pieces of hardened ſteel, each a quarter " of an inch thick; the notches are formed to an " angle of one hundred and twenty degrees, with " their bottoms ſomewhat rounding, and formed " ſo that the whole length of the pivot has an equal " bearing in them; the ends or extremities of the " pivots are ſloped from the edges on which they " move, towards the backs, or upper ſide; and " two plates of hardened ſteel are ſcrewed againſt " the angular notches in which the pivots move, ſo " as to confine them always to the ſame place in the " notches, and prevent ſuch irregularities as might " otherwiſe happen if the ſhoulders of the pivots " ſhould chance to touch.

" Towards one end of the axis is pierced an ob- " long ſquare hole, from the upper to the under " ſide, into which the upper end of the pendulum " rod (having its ſides ſomewhat flattened) is fitted, " without ſhake, but in ſuch manner that it moves " freely therein from back to front, round a ſteel " pin

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" pin which passes horizontally through it and the " axis, that both the pivots may have an equal bear- " ing, and the pendulum may hang truely perpen- " dicular, without any tendency to bend its rod, and " by that means alter its time of vibration, even " though the axis be not accurately adjusted to a " level position: The error which might arise from " accidental friction on the above supposition, of an " inaccurate levelling of the axis, is obviated by " means of the steel plates against which the *very* " *central point* of the lowest pivot must in such case " act.

" To the other end of the axis, is screwed a pair " of pallets, constructed nearly on Mr. Graham's " principle of the *dead-beat*, but differing from it " in having a degree of recoil which tends to ren- " der the longer vibrations of the pendulum as " quick as the shorter: but this precaution is the " less necessary, because the weight which keeps " the machine in motion is so adjusted, as to make " the angle of constant vibrations as nearly as " possible the same with the angle of scapement; " that is, to make the vibrations the shortest, that " will admit of the wheel to escape the pallets: by " this means, if the oil applied should become " glutinous, so as to diminish the action of the " wheel on the pendulum, or if any other circum- " stance should happen to shorten the arc of vi- " bration of the pendulum, the weight which " keeps it in motion must be increased, till it is

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" found juſt ſufficient to keep the machine going; " by which means there is a certainty that the pen- " dulum vibrates ſimilar arcs in each experiment, " even if the obſerver ſhould not attend to that " circumſtance.

" The ſwing-wheel is made of tempered ſteel, " and the points of its teeth are left much thicker " than they uſually are in clocks, in order to avoid " accidents; it has thirty teeth, and carries with " it a divided circle which ſhews ſeconds.

" On the axis of the ſwing-wheel there is a pi- " nion, on which another wheel acts: and in the " axis of this laſt, there is a ſmall pulley, in the " groove of which is applied the line which keeps " the machine going, by means of a weight and " counter-weight, in the manner deſcribed by " Huygens in the eighth and eighteenth pages of " his *Horologium oſcillatorium:* this method is the " ſimpleſt of any for keeping the wheels in motion " while the weight is winding up, and is peculi- " arly advantageous in ſuch machines as this, which " require frequent winding: the weight applied " to this machine was ſix ounces Troy, which with " a deſcent of thirty-two inches kept it going for " three hours, with a vibration of three degrees.

" The whole is contained in a ſtrong braſs frame, " ſcrewed on the top of a three-legged wooden " ſtand, three feet four inches high: the front " legs extend three feet eight inches in the direc- " tion of the vibration, and the back leg extends

" three

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"three feet four inches from each of the front "legs, at which diſtance the three legs are ſo "connected at bottom, by horizontal rods, that "they cannot poſſibly alter their relative poſition; "by theſe means the point of ſuſpenſion of the "pendulum is rendered much more immoveable "than could be done in any portable clock having "a caſe of the uſual dimenſions, without great "trouble, and an apparatus ill ſuited for experiments "of this nature.

"In the middle of the horizontal bar that con-"nects the front legs is fixed a piece of ſilvered-"glaſs, by means of which the whole machine is "readily adjuſted to its proper poſition: the lower "part of the pendulum-ball hangs directly over "this mirror, on which is drawn a line from back "to front; and when the image of a ſmall pin, "which is ſcrewed into the lower part of the pen-"dulum, is ſeen biſected by this line viewed di-"rectly in front, the poſition of the machine is "properly adjuſted.

"On the back leg of the ſtand, immediately be-"hind the pendulum, is a hook to hang a ther-"mometer on, for making frequent obſervations "of the temperature of the air. In order to pre-"pare for an experiment, the pendulum is made "to vibrate till 60 on the ſecond-circle comes to the "index, and is then to be held at the extremity

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"of its vibration by a trigger; on preſſing which "with the finger, the pendulum is diſengaged in "an inſtant: hence the vibrations muſt be of equal "extent in every experiment.

"The wooden ſtand which ſupports the pen-"dulum is ſo conſtructed, that it forms an oblong "ſquare box, in which the pendulum, with every "part of its apparatus, is with great facility and "expedition packed; ſo ſecurely that no part can "receive damage; and the whole is ſo portable, "that it may with eaſe be carried on a man's "ſhoulder to any acceſſible place.

"This pendulum immediately before the voyage "was compared with a well-regulated eight-day "clock, and in twelve hours its beat did not dif-"fer ſenſibly from that of the clock; Fahrenheit's "thermometer being then at 60°."

July the ſixteenth the Pendulum and the Equatorial Inſtrument were landed on a ſmall rocky iſland in latitude 79° 50′ N; and the pendulum being carefully ſet up in a ſmall tent erected for that purpoſe, and its poſition truly adjuſted, a thermometer was ſuſpended on the hook behind the pendulum rod; and the pendulum being repeatedly put in motion, it was found to ſtop, till a muſket bullet and a half was added to the weight, which was found ſufficient to keep it in motion; when

when it was thus found to continue its vibration, it was locked by the trigger at 60″. The equatorial inſtrument was ſet up on a baſis of ſolid rock, and being in this caſe to be uſed only as a tranſit inſtrument, no attempt was made to adjuſt it either to the latitude or meridian of the place; but the azimuth and equatorial circles being truely levelled, the teleſcope was directed towards the ſun, and ſo elevated that it ſhould paſs as near as poſſible through the middle of the field. The inſtrument being thus prepared, the Weſt limb of the ſun was obſerved to touch the Eaſt ſide of the vertical wire in the teleſcope at 5h 19′ 28″ in the afternoon, by the watch; and at the ſame inſtant the pendulum was unlocked, and kept vibrating till after the ſun had completed its revolution, and its Weſt limb was again ſeen to touch the ſame ſide of the vertical wire.

From the vertical poſition of the wire and the time of the day, the ſun's motion had a degree of obliquity with reſpect to the wire, which muſt occaſion its diameter to take a longer time in paſſing than if it croſſed the wire at right angles: this poſition of the wire, together with the change of the ſun's declination, prolong the time of the ſun's coming again to the wire; ſo that there was an interval of twenty-four hours, forty-nine ſeconds and a half, from the time that the ſun's limb touched the wire on the ſixteenth day of July, to the time of

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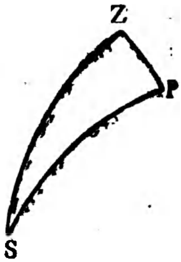
of its return to the same wire on the seventeenth day *.

During the time of this revolution of the sun, an account was kept of the thermometer, and several comparisons made of the rate of the going of the pendulum with my second-watch: in making which, I always took the time by the watch, when the pendulum shewed 60″: these comparisons were chiefly intended to prevent a mistake of a whole minute in estimating the acceleration of the pendulum, which only shewed seconds, having no index



* July the sixteenth P. M. at $5^h\ 19'\ 28'$ by the watch: the angle S between the vertical circle of declination was $10° 49$: the sun's altitude $20°$; its declination $21° 8'$: the change in the sun's declination in 24^h, was $10'\ 11''$: hence the time of the sun's coming to the same vertical hair of a telescope, will be retarded $44'',1$: for (by Cotes, *Æstimatio Errorum*, Theor. 35.)

As sine *Z P* or cosine latitude, —	Com. Ar.	0,75327
Is to tang. S. $10° 49'$; — —		9,28117
So is the change in declin. $10'\ 11''$ sine,		7,47161
To $11'\ 4''$ the change in the hor. angle sine,		7,50600
Which turned into time, gives —		$44'',1$
The change in the equation of time is		5.4
Therefore the interval between the two transits is		$24^h\ 0'\ 49,5$
It was observed — —		24 (2) 4.5
The difference is the gain of the pendulum		(1) 15

To

index for minutes: and as a candid investigation of a matter that had so much engaged the attention of the best philosophers and mathematicians was the only object of my wish, I judged it best, in the first place, to give the observations just as they were made, regularly numbered, that they may be readily referred to from the following tables, in which the order of the original observations is varied, according to the periods of time between each pair of observations. By thus giving the foundations on which the conclusions depend, all persons, who chuse it, may trace and examine every step towards the conclusion, and by that means be enabled to detect any error that may have crept into the operation; or draw such further conclusions as their ingenuity may suggest, and the materials here given may warrant.

To find the time of the sun's diameter passing a vertical hair, (Cotes, *Æstim. Error.* Theor. 21.)

As the product of	Cosine declination	Comp. Ar.	0,03024
	Cosine S. —	Comp. Ar.	0,00778
Is to the product of Radius and Cos. Altitude:			19,97298
So is the sun's diameter in time 135″,6,			2,13226
To the time sought —	139″,1=2′ 19″,1 —		2,14326
It was observed —	2′ 21″,0		
Difference	1″,9		

Although the observation of the sun's diameter passing the wire has no immediate connection with our conclusion; yet the agreement between the calculated and the observed time of its passing, serves to show that the proper allowance was made for the obliquity of the direction in which it passed the wire.

Day

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Day of the Month.	N°	Time by the Watch.	Time by the *Pendulum.*	Thermometer.	Remarks.
		h ′ ″	″		
July 16 P. M.	1	5 19 28	60	50	Equatorial fixed.
	2	6 30 00	. .	49½	
	3	7 00 00	. .	50	
	4	8 00 00	. .	49	
	5	8 30 00	. .	49	
	6	9 00 00	. .	45	
	7	9 30 00	. .	45	
	8	10 00 00	. .	45	
	9	11 00 00	. .	45	
	10	11 30 00	. .	48½	
	11	12 00 00	. .	48½	
	12	12 30 00	. .	46	
	13	12 39 14	60	51	
17 A. M.	14	1 00 00	. .	50½	
	15	2 55 9	60	49	
	16	5 00 00	. .	45	
	17	6 00 00	. .	44	
	18	7 00 00	. .	49½	
	19	8 00 00	. .	47	
	20	9 00 00	. .	49½	
	21	11 2 23	60	58½	
	22	12 00 20	60	56	
P. M.	23	1 00 00	. .	54	
	24	2 30 00	. .	52½	
	25	3 30 00	. .	56	
	26	4 00 00	. .	55½	
	27	4 46 10½	60	52½	
	28	[5 19 24]	4½		Tranſit of the Sun's W. limb.
	29	. . . .	25		Tranſit of the Sun's E. limb.
	30	5 24 9	60	51	

It

It has already been ſaid that the watch was uſed only to prevent an error of *whole minutes*, in eſtimating the time gained by the pendulum in twenty-four hours; the exact period of twenty-four hours being determined by the revolution of the ſun.

In order to obtain the acceleration of the pendulum, the original obſervations are transferred from the foregoing table, to that which follows, for the convenience of arranging them according to the length of the intervals, beginning with thoſe of the ſhorteſt duration: ſo that the concluſion from each period becomes a check upon thoſe that follow.

In this table *the firſt column* refers to the original obſervations, from which a concluſion is here to be drawn; thus, in the firſt line, we find 27—30, by which is meant that a concluſion is to be drawn in this line from obſervations 27 and 30, that is, from the acceleration of the pendulum from four hours, forty-ſix minutes, ten ſeconds and a half, to five hours, twenty-four minutes nine ſeconds in the afternoon, July 17.

The ſecond column expreſſes the interval of time by the watch, between each pair of obſervations referred to in the firſt.

The third column ſhews how much the pendulum gained on the watch, in each period expreſſed in the ſecond.

The fourth column ſhews the mean height of the Thermometer for each period.

The

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Day of the Month.	N°	Time by the Watch.	Time by Pendulum.	Thermom.	Remarks.
		h ′ ″	″	°	
Aug. 14th, P. M.	1	6 00 00	60	44	
	2	7 29 53½	60	43	
	3	12 13 30½	60	40	
15th A. M.	4	5 00 09	60	36	The *Pendulum* set agoing with the additional Weight.
	5	6 00 00	60	35	
P. M.	6	2 09 22½	60	36 36	
	7	8 59 49	60	37	
16th, A. M.	8	2 00 00	.	36 36½	
	9	3 00 00	.	37	
	10	4 00 00	.	36	
	11	5 00 00	.	37	
	12	6 00 00	.	36½	
	13	7 00 00	.	37	
	14	8 00 00	.	37	
	15	9 00 00	.	37	
	16	10 00 00	.	37	
	17	11 00 00	.	37	
Noon	18	12 00 00	.	37	
P. M.	19	1 00 00	.	37	
	20	2 01 39½	60	37	
	21	3 01 34½	60	37	

Day

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T A

Obfervations with the Pendulum from the

1 Obfervations referred to.	2 Duration in Time by the Watch.	3 Seconds gained by the Pendulum on the Watch.	4 Mean Height of the Thermometer.	5 Difference between the Height of the Thermometer at the Time of Adjuftment at London, and the Time of Obfervation.
	H ′ ″	″	°	°
27——30	0 37 58½	1½	52	8
21——22	0 57 57	3	57	3
13——15	2 15 55	5	49¼	10¾
22——27	4 45 50½	9½	53¾	6¼
22——30	5 23 49	11	53	7
21——27	5 43 47½	12½	54½	5½
21——30	6 21 46	14	54½	5½
1——13	7 19 46	14	47½	12½
15——21	8 7 14	46	48¾	11¼
15——22	9 5 11	49	50¾	9¼
1——15	9 35 41	19	48	12
13——21	10 23 9	51	49½	10½
13——22	11 21 6	54	50	10
15——27	13 51 1½	58½	52	8
15——30	14 29 0	60	51¾	8¼
13——27	16 6 56½	63½	54	6
13——30	16 44 55	65	53¾	6¼
1——21	17 42 55	65	48¾	11¼
1——22	18 40 52	68	49¼	10¾
1——27	23 26 42½	77½	50½	9½
1——30	24 4 41	79	50¼	9¾

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It appears by the original obſervations that the pendulum began its vibrations at 60″, the inſtant in which the firſt limb of the ſun was obſerved to touch the ſide of the vertical wire in the teleſcope of the Equatorial, that is, at five hours, nineteen minutes, twenty-eight ſeconds in the afternoon by the watch, on the 16th of July; and by every compariſon of the pendulum with the watch, that the pendulum was conſtantly gaining on the watch, and in a period of twenty-four hours, four minutes, forty-one ſeconds, had gained on the watch ſeventy-nine ſeconds; and when the revolution of the ſun was completed, it appeared, that the watch had loſt four ſeconds in the exact period of twenty-four hours; therefore, if four ſeconds loſt by the watch, be ſubtracted from ſeventy-nine, the time gained by the pendulum on the watch, it will leave ſeventy-five ſeconds for the time gained by the pendulum on the *mean*, or true time, no deduction being here made for the contraction of the pendulum rod by the cold.

The odd fifteen ſeconds are determined by obſerving, that the pendulum ſhowed four ſeconds and a half exactly when the ſun had again returned to the vertical wire; ſo that this period is determined wholly by the ſun, and totally independent of the watch; but as the watch is found by the ſame obſervation to have loſt only four ſeconds, recourſe is had to the intermediate compariſons of it with the pendulum, which clearly ſhow that the pendulum

pendulum had gained *one whole minute*, together with the fifteen seconds determined by the pendulum and the revolution of the sun: and although it appears by the eleventh column of the foregoing table that the watch did not lose uniformly at the rate of four seconds in twenty-four hours, yet its mean rate leaves as little doubt with regard to the *whole minute* gained by the pendulum, as if its going had been perfectly uniform during the whole time. For, if from the sum of all the periods in the second column, and of all the accelerations in the tenth, a mean rate be taken, it makes the acceleration of the pendulum on the watch to be 80″ 79 in twenty-four hours, which differs from the acceleration observed by the revolution of the sun only 5″, 75; and from the rate of going of the watch, determined by the revolution of the sun, only 1″,79: hence there can be no possible room to suppose an error of a whole minute.

Although the period of twenty-four hours, and the rate of going of the watch for that time, are very accurately determined by the revolution of the sun; it may not be improper here to take notice, that from a mean of six altitudes of the sun, taken by a very good astronomical quadrant of eighteen inches radius, the watch was computed to have lost 5″½, in twenty four hours, which differs from the rate given by the revolution of the sun only 1″½; this may serve to shew how far the mean of a great number of observations by the

same

ſame obſerver and inſtrument may be relied on, when there is no other obſervation to check or corroborate.

It may alſo be proper here to mention, that the time by the watch was not obſerved at the inſtant that the ſun had returned to the vertical wire, and at which the pendulum was obſerved to ſhow 4½ ſeconds, my attention being wholly engaged in obſerving the pendulum. The watch was found to have loſt 77″ ½ by the pendulum, in twenty-three hours, twenty-ſix minutes, forty-two ſeconds and a half. An allowance according to this rate for 34′ 4″ (the ſupplement of the laſt obſervation by the watch to the time of the ſun's paſſage when the pendulum ſhewed 4″ ½) amounts to 1″ ½.

From whence it follows, that the Weſt limb of the ſun touched the Eaſt ſide of the vertical hair at five hours, twenty minutes, thirteen ſeconds and a half, by the watch; which had therefore loſt four ſeconds in twenty-four hours.

As the compariſon of the watch and the pendulum in this one inſtance is not from actual obſervation, *at the inſtant*, but ſuppoſes that the watch had kept for thirty-four minutes to the ſame rate of loſing at which it had been obſerved to loſe for nearly twenty-four hours immediately preceding; the time by the watch *thus found* is inſerted in the table of obſervations within hooks to diſtinguiſh it, that every perſon may have an opportunity

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tunity of judging how far it ought to be admitted. Upon the whole it appears, that by the revolution of the ſun, corrected for the oblique direction in which it paſſed the vertical wire in the teleſcope, the change of declination and the equation from the time of its Weſt limb touching the wire on the 16th, to the time of its touching the ſame wire on the 17th of July, that the pendulum gained ſeventy-five ſeconds in twenty-four hours. But as the mean height of the thermometer for the time of this experiment was $9^\circ\frac{1}{2}$ lower than 60°, the height at which it was at London when the pendulum was compared with the clock, the pendulum ought on this account, according to Mr. Smeaton's experiments, to have been contracted $\frac{14}{10000}$ of an inch, and to have gained on that account $2,''72$; ſo that the acceleration of the pendulum ariſing only from the difference between the latitude of London and $79^\circ\ 50'$ N, is $72'',28$.

The pendulum was continued in motion, and the compariſons between it and the watch made as before, with intention to take a ſecond revolution of the ſun: but at eleven o'clock next morning, the wind being fair, and the weather cloudy ſo as to afford no proſpect of ſeeing the ſun in the afternoon, the inſtruments were taken on board, and the ſhips ſailed immediately.

August

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August the fourteenth, we landed the Pendulum, Equatorial Instrument, and astronomical Quadrant on Smeerenberg Point, latitude 79° 44′ N; and set up the pendulum in every respect as formerly described. The equatorial and quadrant were also set up, and prepared for observation.

The pendulum was set a going when it was exactly 6ʰ 0′ 0″ P. M. by my watch, from which time it was frequently compared with the watch, till 5ʰ 50′ A. M. the 15th; when the pendulum stopped. It was again set a going with the additional weight which had formerly been used, when the watch was exactly 6ʰ 00′ 00″, and continued going from that time till after five in the morning of the 18th, in which time the thermometer was observed, and the watch and pendulum compared, as in the following table: many altitudes of the sun were taken with the quadrant, on the 15th A. M. but without any further opportunity till the 18th A. M. when they were repeated to ascertain the rate of the watch's losing.

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Day of the Month.	N°	Time by the Watch.	Time by Pendulum.	Thermom.	Remarks.
		h ′ ″	″	°	
Aug. 14th, P. M.	1	6 00 00	60	44	
	2	7 29 53½	60	43	
	3	12 13 30½	60	40	
15th A. M.	4	5 00 09	60	36	The *Pendulum* set agoing with the additional Weight.
	5	6 00 00	60	35	
P. M.	6	2 09 22½	60	{ 36 36	
	7	8 59 49	60	37	
16th, A. M.	8	2 00 00	.	{ 36 36½	
	9	3 00 00	.	37	
	10	4 00 00	.	36	
	11	5 00 00	.	37	
	12	6 00 00	.	36½	
	13	7 00 00	.	37	
	14	8 00 00	.	37	
	15	9 00 00	.	37	
	16	10 00 00	.	37	
	17	11 00 00	.	37	
Noon	18	12 00 00	.	37	
P. M.	19	1 00 00	.	37	
	20	2 01 39½	60	37	
	21	3 01 34½	60	37	

Day

Day of the Month.	No	Time by the Watch.			Time by Pendulum	Thermom.	Remarks.
		h	′	″	″	°	
	22	7	13	16	60	38	
	23	9	00	00	.	38	
	24	10	00	00	.	37½	
	25	11	00	57	60	37	
Midnight,	26	12	00	00	.	38	
Aug. 17th, A. M.	27	1	00	00	.	38	
	28	2	00	00	.	38	
	29	3	00	00	.	38	
	30	4	00	00	.	37½	
	31	5	00	00	.	37½	
	32	6	00	00	.	38	
	33	7	00	00	.	37½	
	34	8	00	00	.	37¼	
Noon	35	9	00	00	.	37½	
P. M.	36	10	00	00	.	38½	
	37	11	00	00	.	37	
	38	12	00	00	.	39½	
	39	1	00	00	.	40	
	40	2	02	58	60	41	
	41	4	23	45½	60	40	
	42	10	00	19½	60	39	

Between five and six in the morning of the eighteenth, it blew hard, and the Pendulum ſtopped.

 The

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The following table is constructed in every respect the same as that described page 155, and differs from it only in having an *additional column*, in which is given the rate of acceleration of the Pendulum in twenty-four hours, according to the time by the watch, corrected by a mean of sixteen altitudes of the sun taken on the 15th, and a mean of thirty-nine altitudes on the 18th of August, from which the watch appears to have lost, during the interval of the three days, at the rate of 23″,7 per day. The rate of acceleration of the pendulum in twenty-four hours being thus determined, agreeable to the acceleration observed in each of the last eight periods, being those of the longest duration; and these observations being already corrected for the thermometer; a mean is taken from the whole as the true rate of acceleration of the pendulum on mean time in twenty-four hours.

TABLE

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ıſt, 1773, in Latitude 79° 44′ N.

	9	10	11	12
	One loſt by watch, ac- ceding to its e of going, determined the Sun's itudes.	Time gained by the Pendulum on the Mean Time, allowing for the Thermometer, and Rate of the Watch's loſing.	Ratio of Accelera- tion per Hour.	Ratio of accelera- tion of the Pendu lum on the Mean Time in Twenty- four Hours.
	″	″	″	
2(	0,99	3,75	3,75	
	1,47	4,78	3,19	
4(	2,31	9,65	4,11	
4	5,63	19,12	3,41	
	6,14	21,95	3,52	
	8,04	27,20	3,34	
	10,86	37,44	3,41	
	14,79	41,04	2,73	″
2	22,71	69,04	3,00	. . 72,07
2	22,73	67,91	2,95	. . 70,79
	23,55	72,85	3,05	. . 73,24
2	23,72	71,78	2,99	. . 71,71
	24,59	76,66	3,08	. . 73,98
2	24,43	78,08	3,07	. . 73,86
	25,49	146,81	3,06	. . 73,57
	[illegible]3,20	200,63	3,13	. . 75,23
				Mean 73,06
				Which gives the Acceleration of the Pendulum on true Time from the change of lat.

From

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From the refult of this table, the time gained by the pendulum in twenty-four hours of mean time, after deducting the acceleration on account of the contraction of its rod by the cold, is feventy-three feconds, and fix hundredths of a fecond; which is one fecond, and two hundredths of a fecond more than by the refult of the obfervations of the 16th and 17th of July. But although the rate of going of the watch from the 15th to the 18th days of Auguft, was afcertained by a mean of fifty-five altitudes of the fun, I am inclined to give the preference to the obfervations of July, where the exact period of twenty-four hours was determined by a revolution of the fun, obferved with a telefcope whofe magnifying power was fixty. And notwithftanding that the height of the thermometer during the time of obfervation in Auguft was remarkably uniform, and that the watch was found by the comparifons with the pendulum to have loft during the whole time as uniformly as could reafonably be expected; yet a fmall irregularity in its rate of going near the beginning or end of the obfervation, might occafion the difference of this refult from the former.

As the time corrected by the mean of fix altitudes of the fun taken on the 16th and 17th July, differed only one fecond and a half from that obferved by the revolution of the fun, there is reafon to believe that the period of three days, determined by a mean of fifty-five altitudes, taken on the 15th and 18th of Auguſt, might be relied on to one ſecond at moſt: and that, although the concluſion from the obſervations of Auguſt are not ſo deciſive, on account of its depending in ſome ſmall degree on the regularity of the watch, it ſtrongly corroborates the concluſion from the obſervations in July, as it proves that the acceleration of the pendulum proceeded from an uniform cauſe, which produced equal effects in each caſe. This is yet further proved, by comparing the pendulum when it returned to London with the ſame clock with which it had been compared before the voyage, the thermometer being at this time alſo at 60°, and the additional weight of a muſket bullet and a half being applied to the weight which kept it going; the pendulum and the clock were found to agree ſo well, that no ſenſible difference could be diſtinguiſhed in their beats for the ſpace of twelve hours.

From all which circumſtances it may fairly be concluded, that a pendulum which vibrates ſeconds at London, will gain from ſeventy-two to ſeventy-three ſeconds in twenty-four hours, in latitude 79° 50′; allowing the temperature of the air to be the ſame at both places.

Theſe obſervations give a figure of the earth nearer to Sir Iſaac Newton's computation than any others which have hitherto been made.

According

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According to Sir Isaac Newton the Pendulum gains in latitude 79° 50′, - - 66″,9;

In which case the equatorial diameter would be to the polar as 230 to 229:

According to Mr. Bradley's computation, from Mr. Campbell's observations, - 76,6;

Equatorial diameter to the polar as 201 to 200:

According to Maupertuis, 86,5;

Equatorial diameter to the polar as 178 to 179:

According to my observations, { 72,28 / 73,06 ;

Equatorial diameter to the polar as - - - { 212,9 to 211,9 / 210,7 to 209,7:

The mean of which is very nearly as 212 to 211.

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NATURAL HISTORY.

THOUGH the ſhortneſs of my ſtay at Spitſbergen, and the multiplicity of occupations, in which I was neceſſarily employed, during the greateſt part of that time, rendered it impoſſible for me to make many obſervations on its natural productions; yet as there are among thoſe few ſome which have not before been made public, I am in hopes that this article will not be found wholly unprofitable. The following catalogue, imperfect as it is, may ſerve to give a general idea of the ſparing productions of that inhoſpitable climate.

As modern naturaliſts have formed the technical terms of the ſcience out of the Latin, it becomes neceſſary to make ſome uſe of that language, in order to render the deſcriptions of ſuch things as are new, intelligible to thoſe for whoſe uſe they are intended; I ſhall always, however, annex Engliſh names to the ſcientifick ones, when ſuch are to be found.

MAMMALIA.

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MAMMALIA.

TRICHECHUS *Rosmarus*, *Linn. Syst. Nat.* 49. 1.
Arctick Walrus. *Penn. Syn. Quadr.* p. 335.

This animal, which is called by the Russians Morse, from thence by our seamen corruptly Sea Horse, and in the Gulph of St. Lawrence Sea Cow, is found every where about the coast of Spitsbergen, and generally where-ever there is ice, though at a distance from the land. It is a gregarious animal, not inclined to attack, but dangerous if attacked, as the whole herd join their forces to revenge any injury received by an individual.

PHOCA *Vitulina. Linn. Syst. Nat.* 56. 3.
Common Seal. *Pinn. Syn. Quadr.* p. 339.
Found on the coast of Spitsbergen.

CANIS *Lagopus. Linn. Syst. Nat.* 95. 63.
Arctick Fox. *Penn. Syn. Quadr.* p. 155.
Found on the main land of Spitsbergen and islands adjacent, though not in any abundance. It differs from our Fox, besides its colour, in having its ears much more rounded. It smells very little. We ate of the flesh of one, and found it good meat.

URSUS

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Ursus *Maritimus. Linn. Syst. Nat.* 70. 1.
Polar Bear. *Penn. Syn. Quadr.* p. 192. T. 20. F. 1.

Found in great numbers on the main land of Spitsbergen; as also on the islands and ice fields adjacent. We killed several with our musquets, and the seamen ate of their flesh, though exceeding coarse. This animal is much larger than the black bear; the dimensions of one were as follows:

	Feet.	Inches.
Length from the snout to the tail,	7	1
Length from the snout to the shoulder-bone,	2	3
Height at the shoulder, - -	4	3
Circumference near the fore legs, -	7	0
Circumference of the neck close to the ear,	2	1
Breadth of the fore paw, -	0	7
Weight of the carcass without head, skin or entrails, - - -	610 lb.	

Cervus *Tarandus. Linn. Syst. Nat.* 93. 4.
Rein Deer. *Penn. Syn. Quadr.* p. 46. T. 8. F. 1.

Found every where on Spitsbergen.

We ate the flesh of one which we killed, and found it excellent venison.

Balaena *Mysticetus. Linn. Syst. Nat.* 105. 1.
Common Whale. *Penn. Brit. Zool.* p. 85.

This

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This ſpecies, which is ſought after by the fiſhermen in preference to all other whales, is found generally near the ice. We ſaw but few of them during our ſtay.

BALAENA *Phyſalas. Linn. Syſt. Nat.* 106. 2.
Fin Fiſh. *Penn. Brit. Zool.* p. 41.
Found in the ocean near Spitſbergen.

AVES.

ANAS *molliſſima. Linn. Syſt. Nat.* 198. 15.
Eider Duck. *Penn. Brit. Zool*, p. 454.
Found on the coaſt of Spitſbergen.

ALCA *arctica. Linn. Syſt. Nat.* 211. 4.
The Puffin. *Penn. Brit. Zool.* p. 405.
Found on the coaſt of Spitſbergen.

ALCA *Alle. Linn. Syſt. Nat.* 211. 5.
Found on the coaſt of Spitſbergen in great abundance.

PROCELLARIA *glacialis. Linn. Syſt. Nat.* 213. 3.
The Fulmar. *Penn. Brit. Zool.* p. 431.
Found on the coaſt of Spitſbergen.

COLYMBUS *Grylle. Linn. Syſt. Nat.* 220. 1.
Found on the coaſt of Spitſbergen.

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Colymbus *Troile. Linn. Syst. Nat.* 220. 2.
Found on the coast of Spitsbergen.

Colymbus *glacialis. Linn. Syst. Nat.* 221. 5.
The great Northern Diver. *Penn. Brit. Zool.* p. 413.
Found on the coast of Spitsbergen.

Larus *Rissa. Linn. Syst. Nat.* 224. 1.
Found on the coast of Spitsbergen.

Larus *Parasiticus. Linn. Syst. Nat.* 226. 10.
The Arctick Gull. *Penn. Brit. Zool.* p. 420.
Found on the coast of Spitsbergen.

Larus *Eburneus*, niveus, immaculatus, pedibus plumbeo-cinereis.
Found on the coast of Spitsbergen.

This beautiful bird is not described by Linnæus, nor, I believe, by any other author; it is nearly related indeed to the Rathsher, described by Marten in his voyage to Spitsbergen, (See page 77 of the English translation) but, unless that author is much mistaken in his description, differs essentially from it. Its place in the *Systema Naturæ* seems to be next after the *Larus nævius*, where the specifick difference given above, which will distinguish it from all the species described by Linnæus, may be inserted.

Description.

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Description.

Tota avis (quoad pennas) nivea, immaculata.
Roſtrum plumbeum.
Orbitæ oculorum croceæ.
Pedes cinereo-plumbei. *Ungues* nigri.
Digitus Poſticus articulatus, unguiculatus.
Alæ cauda longiores.
Cauda æqualis, pedibus longior.

Longitudo totius avis, ab apice roſtri ad finem caudæ,	- -	Uncias 16
Longitudo inter apices alarum expanſarum,		37
——— Roſtri,	- - -	2

Sterna *Hirundo. Linn. Syſt. Nat.* 227. 2.
The greater Tern. *Penn. Brit. Zool.* p. 428.
Found on the coaſt of Spitſbergen.

Emberiza *nivalis. Lynn. Syſt. Nat.* 308. 1.
The greater Brambling. *Penn. Brit. Zool.* 321.
Found not only on the land of Spitſbergen, but alſo upon the ice adjacent to it, in large flocks: what its food can be is difficult to determine; to all appearance

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pearance it is a granivorous bird, and the only one of that kind found in these climates, but how that one can procure food in a country which produces so few vegetables, is not easy to guess.

AMPHIBIA.

CYCLOPTERUS *Liparis. Linn. Syst. Nat.* 414. 3.
Sea Snail. *Penn. Brit. Zool.* III. p. 105.
Two only of these were taken in a trawl near Seven Island Bay.

PISCES.

GADUS *carbonarius. Linn. Syst. Nat.* 438. 9.
The Coal Fish. *Penn. Brit. Zool.* III. p. 152.
Though we trawled several times on the North side of Spitsbergen, and the seamen frequently tried their hooks and lines, yet nothing was taken except a few individuals of this and the foregoing species.

INSECTA.

CANCER *Squilla. Linn. Syst. Nat.* 1051. 66.
The Prawn. *Merr. Pin.* 192.

Found

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Found in the ſtomach of a ſeal, caught near the coaſt of Spitſbergen.

CANCES *Boreas*, macrourus, thorace carinato aculeato, manibus lævibus, pollice ſubulato incurvo.

This ſingular ſpecies of Crab, which has not before been deſcribed, was found with the former in the ſtomach of a Seal; its place in the *Syſtema Naturæ* ſeems to be next after *Cancer Norwegicus.*

DESCRIPTION.

Thorax ovatus, tricarinatus: *Carinæ laterales* tuberculoſæ, antice ſpina acuta terminatæ; *Carina dorſalis* ſpinis tribus vel quatuor validis armata; antice producta in roſtrum porrectum, acutum, breve, Thorace quintuplo brevius; præter ſpinas carinarum, anguli laterales thoracis antice in ſpinas terminantur.

Antennæ duæ, thorace fere triplo breviores, bifidæ: *Ramulus ſuperior* craſſiuſculus, filiformis, obtuſus; *Inferior* gracilis, ſubulatus.

Palpi duo, duplicati; *Ramus ſuperior* foliatus, ſeu explanatus in *laminam* ovalem, obtuſam, longitudine antennarum, intus et antice villis ciliatam; *Ramus interior* antenniformis, ſubulatus, multiarticulatus, antennis triplo longior.

Paraſtatides

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Paraſtatides decem, anteriores parvi; poſtremi magni, pediformes articulo ultimo explanato in laminam ovali-oblongam.

Pedes decem, duo primores cheliferi, carpis incraſſatis, reliqui ſimplices; pares ſecundi et tertii filiformes, graciles; quarti et quinti craſſiuſculi.

Cauda thorace longior, ſexarticulata; articulis quinque anterioribus carinatis, carinis ſpina antrorſum vergente armatis; articulus ſextus ſupra bicarinatus, muticus, terminatus *foliolis* quinque, articulis caudæ longioribus; intermedio lanceolato, acuto, porrecto, craſſo, ſupra planiuſculo, quadricarinato carinis interioribus obſoletis, ſubtus concavo; lateralibus ovali-oblongis, obtuſis.

Neuſteri decem (nulli ſub articulo ultimo) duplicati: Foliolis lanceolatis, ciliatis.

Obſ. Specimina magnitudine variant, alia triuncialia, alia ſeptem uncias longa.

Cancer *Ampulla*, macrourus, articularis, corpore ovali, pedibus quatuordecim ſimplicibus, laminis femorum poſtici paris ovato-ſubrotundis.

This ſingular animal was alſo taken out of the ſtomach of the ſame ſeal in which the two former were found. Its place in the *Syſtema Naturæ* is next to *Cancer Pulex*.

Description.

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DESCRIPTION.

Insectum ex ovali-oblongum, glabrum, punctulatum, articulis quatuordecim compositum, quorum primus capitis est, septem thoracem mentiuntur, et sex caudam tegunt.

Capitis clypeus antice inter antennas in processum conicum, acutum descendit.

Antennæ quatuor, subulatæ, articulatæ, simplices, corpore decuplo breviores.

Pedes quatuordecim, simplices, unguiculati; *femora* postremi paris postice acuta, lamina dimidiato-subrotunda, integra, magna, quatuor lineas longa.

Cauda foliata, foliolo unico brevi bifido: *Laciniæ* lanceolatæ, acutæ.

Neusteri duodecim, duplicati, subulati, pilis longis ciliati, posteriores retrorsum porrecti.

Obs. Specimina magnitudine variant, uncialia et biuncialia erant.

CANCER *nugax*, macrourus, articularis, pedibus quatuordecim simplicibus, laminis femorum sex posteriorum dilatatis subrotundo-cordatis.

This animal, which has not before been described, should be inserted in the *Systema Naturæ* near *Cancer Pulex*; it was taken in the trawl near Moffen Island.

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Description.

Inſectum oblongum, compreſſum, dorſo rotundatum, glabrum, ſeſquiunciale, articulis quatuordecim compoſitum, quorum primus capitis eſt, ſeptem thoracem mentiunter, et ſex caudam efficiunt.

Capitis Clypeus ſinu obtuſo antice pro antennis emarginatus.

Antennæ quatuor, ſubulatæ, multiarticulatæ; *ſuperiores* corpore ſextuplo breviores, bifidæ: articulo baſeos communi, magno; *Ramulus* interior exteriori duplo brevior.

Inferiores ſimplices, ſuperioribus duplo longiores.

Pedes quatuordecim, ſimplices, unguiculati, unguibus parum incurvis. *Femora* ſex poſteriora poſtice aucta.

Lamina foliacea, ſubrotundo-cordata, dimidiata, margine integra, magna, (tres lineas longa.)

Cauda apice foliata. *Foliolis* duobus, oblongis, obtuſis, parvis.

Neuſteri duodecim, duplicati, lineari-lanceolati, poſteriores retrorſum porrecti, ut facile pro appendicibus caudæ ſumantur.

Cancer *Pulex. Linn. Syſt. Nat.* p. 1055. 81.
Taken up in the trawl along with the former.

VERMES.

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VERMES.

Sipunculus *Lendix*, corpore nudo cylindraceo, apertura ſubterminali.

Found adhering, by its ſmall ſnout, to the inſide of the inteſtines of an Eider Duck. Mr. Hunter, who at my requeſt diſſected it, informed me that he had ſeen the ſame ſpecies of animal adhering to the inteſtines of whales.

Description.

Corpus croceum, ſubcylindraceum, tres lineas longum, craſſitie pennæ paſſerinæ, utraque extremitate parum attenuatum, apice terminatum in *Roſtrum* anguſtum corpore quintuplo brevius, quo tunicis internis inteſtinorum ſeſe affigit; prope alteram extremitatem *Apertura* ſimplex, pro lubitu extenſibilis.

Ascidia *gelatinoſa*. *Linn. Syſt. Nat.* 1087. 2.

Taken up in the trawl, on the North ſide of Spitſbergen.

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Ascidia *rustica. Linn. Syst. Nat.* 1087. 5.
Taken up likewise in the trawl, on the North side of Spitsbergen.

Lernea *branchialis. Linn. Syst. Nat.* 1092. 1.
Found in the gills of the Sea snail mentioned before.

Clio *helicina* nuda corpore spirali.
Marten's Spitsbergen English, p. 141. t. Q. fig. *e*. Snail slime fish.
Found in innumerable quantities throughout the Arctick seas.

Description.

Corpus magnitudine pisi, in spiram ad instar helicis involutum.
Alæ ovatæ, obtusæ, expansæ, corpore majores.

Clio *limacina* nuda, corpore obconico.
The Sea May Fly. *Marten's Spitsbergen English*, p. 169. Tab. P. f. 5.

This little animal is found where the last is, in equal abundance, peopling as it were this almost unin-

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uninhabited ocean. Marten ſays that they are the chief food of the whale-bone whale; and our fiſhermen, who call them by the name of whale food, are of the ſame opinion.

Medusa *capillata. Linn. Syſt. Nat.* 1097. 6.
Sea Blubber.

Taken up on the paſſage home, about the latititude 65°.

Asterias *pappoſa. Linn. Syſt. Nat.* 1098. 2.
Taken up on the North ſide of Spitſbergen.

Asterias *rubens. Linn. Syſt. Nat.* 1099. 3.
Sea Star.

Alſo taken up in the trawl on the North ſide of Spitſbergen.

Asterias *Ophiura. Linn. Syſt. Nat.* 1100. 11.
We likewiſe took this up in the trawl, on the North ſide of Spitſbergen.

Asterias *pectinata. Linn. Syſt. Nat.* 1101. 14.
This, as well as all the reſt of this genus, was taken up in the trawl on the North ſide of Spitſbergen.

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Chiton *ruber*. *Linn. Syst. Nat.* 1107. 7.

Coat of Mail Shell.

Taken in the trawl, on the North side of Spitsbergen.

Lepas *Tintinnabulum*. *Linn. Syst. Nat.* 1168. 12.

Acorn Shell.

Was picked up on the beach of Smeerenberg harbour; but as it is much worn and broken, it is impossible to be certain, whether it is a native of those seas, or has been brought there by accident.

Mya *truncata*. *Linn. Syst. Nat.* 1112. 26.

Likewise found on the beach in Smeerenberg harbour.

Mytilus *rugosus*. *Linn. Syst. Nat.* 1156. 249.

Was found with the former on the beach at Smeerenberg.

Buccinum *carinatum*, testa oblongo-conica transversim striata; anfractibus superioribus oblique obtuseque multangulis; inferioribus unicarinatis.

Found on the beach at Smeerenberg harbour.

Turbo

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Turbo *helicinus*, testa umbilicata convexa obtusa: anfractibus quatuor lævibus.

Taken up in the trawl, on the North side of Spitsbergen.

Serpula *spirorbis*. *Syst. Nat.* 1265. 794.

Found in plenty sticking to the stones and dead shells in Smeerenberg harbour.

Serpula *triquetra*. *Linn. Syst. Nat.* 1265. 795.

Found with the last adhering to dead shells.

Sabella *frustulosa*, testa solitaria libera simplici curvata: fragmentis conchaceis sabulosisque.

Taken up in the trawl on the North side of Spitsbergen.

Description.

Vagina spithamea vel longior, crassitie pennæ anserinæ, undique tecta *fragmentis conchaceis* sæpe magnitudine unguis, et sabulis magnitudine seminum cannabis.

Millepora *polymorpha*. *Linn. Syst. Nat.* 1285. 53.

Varietas rubra.

Found thrown up on the beach at Smeerenberg harbour.

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Cellepora *pumicosa. Linn. Syst. Nat.* 1286. 56. Found on the beach at Smeerenberg.

Synoicum *turgens.*

Taken up in the trawl, on the North side of Spitsbergen.

This animal is quite new to the Natural Historians, and so different from the Zoophytes which have been hitherto described, that it may be considered as a distinct genus, whose characters are the following:

Animalia nonnulla, ex apice singuli stirpis sese aperientia.

Stirpes plures, radicatæ, carnoso-stuposæ, e basi communi erectæ, cylindraceæ, apice regulariter pro animalibus pertusæ.

It should be inserted next to the Alcyonium, with which it in some particulars agrees, but differs from it materially in having the openings for the animals only at the top, and the animals themselves not exserted like polypes (Hydra) which is the case in the Alcyonium.

Description.

Stirpes plures, radicatæ, carnoso-stuposæ, digitiformes, cylindraceæ, superne paulo crassiores, obtusæ, magnitudine digiti infantis, suberectæ, apice orificiis nonnullis perforatæ, inferne dilatatæ sue explanatæ

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explanatæ in basin communem lapidibus adhærentem.

Orificia sex ad novem, ordine circulari plerumque dispofita; sub singulo orificio cavitas longitudinalis, forsitan singulo animali propria, in qua

1mo Faux angusta, brevis.

2do *Intestinum* instar stomachi dilatatum, oblongo-ovatum, inferne *foraminibus* duobus pertusum; inter illa foramina aliud descendit intestinum, valde angustum, filiforme, arcum brevem formans.

Cavitas, quæ per totam stirpem longitudinaliter pro singulo animali deorsum tendit, superne ab intestinis vix distincta, infra illa autem cylindrum exhibet granulis parvis (forsitan ovulis) repletam.

FLUSTRA *pilosa*. *Linn. Syst. Nat.* 1301. 3.
Found adhering to stones in Smeerenberg harbour.

FLUSTRA *membranacea*. *Linn. Syst. Nat.* 1301. 5.
Found with the last mentioned species.

PLANTÆ.

AGROSTIS *algida* panicula mutica contracta, calycibus brevissimis inæqualibus.

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This ſmall graſs, which has not before been known to botaniſts, may be inſerted among the ſpecies of *Agroſtis* next to the *minima*.

DESCRIPTION.

Gramen in cæſpitibus naſcens.

Radix fibroſa, perennis.

Folia plurima radicalia, pauciſſima caulina, glabra, latiuſcula, longitudine culmi, patula, baſi dilatata in vaginas laxas.

Culmi adſcendentes, glabri, ſeſquiunciales.

Panicula lineari-oblonga, contracta, ſtricta, multiflora.

Calycis Glumæ membranaceæ, albidæ, glabræ, muticæ, inæquales: *exterior* minutiſſima, ovata, obtuſa; *interior* oblonga, acuta, corolla quintuplo brevior.

Corollæ Glumæ oblongæ, acutæ, carinatæ, muticæ, glabræ, ſemilineares: exterior paulo longior.

Stamina tria.

Stigmata duo.

Semen unicum, oblongum, utrinque acuminatum, a corolla liberum.

TILLÆA *aquatica. Linn. Spec. Plant.* 186. 2.

JUNCUS *campeſtris. Linn. Spec. Plant.* 468. 17.

SAXIFRAGA

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Saxifraga *oppositifolia. Linn. Spec. Plant.* 575. 18.

Saxifraga *cernua. Linn. Spec. Plant.* 577. 26.

Saxifriga *rivularis. Linn. Spec. Plant.* 577. 28.

Saxifriga *cæspitosa. Linn. Spec. Plant.* 578. 34.

Cerastium *alpinum. Linn. Spec. Plant.* 628. 8.

Ranunculus *sulphureus*, calycibus hirsutis, caule subifloro, petalis rotundatis, integerrimis, foliis inferioribus sublobatis, supremis multipartitis.

Ranunculus quartus. *Mart. Spitz. Engl.* p. 58. T. T. F. *d.*

Obs. Primo intuitu *Ranunculo glaciali* simillimus, differt autem, quod *Petala* rotundata, integerrima, intense lutea, fulgida; et *Folia* minus subdivisa; *superiora* fissa, laciniis oblongo-lanceolatis integerrimis *inferiora caulina* lata, plana, leviter triloba vel quadriloba.

This new plant should be inserted next to *Ranunculus glacialis.*

Cochlearia *Danica. Linn. Spec. Plant.* 903. 3.

Cochlearia *Groenlandica. Linn. Spec. Plant.* 904. 4.

Salix *herbacea. Linn. Spec. Plant.* 1445. 16.

Polytrichum *commune. Linn. Spec. Plant.* 1573. 1.

Bryum

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BRYUM *Hypnoïdes. Linn. Spec. Plant.* 1584. 21.

Besides these, there were two other kinds of Bryum, the species of which could not be determined, for want of the fructification; the one resembled Bryum trichoides læte virens, &c. *Dill. Musc.* 391, t. 50, f. 61; and the other Bryum hypnoïdes pendulum, *Dill. Musc.* 394, t. 50, F. 64, C.

HYPNUM *aduncum. Linn. Spec. Plant.* 1592. 23.

JUNGERMANNIA *julacea. Linn. Spec. Plant.* 1601. 20.

Another species of Jungermannia was also found, but without fructification; it is not much unlike Lichenastrum ramosius foliis trifidis. *Dill. Musc.* 489, t. 70, f. 15.

LICHEN *ericetorum. Linn. Spec. Plant.* 1608. 12.

LICHEN *Islandicus. Linn. Spec. Plant.* 1611. 29.

LICHEN *nivalis. Linn. Spec. Plant.* 1612. 30.

LICHEN *caninus. Linn. Spec. Plant.* 1616. 48.

LICHEN *polyrrhizos. Linn. Spec. Plant.* 1618. 57.

LICHEN *pyxidatus. Linn. Spec. Plant.* 1619. 60.

LICHEN *cornutus. Linn. Spec. Plant.* 1620. 64.

LICHEN

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LICHEN *rangiferinus*. *Linn. Spec. Plant.* 1620. 66.

LICHEN *globiferus*. *Linn. Mant.* 133.

LICHEN *paschalis*. *Linn. Spec. Plant.* 1621. 69.

LICHEN *chalybeiformis*. *Linn. Spec. Plant* 1623. 77.

ACCOUNT

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Account of Doctor Irving's Method of obtaining fresh Water from the Sea by Distillation.

As the method of rendering salt water fresh, by distillation, introduced by Doctor Irving into the Royal Navy in the year 1770, and practised in this voyage, is an object of the highest importance to all navigators, and has not hitherto been generally known, I have added the following very full account of its principles, apparatus, and advantages, with which I was favoured by Doctor Irving himself.

" Previous to an account of this method of " rendering sea water fresh by distillation, it may " not be improper to give a short detail of the ex- " periments which have been formerly made by " others on this subject, pointing out at the same " time the several disadvantages attending their pro- " cesses, and the general causes which obstructed " the desired success.

" Without entering into an account of the ear- " lier experiments, it will be sufficient to take a " view of such as have been prosecuted with most " attention, for the last forty years.

" The first of these was the process of Mr. Ap- " pleby, published by order of the Lords of the Admiralty,

" Admiralty, in the Gazette of June 22d, 1734.
" By the account of that procefs it appears, that
" Mr. Appleby mixed with the fea water to be dif-
" tilled, a confiderable quantity of the *Lapis In-*
" *fernalis* and calcined bones. The highly unpa-
" latable tafte of the water, however, exclufive of the
" extreme difficulty, if not impoffibility, of reduc-
" ing the procefs into practice, prevented the fur-
" ther profecution of this method.

" Another procefs for procuring frefh water at
" fea, was afterwards publifhed by Doctor Butler.
" Inftead of the *Lapis Infernalis* and calcined bones,
" he propofed the ufe of foap leys; but though the
" ingredients were fomewhat varied, the water
" was liable to the fame objections as in the preced-
" ing experiment. Doctor Stephen Hales ufed
" powdered chalk; and introduced ventilation, by
" blowing fhowers of air up through the diftilling
" water, by means of a double pair of bellows. It
" was found by this method, that the quantity of
" frefh water obtained in a given time, was fome-
" what greater than what had been procured by
" the procefs of Mr. Appleby. This invention,
" however, was fubject to feveral difadvantages.
" The air box which lay on the bottom of the ftill,
" as well as the chalk, much obftructed the action
" of the fire upon the water, at the fame time that
" the boiling heat of the latter was diminifhed by
" the ventilation: fo that more than double the

" ufual

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" usual quantity of fuel was necessary to produce the " same effect. Besides this method by no means " improved the taste of the water.

" The next who attempted any improvement " was the learned Doctor Lind, of Portsmouth. " He distilled sea water without the addition of " any ingredients; but as the experiment he made " was performed in a vessel containing only two " quarts, with a glass receiver, in his study, no-" thing conclusive can be drawn from it for the use " of shipping. Indeed experiments of the like " kind had been made by the chemists in their la-" boratories, for at least a century before.

" In the year 1765, Mr. Hoffman introduced " a Still of a new construction, with a *secret ingre-" dient*; but the large space which this machine " occupied, being seven feet five inches by five " feet eight inches, and, with its apparatus, six " feet seven inches high, made it extremely incon-" venient: at the same time that, on account of " its shallow form, the use of it was impracticable " during any considerable motion of the ship. The " water obtained, likewise, possessed all the disad-" vantages common to the preceding methods.

" About the same time experiments were made " with a still of the common construction, and Mr. " Dove's *ingredient*. This method was attended " with

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"with no advantage over any that had been formerly used; the distilled water was most unpalatable; and the enormous size of the apparatus, "which occupied a space of thirteen feet seven "inches by six feet one inch, and six feet five inches "in height, rendered it impracticable on board "ships. An experiment was immediately afterwards made with the same still without any ingredient; the result, however, was uniformly a "most unpalatable taste of the water.

"About this period, also, M. Poissonnier of Paris "introduced into the French marine a still, three "feet six inches long, two feet wide, and eighteen "inches deep. A portion of the chimney passed "through the upper part of the still, much in the "same manner as that of Mr. Hoffman: these "gentlemen supposed that by this means they "should save fuel. The mouth of M. Poissonnier's still was thirteen inches wide, on which he "placed a tin plate, pierced like a cullender, with "thirty-seven holes of six lines diameter each; to "these were fixed tin pipes, of the same bore and "seven inches long, terminating within the still-head. The intention of this contrivance is to "prevent any of the water in the still from passing over into the worm, while the ship is in "considerable motion.

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"In every other reſpect M. Poiſſonnier employs "a ſtill-head, worm-pipe, and worm-tub, with "all its uſual apparatus; and he directs ſix ounces "of *foſſil alcali* to be mixed with the ſea water at "each diſtillation, to prevent the acid of the Mag-"neſia ſalt from riſing with the vapour, when ſalt "begins to form on the bottom of the ſtill. It is "probable that in M. Poiſſonnier's ſtill, which was "even more ſhallow in its form than Mr. Hoff-"man's, ſome of the water might be thrown up "toward the worm; in which caſe the pierced "plate with pipes might be of ſome ſervice in "breaking the direction of the water. But by "Doctor Irving's tube this inconvenience is entirely "prevented, as experience fully evinces, viz. in a "voyage to Falkland's Iſlands, where it has been "uſed in diſtillation every day; in ſeveral voyages "to the Eaſt Indies; and in this voyage, as is men-"tioned in the Journal.

"M. Poiſſonnier, in correcting this error in the "conſtruction of his ſtill, has introduced another "of the moſt capital nature in diſtillation. For "by means of the pipe-cullender, the vapour will "meet with the greateſt reſiſtance to its aſcent, "which will retard the progreſs of diſtillation in a "very high degree, and increaſe the *Empyreuma*.

"From all the experiments abovementioned, it "is evident, that no method had hitherto been "invented of making ſea-water freſh, which was "not attended with ſuch inconveniences as rendered

"the

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" the ſeveral proceſſes of ſcarce any utility. The de-
" fects of the various methods above enumerated,
" may be reduced to the following heads:

" 1. The ſmall quantity of water produced by
" the ordinary methods of diſtillation with a ſtill-
" head, and worm, could never be adequate to the
" purpoſes of ſhipping, though the apparatus
" ſhould be kept in conſtant uſe; and at the ſame
" time, this mode of diſtillation required a quantity
" of fuel, which would occupy greater ſpace than
" might be ſufficient for the ſtowage of water.

" 2. A *Still-burnt* taſte, which always accompanies
" this method of diſtillation, and renders the wa-
" ter extremely unpalatable, exciting heat and
" thirſt, if drank when recently diſtilled.

" 3. A total ignorance with reſpect to the proper
" time of ſtopping the diſtillation, whereby ſalt was
" permitted to form on the bottom of the boiler;
" which burning, and corroding the copper, de-
" compoſed the ſelenitic and magneſia ſalts, cauſ-
" ing their acids to aſcend with the vapour, and
" act on the ſtill-head and worm pipe, impregnating
" the water with metallic ſalts of the moſt pernici-
" ous quality.

" 4. The ſpace occupied by the ſtill, ſtill-head,
" and worm-tub, renders the uſe of them in moſt
" caſes totally impracticable on board ſhips. Add
" to this, their wearing out ſo faſt on account of the

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"causes above mentioned, the great expence of "the apparatus, with the hazard of the still-head "being blown off, and the inconveniences thence "arising.

"5. The use of ingredients, which though "omitted in some experiments in small, were nevertheless erroneously considered as essential to the "making sea-water sweet and palatable by distillation.

"6. The inconvenience of a cumbersome apparatus, calculated only to be eventually useful in "unexpected distress for water, but constantly "occupying a great deal of room in a ship, too "necessary for the ordinary purpose to be spared "for that object.

"Having specified the principal defects of the "several methods hitherto proposed for making sea "water fresh, it will be proper before stating the "advantages of Doctor Irving's method, to con-"sider briefly the principles of distillation in gene-"neral, and the chemical analysis of sea water.

"Water, in an exhausted receiver, rises in va-"pour more copiously at 180° of Fahrenheit's "thermometer, than in the open air at 212°, "which may be considered as its boiling point.

"It therefore follows, that any compression upon "boiling fluid checks the vapour in rising, and "consequently diminishes the quantity of water "obtained. This is clearly exemplified in the

"steam-

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" ſteam-engine, where the conſumption of water
" in the boiler is very inconſiderable, in compa-
" riſon to what would happen if the compreſſion
" ariſing from the throat-pipe and valve of that
" machine was taken off, and the preſſure of the
" atmoſphere only admitted. But by the reſtraint
" of that valve, the vapour becomes hotter, and
" increaſes in rarity and elaſticity; qualities eſſen-
" tial to the purpoſes of the engine, although the
" reverſe of thoſe which ought to take place in
" common diſtillation. For the columns of vapour
" ſhould be removed from the boiling fluid as faſt as
" they aſcend, without ſuffering any other reſiſtance
" than that of the atmoſphere, which, in the or-
" dinary buſineſs of diſtillation, cannot be prevented.

" The impropriety of the common proceſs of
" diſtillation, will appear evident by comparing it
" with the above principles and facts.

" In the common method of diſtillation, the
" whole column of vapour from a ſtill of whatever
" ſize, after aſcending to the ſtill-head, muſt not
" only find its paſſage through a pipe of ſcarce an
" inch and half diameter; but deſcend contrary to
" its ſpecific gravity through air which is fifteen
" times its weight, in ſpiral convolutions: a courſe
" ſo extremely ill adapted to the progreſs of an
" elaſtic vapour, that frequently the ſtill-head is
" blown off with incredible violence, owing to the

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" increaſed heat and elaſticity of the vapour confined " by this conſtruction. In the mean time, the ex- " ternal ſurface of the pipe communicates heat to " the water in contact with it, which, inſtead of " being entirely carried off, mixes with the ſur- " rounding fluid, and heats the whole, rendering " it unfit for condenſing the vapour within; eſpe- " cially when it is conſidered that the ſubſtance of " the pipe is at leaſt a quarter of an inch thick.

" From what has been ſaid, it is plain, that the " quantity of diſtilled water will be leſſened in pro- " portion to the reſiſtance made to the aſcent of the " vapour, while the difficulty of condenſation will " be greatly augmented, in conſequence of the in- " creaſed heat and elaſticity of the vapour. But " theſe diſadvantages, however great, reſpecting " the mode of diſtillation, give riſe to another evil " of a ſtill more important nature, as affecting the " diſtilled fluid with a noxious *burnt taſte* or *empy-* " *reuma*; occaſioned by the vapour, highly heated, " paſſing over ſo much ſurface of metal, viz. the " ſtill-head, crane-neck, and a pipe of ſix or ſeven " feet in length, before it reaches the water in the " worm tub.

" Having diſcuſſed the ſubject of diſtillation, we " come now to treat of the chemical analyſis of ſea " water.

" Sea-water,

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" Sea-water contains chiefly a neutral ſalt, com-
" poſed of foſſil alcali and marine acid. It likewiſe
" contains a ſalt which has magneſia for its baſis,
" and the ſame acid. Theſe two ſalts are blended
" together in our common ſalt in England, which
" is prepared by quick boiling down ſea water.
" But when the proceſs is carried on by the ſun, or
" a ſlow heat, they may be collected ſeparately;
" that which has the foſſil alcali for its baſis cryſtal-
" lizing firſt; and this is of a vaſtly ſuperior quality
" for preſerving meat, and for the other culinary
" purpoſes. The mother liquor now remaining,
" being evaporated, affords a vitriolic magneſia ſalt,
" which in England is manufactured in large quan-
" tities, under the name of Epſom ſalt.

" Beſides theſe ſalts, which are objects of trade,
" ſea-water contains a ſelenitic ſalt, a little true
" Glauber's ſalt, often a little nitre, and always a
" quantity of gypſeous earth ſuſpended by means of
" fixed air.

" The ſpecific gravity of ſea-water to that of
" pure diſtilled water, is at the Nore as 1000 to
" 1024,6; in the North ſea as 1000 to 1028,02.

" The quantity of ſalt obtained by boiling ſea-
" water in different latitudes, from 51° 30′ to
80°, 43 N. L. is inſerted in a table in the former part
of this Appendix.

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"Sea-water, when boiled down to a ſtrong brine, "admits with difficulty the ſeparation of freſh water "from it; the diſtillation becoming ſlower as the "ſtrength of the brine increaſes, ſo that a greater "quantity of fuel is conſumed in procuring a ſmaller "portion of water, and this likewiſe of a bad qua- "lity. From this eſſential circumſtance ariſes the "neceſſity of letting out the brine by the cock of "the boiler, when the diſtillation is advanced to a "certain degree; and of adding more ſea-water to "continue the proceſs if required.

"The defects of the ſeveral ſchemes formerly "propoſed for rendering ſea-water freſh being point- "ed out, the general principles of diſtillation ex- "plained, and the component parts of ſea-water "analytically examined; the advantages of the "method invented by Doctor Irving remain to be "ſtated, which may be reduced to the following:

"1. The aboliſhing all ſtills, ſtill heads, worm "pipes, and their tubs, which occupy ſo much "ſpace as to render them totally incompatible with "the neceſſary buſineſs of the ſhip; and uſing in "the room of theſe, the ſhip's kettle or boiler, to "the top whereof may occaſionally be applied a "ſimple tube, which can be eaſily made on board "a veſſel at ſea, of iron plate, ſtove funnel, or tin "ſheet; ſo that no ſituation can prevent a ſhip from "being completely ſupplied with the means of "diſtilling ſea-water.

"2. In

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" 2. In consequence of the principles of distilla-
" tion being fully ascertained, the contrivance of
" the simplest means of obtaining the greatest quan-
" tity of distilled water, by making the tube suffi-
" ciently large, to receive the whole column
" of vapour; and placing it nearly in a horizontal
" direction to prevent any compression of the fluid,
" which takes place so much with the common
" worm.

" 3. The adopting the simplest and most effica-
" cious means of condensing vapour; for nothing
" more is required in the distillation but keeping the
" surface of the tube always wet; which is done
" by having some sea-water at hand, and a person
" to dip a mop or swab into this water, and pass it
" along the upper surface of the tube. By this
" operation the vapour contained in the tube will be
" entirely condensed with the greatest rapidity ima-
" ginable; for by the application of the wet mop
" thin sheets of water are uniformly spread, and
" mechanically pressed upon the surface of the hot
" tube; which being converted into vapour, make
" way for a succession of fresh sheets; and thus
" both by the evaporation and close contact of the
" cold water constantly repeated, the heat is carried
" off more effectually than by any other method
" yet known.

" 4. The carrying on the distillation without any
" addition, a correct chemical analysis of sea wa-
" ter having evinced the futility of mixing ingre-
" diens

"dients with it, either to prevent an acid from "rising with the vapour, or to deſtroy any bitu-"minous oil ſuppoſed to exiſt in ſea water, and to "contaminate the diſtilled water, giving it that "fiery unpalatable taſte inſeparable from the former "proceſſes.

"5. The aſcertaining the proper quantity of "ſea water that ought to be diſtilled, whereby the "freſh water is prevented from contracting a "noxious impregnation of metallic ſalts, and the "veſſel from being corroded and otherwiſe damaged "by the ſalts caking on the bottom of it.

"6. The producing a quantity of ſweet and "wholeſome water, perfectly agreeable to the taſte, "and ſufficient for all the purpoſes of ſhipping.

"7. The taking advantage of the dreſſing the "ſhip's proviſions, ſo as to diſtil a very conſiderable "quantity of water from the vapour which would "otherwiſe be loſt, without any addition of fuel.

"To ſum up the merits of this method in a few "words:

"The uſe of a ſimple tube, of the moſt eaſy "conſtruction, applicable to any ſhip's kettle. The "rejecting all ingredients. Aſcertaining the pro-"portion of water to be diſtilled, with every ad-"vantage of quality, ſaving of fuel, and preſerva-"tion of boilers. The obtaining freſh water, "wholeſome, palatable, and in ſufficient quantities.

"Taking

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"Taking advantage of the vapour which aſcends in "the kettle while the ſhips proviſions are boiling.

"All theſe advantages are obtained by the above-"mentioned ſimple addition to the common ſhip's "kettles. But Doctor Irving propoſes to introduce "two further improvements.

"The firſt is a hearth, or ſtove, ſo conſtructed, "that the fire which is kept up the whole day for "the common buſineſs of the ſhip, ſerves likewiſe "for diſtillation; whereby a ſufficient quantity of "water for all the oeconomical purpoſes of the ſhip "may be obtained, with a very inconſiderable ad-"dition to the expence of fuel.

"The other improvement is that of ſubſtituting, "even in the largeſt ſhips, caſt-iron boilers, of a "new conſtruction, in the place of coppers."

DIRECTIONS

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Directions for Distilling Sea-Water.

"As ſoon as ſea-water is put into the boiler, the "tube is to be fitted either into the top or lid, "round which, if neceſſary, a bit of wet linen may "be applied, to make it fit cloſe to the mouth of "the veſſel; there will be no occaſion for luting, "as the tube acts like a funnel in carrying off the "vapour.

"When the water begins to boil, the vapour "ſhould be allowed to paſs freely for a minute, "which will effectually clean the tube and upper "part of the boiler. The tube is afterwards to be "kept conſtantly wet, by paſſing a mop or ſwab, "dipped in ſea-water, along its upper ſurface. "The waſte water running from the mop, may be "carried off by means of a board, made like a "ſpout, and placed beneath the tube.

"The diſtillation may be continued till three "fourths of the water be drawn off, and no further. "This may be aſcertained either by a gauge-rod put "into the boiler, or by meaſuring the water diſtilled. "The brine is then to be let out.

"Water may be diſtilled in the ſame manner "while the proviſions are boiling.

"When

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"When the tube is made on ſhore, the beſt "ſubſtance for the purpoſe is thin copper well "tinned, this being more durable in long voyages "than tin plates.

"Inſtead of mopping, the tube, if required, "may have a caſe made alſo of copper, ſo much "larger in diameter as to admit a thin ſheet of "water to circulate between them, by means of a "ſpiral copper thread, with a pipe of an inch dia-"meter at each end of the caſe; the lower for "receiving cold water, and the upper for carrying "it off when heated.

"When only a very ſmall portion of room can be "conveniently allowed for diſtillation, the machine, "which is only twenty-ſeven inches long, may be "ſubſtituted, as was done in this voyage. The "principal intention of this machine, however, is "to diſtil rum and other liquors; for which purpoſe "it has been employed with extraordinary ſucceſs, "in preventing an *empyreuma*, or *fiery* taſte."

ACCOUNT

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Account of the Astronomical Observations and Time-Keepers, by Mr. Lyons.

"THE obſervations for finding the time at ſea, " were taken with a braſs Hadley's Sextant " of eighteen inches radius, made by Dollond; " and ſometimes by Captain Phipps, with a ſmaller " of four inches radius, made by Ramſden, which " commonly agreed with the other within a mi- " nute. The error of the ſextant was generally " found by obſerving the diameter of the Sun; " which if the ſame as double the ſemidiameter " ſet down in the Nautical Almanac, ſhewed that " the inſtrument was perfectly adjuſted; if it dif- " fered, the difference was the error of the ſextant. " It was neceſſary to know this error of adjuſtment " very exactly, and therefore I generally repeated " the obſervation of the Sun's diameter ſeveral " times, and from the mean of the reſult found " the error of the ſextant. This error will equally " affect all the obſervations taken near the ſame " time, and therefore cannot be diſcovered from " the compariſon of ſeveral obſervations. Under " the equator, an error of one minute in altitude, " near the prime vertical, will only produce an er- " ror of four ſeconds in the apparent time; but in " the latitude of eighty degrees it will cauſe an " error of twenty-three ſeconds. As we generally

" took

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"took ſeveral ſucceſſive obſervations, any error in "the obſervation itſelf will be generally independent of the reſt; and as I have calculated each "ſeparately, the concluſions will ſhew which are "erroneous, by their differing much from the "mean of all, which cannot but be very near the "truth.

"In calculating theſe obſervations, I found by "the logboard how much we had altered our latitude ſince the laſt obſervation; and ſometimes, "when we had an obſervation the noon following "the obſervation for the time, the latitude of the "ſhip at the time the altitudes were taken was inferred from it. As moſt of our altitudes were "obſerved when the ſun was near the prime vertical, a ſmall error in the latitude will not produce any conſiderable change in the time; indeed, if it is exactly in the prime vertical, it "will not make any change at all.

"To find the Longitude from theſe obſervations: to the apparent time found by calculation, "apply the equation of time according to its ſign, "which will give the mean time; the difference "between which and that marked by the watch, "will ſhew how much it is too ſlow or too faſt for "mean time.

"Captain

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"Captain Phipps's pocket watch, made by Mr. "Arnold, when compared with the regulator at "Greenwich, May 26th, was twenty-four seconds "too slow; it was there found to lose twelve se-"conds and a quarter a day on mean time From "this it is easy to find what time it is at Greenwich "at any moment shewn by the watch.

"The watch was compared every day about "noon with the two time-keepers made by Mess. "Arnold and Kendal; and from this comparison, "and their rates of going previously settled at "Greenwich, together with knowing how much "they differed from mean time at Greenwich be-"fore we set out, was calculated the table which "shews what the mean time is at Greenwich ac-"cording to each time-keeper, when the watch is "at twelve hours.

"By the help of this table, we may easily find "the longitude of the ship, as deduced from the "going of each time-keeper. Having found how "much the watch is too fast or too slow for mean "time at the ship, we know what the mean time "is at the ship when the watch is at twelve hours; "and by the table we can find what is the mean "time at Greenwich at the same time, supposing "each time-keeper had kept the same rate of go-"ing as it had before our departure: the difference "of these mean times will give the longitude of the "ship.

"For

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"For example, June 19th, in the afternoon, "the watch was 1′ 24″ too slow for mean time at "the place where we observed; therefore, when "the watch shews twelve hours, the mean time "at this place was 12h 1′ 24″. At this time I find "by the table, that according to Kendal's time-"keeper, the mean time at Greenwich was 12h "2′ 7″: from this subtracting 12h 1′ 24″, the "mean time at the ship, the remainder, 0′ 43″ is "the difference of meridians; which, converted "into parts of a degree, gives 0° 10′ 45″ for the "longitude of the ship according to Kendal, which "is to the Westward, because the mean time at "the ship is less than that at Greenwich.

"When we were on shore, the observations "were made with an Astronomical Quadrant, di-"vided by Mr. Ramsden, of eighteen inches ra-"dius, which was placed on a solid rock of mar-"ble; the error of the line of collimation was "found by inverting the quadrant, which was ad-"justed by a spirit level. The weather did not "permit us to take corresponding altitudes of the "Sun, so that we determined the apparent time "by computation from altitudes of the Sun's limb; "having before settled the latitude of the place "of observation, from meridian altitudes of the "Sun's limbs taken with the same instrument.

" The Latitudes of the ſhip were determined " moſt commonly by the meridian altitude of the " Sun's lower limb; in a few inſtances, by that of " his upper limb, when the lower was not ſo di- " ſtinct, or was hid by clouds. The height of the " eye above the level of the ſea, in all theſe obſer- " vations, was ſixteen feet. When we could not " get a meridian obſervation, we made uſe of the " method deſcribed in the Nautical Almanac for " 1771, from two altitudes taken about noon, and " at a little diſtance from it.

" It ſometimes happens that we can only take " ſome altitudes very near the time of noon. If " we have obſerved any altitudes of the Sun near " the prime vertical, we may thence determine " how much the watch is too faſt or too ſlow for " apparent time; and conſequently, how much the " time when the altitudes were taken, is diſtant " from noon; it therefore remains to find how " much theſe altitudes are different from the me- " ridian altitude. This may eaſily be found by " the following Rule:

" To the logarithm of the riſing, taken out of the " tables in the Nautical Almanac for 1771, add the " complement arithmetical of the logarithmic co- " ſine of the ſuppoſed meridian altitude; from the " ſum (the index being increaſed by five) ſubtract " the logarithm ratio (found by the rules in the " abovementioned Ephemeris) the remainder is the " logarithmic ſine of the change in altitude.

"EXAMPLE

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"EXAMPLE I.

" June the twenty-firſt, the altitude of the Sun's center was obſerved to be 46° 6′ at 16′ 45″ after apparent " noon; the latitude by account was 67° 17′; the Sun's declination being then 23° 28′ N, the ſuppoſed meri- " dian altitude 46° 11′.

" Suppoſed Latitude 67° 17′	Co. Ar. Coſ. 0,41322.	Riſing 16′ 45″	5. 2,42643
" Sun's declination 23 28	Co. Ar. Coſ. 0,03749.	Suppoſed Mer. Alt. Ar. Co. Coſ. .	0,15967
			7,58610
" Log. Ratio 0,45071			0,45071
" The change in Altitude is + 0° 5′		Sine	7,13539

" Obſerved Altitude	46 0
" Meridian Altitude	46 11
" Declination	23 28
" Altitude of the Equator	22 43
" Latitude	67 17 N

" As the altitudes for determining how much the watch differs from apparent time were taken near the prime " vertical, a great error in the ſuppoſed latitude will make a very inſenſible change in the apparent time; nor will " it create any great difference in the variation of altitude near noon in a given time, as will appear by the fol- " lowing computation:

" Suppoſe

" Suppose the latitude by account was 68° 17′, a degree greater than before.

" Supposed Latitude	68° 17′	Cos. Co. Ar.	0,43178	Rising 16′ 45″	— —	5. 2,42643
" Declination	23 28	——	0,03749	Supposed Mer. Alt. 45. 1r. Cos. Co. Ar.		0,15191
						7,57834
" Log. Ratio			0,46927	— — — ——		0,46927
" The change in the Sun's Altitude is	0° 4′ 25″.			— —	Sine	7,10907
" Observed Altitude	46 6					
" Meridian Altitude	46 10 25					
" Declination	23 28					
" Altitude of the Equator	22 42 25					
" Latitude	67 17 35					

which only differs thirty-five seconds from " the true latitude we found before.

EXAMPLE

E X A M P L E II.

" June the twentieth, the altitude of the Sun's center was observed oh 28′ 38″ after midnight, " to be 1° 13′, the latitude by account being 67° 40′ N.

" Supposed Latitude	67°	40′	Cos. Co. Ar.	0,42022	Rising 28′ 38″	— —	5. 2,89380
" Declination	23	28	———	0,03749	Supposed Mer. Alt. 1° 8′ Cos. Co. Ar.		0,00001
							7,89381
" Log. Ratio 0,45771							0,45771

" Change in the Altitude —	0°	9′	— ——— — Sine	7,43610
" Observed Altitude	1	13		
" Meridian Altitude	1	4		
" Co-Declination	66	32		
" Latitude	67	36 N		

" There

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"There were two time-keepers sent out for trial "by the Board of Longitude; one made by Mr. "Kendal after Mr. Harrison's principles; the other, "by Mr. Arnold: this last was suspended in gim- "mals, but Mr. Kendal's was laid between two "cushions which quite filled up the box. They "were both kept in boxes screwed down to the "shelves of the cabin, and had each three locks; "the key of one of which was kept by the cap- "tain, of another by the first lieutenant, and of "the third by myself; they were wound up each "day soon after noon, and compared with each "other and with Captain Phipps's watch. They "stopped twice in the voyage, owing to their being "run down; they were set a-going again, and as "they had been daily compared together, it was "easy to know how long each had stopped, from "the others that were still going; this time is al- "lowed for in the table of the mean time at Green- "wich by each time-keeper.

"When we were on shore at the island where "we observed July 15th, we found how much the "watch was too slow for mean time. When we re- "turned from the ice to Smeerenberg, and again "compared the watch with the mean time, allow- "ing the same difference of longitude between the "island and Smeerenberg, we found that it went "very nearly at the same rate, as it did when tried "at Greenwich: so that its rate of going was nearly "the same in our run from England to the island,

"from

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" from thence to the ice and back again to Smeeren-" berg, and in our voyage from thence to England, as " we found on our return. By this means we were in-" duced to give the preference to the watch, and " to conclude that the longitude found by it was " not very different from the truth.

" The principles on which this watch is con-" ſtructed, as I am informed by the maker, Mr. " Arnold, are theſe: the balance is unconnected " with the wheel-work, except at the time it re-" ceives the impulſe to make it continue its mo-" tion, which is only while it vibrates 10° out of " 380°, which is the whole vibration; and during " this ſmall interval it has little or no friction, but " what is on the pivots, which work in ruby holes " on diamonds: it has but one pallet, which is a " plane ſurface formed out of a ruby, and has no " oil on it.

" Watches of this conſtruction go whilſt they " are wound up; they keep the ſame rate of going " in every poſition, and are not affected by the dif-" ferent forces of the ſpring: the compenſation " for heat and cold is abſolutely adjuſtable.

" Time-keepers of this ſize are more convenient " than larger, on ſeveral accounts; they are equally " portable with a pocket watch, and by being kept " nearly in the ſame degree of heat, ſuffer very " little or no change from the viciſſitudes of the " weather.

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" This watch was exceedingly useful to us in " our observations on land, as the other time-keep- " ers could not safely be moved: and indeed, in " the present voyage, where they were on trial, it " was contrary to the intent for which they were " put on board, and might have been attended " with accidents by which the rate of their going " might have been greatly affected.

" The longitudes by Mr. Arnold's larger time- " keeper are very different from those by the " watch in our voyage back from Spitsbergen to " England; owing, probably, to the balance-spring " being rusted, as we found when it was opened at " the Royal Observatory at Greenwich, on our " return.

" The longitudes found by the Moon are de- " duced from distances of the Moon from the Sun's " limbs, or from Stars, taken with the sextant; " whilst the altitudes of the Moon and Sun, or " Star, were taken by two other observers.

" In one instance (June 26th) the observations " were all made by Captain Phipps with the small " sextant successively; and the altitudes of the " Moon and Sun at the very instant the distances " were observed, are deduced from the changes " in these altitudes during the interval of observa- " tion.

" I have

"I have calculated the longitude from each ſet "of obſervations ſeparately, to ſhew how near "they agree with each other, and what degree "of preciſion one may expect in ſimilar caſes.

"Obſervations of the diſtances of the Moon and "Sun, or Stars, may be uſeful to inform us if the "time-keepers have ſuffered any conſiderable "change in their rate of going. For if the longi-"tude deduced from the moon differs above two "degrees from that found by the watches, it is "reaſonable to imagine, that this difference is "owing to ſome fault in the watch, as the longi-"tude found by lunar obſervations can hardly vary "this quantity from the truth: but if the differ-"ence is much leſs, as about half a degree, it is "more probable that the watch is right, ſince a "ſmall error in the diſtance will produce this dif-"ference.

"The diſtances of the Moon from Jupiter were "obſerved, becauſe Jupiter is a very bright object; "and the obſervations are eaſier and leſs fallacious, "particularly that of the altitude, than thoſe of "a fixed ſtar, whoſe light is much fainter. This "method, however, requires a different form of "calculation, from that of the obſerved diſtance of "the Moon from a fixed ſtar, whoſe diſtances are "computed for every three hours, in the Nautical "Almanac. The principal difficuly in the calcu-"lation is to find the Moon's longitude from the ob-

"ſervation

" ſervation of the diſtance. This I have endeavour-
" ed to facilitate by the following problem, which
" may be applied to any zodiacal ſtar, and will be of
" uſe when the ſtar ſet down in the Ephemeris
" cannot be obſerved.

"PROBLEM.

" Having given the diſtance of two objects near
" ecliptic, with their latitudes, to find their dif-
" ference of longitude.

"SOLUTION.

" Find an arc A, whoſe logarithmic ſine is the
" ſum of the logarithms of the ſines of the
" two latitudes and the logarithmic tangent of
" half the diſtance, rejecting twenty from the in-
" dex of the ſum.

" Find an arc B, whoſe logarithmic ſine is the
" ſum of the logarithmic verſed ſine of the differ-
" ence of latitude, and the logarithmic cotangent
" of the diſtance, rejecting ten from the index of
" the ſum.

" Then A added to the obſerved diſtance, and
" B ſubtracted from the ſum, leaves the difference
" of longitude.

" If one of the latitudes is South, and the other
" North, the ſum of the two arcs A and B ſub-
" tracted from the diſtance, leaves the difference
" of longitude.

"EXAMPLE.

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"EXAMPLE.

"August the thirty-first, the observed distance of the Moon's center from Jupiter, cleared of "refraction and parallax, was 32° 35′ 52″, the Moon's latitude being 1° 47′ N, and that of "Jupiter 1° 36′ S.

"Latitude ☽	1° 47′	Sine 8,4930	Difference of Latitude,	3° 23′	Vers. Sine	7,2413
"Latitude ♃ -	1 36	Sine 8,4459				
"Half distance	16 18	Tang. 9,4660	Distance	32 36	Contag.	10,1941
"Arc A 0′ 52″ - -		Sine 26,4049	Arc B. 9′ 25″ - - - -		Sine	17,4354

"The sum of these Arcs — 10′ 17″ Subtracted from
"the distance - 32° 35 52

"leaves 32 25 35 the Difference of Longitude between the Moon and Jupiter.

"Knowing the longitude of Jupiter from the Ephemeris, and the difference between it and "that of the Moon, we may infer the longitude of the Moon by observation: and from the longi-"tudes set down for noon and midnight of each day in the Nautical Almanac, find the apparent "time at Greenwich when the moon had that longitude, which compared with the apparent time at "the Ship, will give the difference of meridians.

A Table

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A Table shewing what the Mean Time is at Greenwich, by each Time-keeper, when the Pocket-Watch made by Arnold is at 12^h.

Day of the Month.		Arnold.			Kendal.			Watch.		
		h	'	"	h	'	"	h	'	"
June	2	12	0	38	11	59	56	12	1	49
	3	12	1	1	12	0	14	12	2	2
	4	12	1	16	12	0	25	12	2	15
	5	12	1	36	12	0	45	12	2	27
	6	12	1	50	12	0	55	12	2	39
	7	12	2	6	12	1	10	12	2	51
	8	12	2	8	12	1	10	12	3	4
	9	12	1	50	12	0	53	12	3	16
	10	12	2	3	12	1	5	12	3	28
	11	12	2	11	12	1	28	12	3	40
	12	12	2	16	12	1	34	12	3	53
	13	12	2	4	12	1	28	12	4	5
	14	12	2	10	12	1	38	12	4	17
	15	12	2	16	12	1	48	12	4	29
	16	12	1	59	12	1	35	12	4	42
	17	12	2	6	12	1	48	12	4	54
	18	12	2	5	12	1	51	12	5	6
	19	12	2	14	12	2	7	12	5	18
	20	12	2	2	12	2	3	12	5	31
	21	12	1	57	12	2	5	12	5	43
	22	12	1	43	12	2	3	12	5	55
	23	12	1	13	12	1	30	12	6	8
	24	12	1	2	12	1	39	12	6	20
	25	12	0	24	12	1	17	12	6	32
	26	11	59	52	12	0	59	12	6	44
	27	11	59	44	12	1	4	12	6	57
	28	11	59	26	12	1	2	12	7	9
	29	11	59	11	12	1	3	12	7	21
	30	11	58	55	12	0	59	12	7	34
July	1	11	58	45	12	1	7	12	7	46
	2	11	58	29	12	1	10	12	7	58
	3	11	58	20	12	1	21	12	8	10
	4	11	58	14	12	1	31	12	8	23
	5	11	58	2	12	1	39	12	8	35
	6	11	57	50	12	1	47	12	8	47
	7	11	57	42	12	1	59	12	8	59
	8	11	57	26	12	2	10	12	9	12

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A Table ſhewing what the Mean Time is at Greenwich, by each Time-keeper, when the Pocket-Watch made by Arnold is at 12^h.

Day of the Month.	Arnold.			Kendal.			Watch.		
	h	′	″	h	′	″	h	′	″
July 9	11	57	20	12	2	25	12	9	24
10	11	56	59	12	2	33	12	9	36
11	11	56	47	12	2	45	12	9	49
12	11	56	25	12	2	45	12	10	1
13	11	56	13	12	2	58	12	10	13
14	11	55	33	12	2	44	12	10	25
15	. .	. .	. .	. .	. .	. .	12	10	38
16	11	55	20	12	2	34	12	10	50
17	11	55	5	12	2	52	12	11	2
18	11	54	56	12	3	18	12	11	14
19	11	54	21	12	3	22	12	11	27
20	11	54	1	12	3	32	12	11	39
21	11	53	39	12	3	59	12	11	51
22	11	53	15	12	4	18	12	12	4
23	11	52	50	12	4	38	12	12	16
24	11	52	15	12	4	47	12	12	28
25	11	51	48	12	5	9	12	12	40
26	11	51	10	12	5	16	12	12	53
27	11	50	34	12	5	27	12	13	5
28	11	49	59	12	5	48	12	13	17
29	11	49	31	12	6	12	12	13	29
30	11	48	57	12	6	40	12	13	42
31	11	48	9	12	6	52	12	13	54
Aug. 1	11	47	24	12	7	0	12	14	6
2	11	46	34	12	7	12	12	14	19
3	11	45	50	12	7	32	12	14	31
4	11	44	39	12	7	34	12	14	43
5	11	43	43	12	7	38	12	14	55
6	11	42	36	12	7	31	12	15	8
12	11	58	7	. .	. .	. .	. .	. .	. .
13	11	56	32	. .	. .	. .	. .	. .	. .
14	11	55	16	12	5	21	12	16	45
15	11	54	3	12	5	38	12	16	58
16	11	52	46	12	5	53	12	17	10
17	11	51	27	12	6	10	12	17	23
18	11	50	8	12	6	33	12	17	35
19	11	48	41	12	6	38	12	17	47

A Table

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A Table ſhewing what the Mean Time is at Greenwich, by each Time-keeper, when the Pocket Watch made by Arnold is at 12^h.

Day of the Month.		Arnold.			Kendal.			Watch.		
		h	′	″	h	′	″	h	′	″
Aug.	20	11	47	7	12	6	52	12	18	0
	21	11	45	23	12	6	58	12	18	12
	22	11	43	34	12	6	47	12	18	24
	23	11	41	51	12	6	55	12	18	36
	24	11	39	51	12	6	58	12	18	49
	25	11	37	56	12	6	56	12	19	1
	26	11	35	56	12	6	58	12	19	13
	27	11	34	7	12	7	15	12	19	25
	28	11	32	17	12	7	32	12	19	38
	29	11	30	17	12	7	32	12	19	50
	30	11	28	9	12	7	43	12	20	2
	31	11	26	14	12	7	57	12	20	15
Sept.	1	11	24	5	12	8	13	12	20	27
	2	11	21	46	12	8	13	12	20	39
	3	11	19	43	12	8	38	12	20	51
	4	11	17	29	12	8	53	12	21	4
	5	11	14	59	12	9	4	12	21	16
	6	11	12	22	12	9	22	12	21	28
	7	11	9	38	12	9	22	12	21	40
	9	11	3	53	12	9	44	12	22	5
	11	10	57	16	12	9	46	12	22	30
	13	10	50	45	12	10	16	12	22	54
	14	10	35	0	12	10	31	12	23	6
	15	10	42	31	12	10	47	12	23	19
	16	10	39	35	12	11	4	12	23	31
	17	10	35	59	12	11	31	12	23	43
	18	10	31	53	12	11	47	12	23	56
	19	10	27	11	12	11	52	12	24	8
	20	10	23	0	12	12	15	12	24	20
	21	10	18	38	12	12	40	12	24	32
	23	10	8	54	12	13	39	12	24	57
	24	10	4	13	12	14	10	12	25	9
	25	9	58	52	12	14	37	12	25	21
	26	9	53	54	12	14	59	12	25	34
	27	9	48	8	12	15	35	12	25	46

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Obſervations for finding the Longitude by the Time-keepers.

May 30, P. M. off Sheerneſs.

Time by the Watch.	Alt. of the Sun's lowe. Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 48 4	17 46 0	17 55 0	5 53 47	5 50 57	2 11	Mean of the two laſt,	Eq. Time 2′—50″
5 51 12	17 14 0	17 23 0	5 57 25	5 54 35	3 23	3′ 15″	
5 53 12	16 57 0	17 6 0	5 59 10	5 56 20	3 8		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 3 15	. . . .	12 3 15	. . . .	12 3 15
At Greenwich, by the Watch,	12 1 13	by Arnold,	12 0 27	by Kendal,	11 59 49
Difference of Meridians,	0 2 2		0 2 48		0 3 26
Longitude of the Ship,	0° 30′ 30″E		0° 42′ 0″		0° 51 30′

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Obſervations for finding the Longitude by the Time-keepers.

June 4, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
9 44 15	51 47 30	51 56 30	9 52 44	9 50 37	6 22		Eq. Time 2′—7″
9 47 30	52 8 0	52 17 0	9 55 32	9 53 25	5 55	Mean 6′ 9″	
9 50 0	52 27 30	52 36 30	9 58 16	9 56 9	6 9		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 6 9	. . . .	12 6 9	. . . .	12 6 9
At Greenwich, by the Watch,	12 2 15	by Arnold,	12 1 16	by Kendal,	12 0 25
Difference of Meridians,	0 3 54		0 4 53		0 5 44
Longitude of the Ship,	0° 58′ 30″ E		1° 13′ 15″		1° 26′ 0″

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

June 6, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Eq. Time, 1′—48″
9 49 15	52 25 0	52 33 50	9 59 43	9 57 55	8 40		
9 51 10	52 38 45	52 46 35	10 1 41	9 59 53	8 43	Mean 8′ 51″	
9 52 45	52 51 30	53 0 20	10 3 43	10 1 55	9 10		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 8 51	. . . .	12 8 51	. . . .	12 8 51
At Greenwich, by the Watch,	12 2 39	by Arnold,	12 1 50	by Kendal,	12 0 55
Difference of Meridians,	0 6 12		0 7 1		0 7 56
Longitude of the Ship,	1° 33′ 0″ E		1° 45′ 15″		1° 59′ 0″

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

June 8, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		′ ″
9 28 0	48 48 0	48 56 45	9 35 11	9 33 45	5 45	Mean 5′ 49″	Eq. Time, 1—26
10 54 0	57 10 0	57 19 0	11 1 19	10 59 54	5 54		1—25

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 5 49	. . . .	12 5 49	. . . .	12 5 49
At Greenwich, by the Watch,	12 3 4	by Arnold,	12 2 8	by Kendal,	12 1 10
Difference of Meridians,	0 2 45		0 3 41		0 4 30
Longitude of the Ship,	0° 41′ 15″ E		0° 55′ 15″		1° 9′ 45″

Obfervations for finding the Longitude by the Time-keepers.

June 8, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		′ ″
5 42 0	19 53 0	20 0 0	5 48 12	5 46 56	4 46		Eq. Time 1—16
5 44 35	19 32 0	19 38 50	5 50 38	5 49 22	4 47	Mean 4′ 51″	
5 46 50	19 12 0	19 18 50	5 52 56	5 51 40	4 50		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 4 51	. . . .	12 4 51	. . . .	12 4 51
At Greenwich, by the Watch,	12 3 4	by Arnold,	12 2 8	by Kendal,	12 1 10
Difference of Meridians,	0 1 47		0 2 43		0 3 41
Longitude of the Ship,	0° 26′ 45″ E		0° 40′ 45″		0° 55′ 15″

Obſervations for finding the Longitude by the Time-keepers.

June 11, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too faſt.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		′ ″
9 4 35	44 41 0	44 49 40	9 1 17	9 0 26	4 9	Mean 4′ 2″	Eq. Time 0—51
9 6 10	44 55 0	45 3 40	9 3 1	9 2 10	4 0		
9 7 50	45 9 0	45 17 40	9 4 45	9 3 54	3 56		
10 12 49	52 36 0	52 44 50	10 5 19	10 4 28	8 21		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	11 55 58	. . . .	11 55 58	. . . .	11 55 58
At Greenwich, by the Watch,	12 3 40	by Arnold,	12 2 11	by Kendal,	12 1 28
Difference of Meridians,	0 7 42		0 6 13		0 5 30
Longitude of the Ship,	1° 55′ 30″ W		1° 33′ 15″		1° 22′ 30″

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Obſervations for finding the Longitude by the Time-keepers.

June 13, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
10 16 17	49 39 0	49 50 10	10 20 37	10 20 11	3 54	} Mean 3′ 26″	Lat. 59 24 0
10 20 17	49 55 0	50 6 10	10 24 8	10 23 42	3 25		Eq. Time, 0—26
10 25 35	50 18 0	50 29 10	10 29 27	10 29 1	3 26		

	h ′ ″		h ′ ″		h ′ ″
At 10h by Arnold, mean Time at the Ship,	10 3 26	. . . .	10 3 26	. . . .	10 3 26
At Greenwich, by the Watch,	10 3 50	by Arnold,	10 1 49	by Kendal,	10 1 13
Difference of Meridians	0 0 24		0 1 37		0 2 13
Longitude of the Ship,	0° 6′ 0″ W		0° 24′ 15″ E		0° 33′ 15″ E

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Obſervations for finding the Longitude by the Time-keepers.

June 13, P. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.				
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″				° ′ ″
5 36 22	22 10 30	22 18 0	5 41 6	5 40 44	4 22	*		Lat.	59 46 0
5 38 55	21 52 0	21 59 30	5 43 18	5 42 56	4 1	*		Eq. Time,	0—22
5 39 57	21 44 30	21 54 10	5 44 20	5 43 58	4 1	*			
5 41 17	21 35 0	21 42 30	5 46 25	5 46 3	4 46		Mean of the		
5 43 3	21 20 0	21 27 30	5 48 8	5 47 46	4 43		five marked *,		
5 45 9	21 6 30	21 13 50	5 49 43	5 49 21	4 12		4′ 8″		
5 47 40	20 46 30	20 56 0	5 52 7	5 51 45	4 5	*			
	20 47 0	20 54 20	5 52 53	5 52 31	4 51	*			

	h ′ ″		h ′ ″		h ′ ″	
At 6h by Arnold, mean Time at the Ship,	6 4 8	. . . .	6 4 8	. . . .	6 4 8	
At Greenwich, by the Watch,	6 3 52	by Arnold,	6 1 49	by Kendal,	6 1 14	
Difference of Meridians,	0 0 16		0 2 19		0 2 54	
Longitude of the Ship,	0° 4′ 0″ E		0° 34′ 45″		0° 43′ 30″	

Obfervations for finding the Longitude by the Time-keepers.

June 14, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too faft.		
h ′ ″	° ′ ″	° ′ ′	h ′ ″	h ′ ″	′ ″		° ′ ″
9 44 32	45 57 0	46 8 0	9 43 56	9 43 43	0 49		Lat. 60 17 0
9 48 41	46 21 0	46 32 0	9 48 20	9 48 7	0 34	Mean 0′ 48″	Eq. Time 0—13
9 52 53	46 41 0	45 52 0	9 52 4	9 51 51	1 2		

	h ′ ″		h ′ ″		h ′ ″
At 10h by Arnold, mean Time at the Ship,	9 59 12	. . . .	9 59 12	. . . .	9 59 12
At Greenwich, by the Watch,	10 3 59	by Arnold,	10 1 52	by Kendal,	10 1 20
Difference of Meridians,	0 4 47		0 2 40		0 2 8
Longitude of the Ship,	1° 11′ 45″ W		0° 40′ 0″		0° 32′ 0″

Obfervations

Obſervations for finding the Longitude by the Time-keepers.

June 15, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
8 26 48	38 3 0	38 13 40	8 28 16	8 28 13	1 35		Lat. 60° 17′
8 28 5	38 11 30	38 22 10	8 29 40	8 29 37	1 32	Mean, 1′ 33″	Eq. Time, 0—3″
8 29 8	38 20 0	38 30 40	8 30 53	8 30 50	1 42		

	h ′ ″		h ′ ″		h ′ ″
At 8h by Arnold, mean Time at the Ship,	8 1 33	. . . .	8 1 33	. . . .	8 1 33
At Greenwich, by the Watch,	8 4 9	by Arnold,	8 1 56	by Kendal,	8 1 28
Difference of Meridians,	0 2 36		0 0 23		0 0 5
Longitude of the Ship,	0° 39′ 0″ W		0° 5′ 45″ W		0° 1′ 15″ E

Obſervations for finding the Longitude by the Time-keepers.

June 17, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
9 33 11	43 41 0	43 52 0	9 35 29	9 35 53	2 42		Lat.	62 43 30
9 34 58	43 51 0	44 2 0	9 38 36	9 39 0	4 2		Decl.	23 25 20
9 36 45	44 2 0	44 13 0	9 39 36	9 40 0	3 15	Mean, 3′ 31″	Eq. Time,	0 + 24
9 37 40	44 6 30	44 17 30	9 40 31	9 41 55	4 15			
9 42 4	44 30 0	44 41 0	9 45 13	9 45 37	3 33			

	h ′ ″		h ′ ″		h ′ ″
At 10h by Arnold, mean Time at the Ship,	10 3 31	. . . .	10 3 31	. . . .	10 3 31
At Greenwich, by the Watch,	10 4 50	by Arnold,	10 2 2	by Kendal,	10 1 44
Difference of Meridians,	0 1 19		0 1 29		0 1 47
Longitude of the Ship,	0° 19′ 45″ W		0° 22′ 15″ E		0° 26 45″ E

Obſervations for finding the Longitude by the Time-keepers.

June 18, P. M.

Time by the Watch	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
3 32 41	35 58 30	36 9 10	3 33 5	3 33 45	1 4		Lat. 65 25 0
3 34 24	35 50 0	36 0 40	3 34 35	3 35 15	0 51	Mean 1′ 4″	Decl. 23 26 10
3 37 38	35 29 0	35 39 40	3 38 15	3 38 55	1 17		Eq. Time, 0+40

	h ′ ″		h ′ ″		h ′ ″
At 12° by the Watch, mean Time at the Ship,	12 1 4	. . . .	12 1 4	. . . . .	12 1 4
At Greenwich, by the Watch,	12 5 6	by Arnold,	12 2 5	by Kendal,	12 1 51
Difference of Meridians,	0 4 2		0 1 1		0 0 4
Longitude of the Ship,	1° 0′ 30″ W		0° 15′ 15″		0° 11′ 45″

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Obfervations for finding the Longitude by the Time-keepers.

June 19, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
3 55 38	33 33 0	33 43 30	3 54 51	3 55 45	0 7	*	Lat. 66 27 0
3 56 39	33 20 0	33 30 30	3 57 9	3 58 3	1 24		Decl. 23 27 10
3 58 8	33 12 0	33 22 30	3 58 33	3 59 27	1 49		Eq. Time, 0+54
4 5 28	32 30 0	32 40 30	4 5 55	4 6 49	1 21	Mean of all but	
4 6 8	32 25 0	32 35 30	4 6 47	4 7 41	1 33	the two mark-	
4 7 57	32 16 0	32 26 30	4 8 20	4 9 14	1 17	ed *	
4 8 30	32 12 30	32 23 0	4 8 57	4 9 51	1 21	1′ 24″	° ′ ″
6 4 34	20 44 30	20 54 0	6 5 19	6 6 14	1 40		Lat. 66 35 0
6 5 27	20 41 0	20 50 30	6 5 54	6 6 49	1 22		Decl. 23 27 0
6 9 9	20 9 0	20 18 20	6 11 25	6 12 20	3 11	*	Eq. Time, 0+55

	h ′ ″	h ′ ″	h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 1 24	12 1 24	12 1 24
At Greenwich, by the Watch,	12 5 19 by Arnold,	12 2 14 by Kendal,	12 2 7
Difference of Meridians,	0 3 55	0 0 50	0 0 43
Longitude of the Ship,	0° 58′ 45″ W	0° 12′ 30″	0° 10′ 45″

Obfervations

Obſervations for finding the Longitude by the Time-keepers.

June 21, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
8 50 33	37 14 0	37 24 40	8 52 41	8 53 56	3 23		Lat.	67 35 0
8 54 0	37 30 30	37 41 10	8 56 12	8 57 27	3 27	Mean 3′ 25″	Decl.	23 27 55
8 59 22	37 53 0	38 3 40	9 0 57	9 2 12	2 50		Eq. Time,	1 + 15

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 3 25	. . .	12 3 25	. . .	12 3 25
At Greenwich, by the Watch,	12 5 43	by Arnold,	12 1 57	by Kendal,	12 2 5
Difference of Meridians,	0 2 18		0 1 28		0 1 20
Longitude of the Ship,	0° 34′ 30″ W		0° 22′ 0″ E		0° 20′ 0″ E

Obfervations for finding the Longitude by the Time-keepers.

June 25, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too flow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
7 58 27	32 31 0	32 41 30	8 34 25	8 36 32	38 5		Lat.	73 57 0
8 0 40	32 36 15	32 46 45	8 35 56	8 38 3	37 23		Decl.	23 24 25
8 2 58	32 42 30	32 53 0	8 37 41	8 39 48	36 50	Mean 37′ 36″	Eq. Time,	2+7
8 3 52	32 46 15	32 56 45	8 39 28	8 41 35	37 43			
8 4 58	32 50 30	33 1 0	8 40 0	8 42 7	37 9			
8 5 42	32 54 0	33 4 30	8 41 0	8 43 7	37 25			

	h ′ ″		h ′ ″		h ′ ″
At 8h by Arnold, mean Time at the Ship,	8 37 36	. . . .	8 37 36	. . . .	8 37 36
At Greenwich, by the Watch,	8 8 36	by Arnold,	8 2 28	by Kendal,	8 3 21
Difference of Meridians,	0 29 0		0 35 8		0 34 15
Longitude of the Ship,	7° 15′ 0″ E		8° 47′ 0″		8° 33′ 45″

Obfervations

Observations for finding the Longitude by the Time-keepers.

June 26, P. M.

Time by Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
3 31 36	29 17 0	29 27 15	4 10 25	4 12 49	41 13	Mean 42′ 14″	Lat. 70 25 c
3 34 59	29 3 0	29 13 15	4 14 10	4 16 34	41 35		Decl. 23 21 5c
3 35 31	28 58 30	29 8 45	4 15 21	4 17 45	42 14		Eq. Time, 2+24
3 36 55	28 55 0	29 5 15	4 16 52	4 19 16	42 21		
3 38 14	28 49 0	28 59 15	4 17 52	4 20 16	42 2		
3 39 10	28 44 30	28 54 45	4 19 6	4 21 30	42 20		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 42 14	. . . .	12 42 14	. . . .	12 42 14
At Greenwich, by the Watch,	12 6 44	by Arnold,	11 59 52	by Kendal,	12 0 59
Difference of Meridians,	0 35 30		0 42 22		0 41 15
Longitude of the Ship,	8° 52′ 30″ E		10° 35′ 30″		10° 18′ 45″

Observations

Obſervations for finding the Longitude by the Time-keepers.

June 28, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
5 56 50	20 45 0	20 54 30	6 33 21	6 36 5	39 15		Lat.	77 30 0
5 58 40	20 42 0	20 51 30	6 34 18	6 37 2	38 22	Mean	Decl.	23 16 10
5 59 2	20 40 0	20 49 30	6 34 55	6 37 39	38 37	38′ 29″	Eq. Time	2 + 44

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 38 29	. . . . .	12 38 29	. . . . .	12 38 29
At Greenwich, by the Watch,	12 7 9	by Arnold,	12 59 26	by Kendal,	12 1 2
Difference of Meridians,	0 31 20		0 39 3		0 37 27
Longitude of the Ship,	7° 50′ 0 E″		9° 45′ 45″		9° 21′ 45″

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

June 29, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
3 41 37	27 29 0	27 39 10	4 22 41	4 25 41	44 4		Lat.	78 1 40
3 43 25	27 20 0	27 30 10	4 25 1	4 28 1	44 36		Decl.	23 13 15
3 46 30	27 11 0	27 21 10	4 28 47	4 31 47	45 17	Mean 45′ 25″	Eq. Time	3 + 0
3 47 44	27 6 0	27 16 10	4 30 28	4 33 28	45 44			
3 48 53	27 0 0	27 10 10	4 32 36	4 35 36	46 43			
3 50 24	26 57 0	27 7 10	4 33 29	4 36 29	46 5			

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 45 25	. . . .	12 45 25	. . . .	12 45 25
~~At Greenwich, by the Watch,~~	12 7 21	by Arnold,	11 59 11	by Kendal,	12 1 3
Difference of Meridians,	0 38 4		0 46 14		0 44 22
Longitude of the Ship,	9° 31′ 0″ E		11° 33′ 30″		11° 5′ 30″

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Obſervations for finding the Longitude by the Time-keepers.

June 30, P. M.

Time by the Watch	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
5 58 43	20 27 0	20 36 25	6 40 1	6 43 14	44 31		Lat.	78 7 15
6 0 4	20 20 0	20 29 25	6 42 21	6 45 34	45 30	Mean	Decl.	23 9 20
6 1 37	20 15 30	20 24 55	6 43 52	6 47 5	45 28	45′ 29″	Eq. Time,	3+13
6 2 28	20 14 15	20 23 40	6 44 17	6 47 30	45 2			

	h ′ ″	h ′ ″	h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 45 29	12 45 29	12 45 29
At Greenwich, by the Watch	12 7 34 by Arnold,	11 58 55 by Kendal,	12 0 59
Difference of Meridians,	0 37 55	0 46 34	0 44 30
Longitude of the Ship,	9° 28′ 45″ E	11° 38′ 30″	11° 7′ 30″

Observations for finding the Longitude by the Time-keepers.

July 2, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		h ′ ″
5 46 4	20 55 0	21 4 30	6 28 59	6 32 34	46 30		Lat. 78 23 50
5 47 44	20 52 0	21 1 30	6 29 59	6 33 34	45 50	Mean 44′ 58″	Decl. 23 0 50
5 49 59	20 47 0	20 56 30	6 31 41	6 35 16	45 17		Eq. Time 3+35
5 52 57	20 41 0	20 50 30	6 33 47	6 37 22	44 25		
5 53 55	20 37 0	20 46 30	6 35 11	6 38 46	44 51	of the four last	
5 54 49	20 35 0	20 44 30	6 35 47	6 39 22	44 33	44′ 32″	
5 56 35	20 30 30	20 40 0	6 37 20	6 40 55	44 20		

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 44 32	. . . .	12 44 32	. . . .	12 44 32
At Greenwich, by the Watch,	12 7 58	by Arnold,	11 58 29	by Kendal,	12 1 10
Difference of Meridians,	0 36 34		0 46 3		0 43 22
Longitude of the Ship,	9° 8′ 30″ E		11° 30′ 45″		10° 50′ 30″

Obſervations for finding the Longitude by the Time-keepers.

July 6, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
6 32 12	19 26 0	19 3 40	7 15 59	7 20 16	48 4		Lat.	79 57 0
6 36 0	19 18 0	18 55 40	7 19 19	7 23 36	47 36		Decl.	22 28 20
6 38 35	19 13 0	18 50 40	7 21 24	7 25 41	47 6	Mean, 47′ 41″	Eq. Time,	4+17
6 39 23	19 9 0	18 46 40	7 23 4	7 27 21	47 58			
6 40 57	19 5 30	18 43 10	7 24 20	7 28 37	47 40			

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 47 41	. . . .	12 47 41	. . . .	12 47 41
At Greenwich, by the Watch,	12 8 47	by Arnold,	11 57 50	by Kendal,	12 1 47
Difference of Meridians,	0 38 54		0 49 51		0 45 54
Longitude of the Ship,	9° 43′ 30″ E		12° 27′ 45″		11° 28 30″

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

July 11, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Lat. 80° 4′ 0″
3 32 22	. . . .	17 39 20	4 19 49	4 24 45	52 23	Mean, 52′ 31″	Decl. 22 7 20
3 38 48	. . . .	17 54 30	4 26 31	4 31 27	52 39		Eq. Time, 4+56

	h ′ ″		h ′ ″		h ′ ″
At 3^h by Arnold, mean Time at the Ship,	3 52 31	. . . .	3 52 31	. . . .	3 52 31
At Greenwich, by the Watch,	3 16 23	by Arnold,	3 3 21	by Kendal,	3 9 19
Difference of Meridians,	0 36 8		0 49 10		0 43 12
Longitude of the Ship,	9° 2′ 0″ E		12° 17′ 30″		10° 48′ 0″

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Obfervations for finding the Longitude by the Time-keepers.

July 12, P. M.

Correction for Error of Sextant, —4′ 30″

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
7 26 25	16 5 0	16 9 10	8 15 9	8 20 18	53 53		Lat.	80 4 0
7 27 58	16 3 0	19 7 10	8 16 8	8 21 17	53 19	Mean 53′ 38″	Decl.	21 53 10
7 28 44	16 2 15	16 6 25	8 16 30	8 21 39	52 55		Eq. Time	5+9
7 29 48	15 59 0	16 3 10	8 19 3	8 24 12	54 24			

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 53 38	. . . .	12 53 38	. . . . .	12 53 38
At Greenwich, by the Watch,	12 10 1	by Arnold,	11 56 25	by Kendal,	12 2 45
Difference of Meridians,	0 43 37		0 57 13		0 50 53
Longitude of the Ship,	10° 54′ 15″ E		14° 18′ 15″		12° 43′ 15″

Obfervations

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Obfervations for finding the Longitude by the Time-keepers.

On Shore on an Ifland near Vogel Sang, Latitude 79° 50′
Correction for Error of the Aftronomical Quadrant, +7″

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Eq. Time.	Mean Time.	Watch too flow.	Means.	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	′ ″	h ′ ″	′ ″	′ ″	° ′ ″
July 15 P.M.	3 30 53	25 21 50	25 35 29	4 16 31	5+29	4 22 0	51 7		68 33 2
	3 32 57	25 17 0	25 30 39	4 18 23		4 23 52	50 55	51 0	
	3 34 22	25 13 20	25 26 59	4 19 52		4 25 21	50 59		
16 A.M.	3 9 50	15 39 47	15 52 6	3 54 59	5+31	4 0 30	50 40		68 37 39
P.M.	5 55 25	18 55 12	19 8 8	6 41 1	5+35	6 46 36	51 11	51 5½	68 43 44
	5 59 0	18 46 10	18 59 6	6 44 25		6 50 0	51 0		
17 P.M.	5 31 45	19 46 40	19 59 43	6 17 17	5+40	6 22 57	51 12		68 54 0
18 A.M.	8 28 3	13 8 20	13 20 0	8 52 53	5+41	8 58 34	50 31		68 55 0

July 16,	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ifland,	12 51 0	. . . .	12 51 0	. . . .	12 51 0
At Greenwich, by the Watch,	12 10 50	by Arnold,	11 55 20	by Kendal,	12 2 34
Difference of Meridians	0 40 10		0 55 40		0 48 26
Longitude of the Ifland,	10° 2′ 30″ E		13° 55′ 0″		12° 6′ 30″

Obfervations

Obſervations for finding the Longitude by the Time-keepers.

July 26, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″		° ′ ″
3 29 25	22 46 0	22 55 40	4 25 41	4 31 43	1 2 18	Mean 1h 2′ 16″	Lat. 80 20 0
3 31 14	22 42 0	22 51 40	4 27 23	4 33 25	1 2 11		Co. Decl. 70 40 40
3 33 35	22 36 0	22 45 40	4 29 53	4 35 55	1 2 20		Eq. Time 6 +2
3 35 34	22 33 30	22 43 10	4 31 4	4 37 6	1 1 32		
3 36 50	22 31 0	22 40 40	4 31 59	4 38 1	1 1 11		
3 38 47	22 29 0	22 38 40	4 32 51	4 38 53	1 0 6		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 2 16	. . . .	1 2 16	. . . .	1 2 16
At Greenwich, by the Watch,	12 12 53	by Arnold,	11 51 10	by Kendal,	12 5 16
Difference of Meridians,	0 49 23		1 11 6		0 57 0
Longitude of the Ship,	12° 20′ 45″ E		17° 46′ 30″		14° 15′ 0″

Obſervations

Observations for finding the Longitude by the Time-keepers.

July 27, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″		° ′ ″
5 51 16	16 15 0	16 23 45	6 58 31	7 4 32	1 13 16		Lat. 80 23 0
5 53 22	16 10 30	16 19 15	7 0 24	7 6 25	1 13 3		Co. Decl. 70 55 45
5 55 26	16 5 45	16 14 30	7 2 24	7 8 25	1 12 59	Mean 1° 13′ 3″	Eq. Time, 6 [illegible]
5 58 35	15 58 0	16 6 45	7 5 40	7 11 41	1 13 6		
6 0 56	15 53 0	16 1 45	7 7 47	7 13 48	1 12 52		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 13 3	. . . .	1 13 3	. . . . .	1 13 3
At Greenwich, by the Watch,	12 13 5	by Arnold,	11 50 34	by Kendal,	12 5 27
Difference of Meridians,	0 59 58		1 22 29		1 7 36
Longitude of the Ship,	14° 59′ 30″ E		20° 37′ 15″		16° 54′ 0″

Observations

Obſervations for finding the Longitude by the Time-keepers.

July 28, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″		Lat. 80° 28′ 10″
5 22 34	17 10 0	17 18 50	6 30 46	6 36 46	1 14 12	Mean 1h 14′ 24″	Co. Dec. 71 9 10
5 28 58	16 54 30	17 3 20	6 37 34	6 43 34	1 14 36		Eq. Time, 6+0

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 14 24	. . . .	1 14 24
At Greenwich, by the Watch,	12 13 17	by Kendal,	12 5 48
Difference of Meridians,	1 1 7		1 8 36
Longitude of the Ship,	15° 16′ 45″ E		17° 9′ 0″

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Obſervations for finding the Longitude by the Time-keepers.

July 30, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″			° ′ ″
3 14 40	21 17 0	21 26 30	4 37 24	4 43 20	1 28 40		Lat.	80 33 0
3 22 6	20 59 0	21 8 30	4 45 1	4 50 57	1 28 51		Co. Dec.	71 38 50
3 26 34	20 48 45	20 58 15	4 49 21	3 55 17	1 28 43	Mean	Eq. Time,	5+56
3 29 11	20 41 30	20 51 0	4 52 21	4 58 17	1 29 6	1h 28′ 54″		
3 30 54	20 37 30	20 47 0	4 54 1	4 59 57	1 29 3			
3 32 45	20 33 30	20 43 0	4 55 33	5 1 29	1 28 44			
3 34 43	20 28 0	20 37 30	4 57 39	5 3 55	1 29 12			

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 28 54	. . . .	1 28 54
At Greenwich, by the Watch,	12 13 42	by Kendal,	12 6 40
Difference of Meridians,	1 15 12		1 22 14
Longitude of the Ship,	18° 48′ 0″ E		20° 33′ 30″

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the ſun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.	Mean.	
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″	h ′ ″	° ′ ″
July 31 P. M.	3 53 30	19 26 0	19 35 10	5 18 7	5 24 1	1 30 31		Lat. 80 37 0
	3 55 46	19 21 30	19 30 40	5 19 55	5 25 49	1 30 3		Co.Dec. 71 52 10
	3 58 30	19 17 0	19 26 10	5 21 45	5 27 39	1 29 9		Eq. Time, 5+54
	4 0 2	19 12 30	19 21 40	5 23 29	5 29 23	1 29 21		
	4 0 50	19 8 0	19 17 10	5 25 28	5 31 22	1 30 32		
	4 1 57	19 7 0	19 16 10	5 26 29	5 32 23	1 30 26		
	4 2 50	19 6 30	19 15 40	5 26 56	5 32 50	1 30 0	1 29 55	
	4 4 19	19 3 0	19 12 10	5 27 31	5 33 25	1 29 6		
	4 5 36	18 59 0	19 8 10	5 29 9	5 35 3	1 29 27		
	4 6 35	18 56 0	19 5 10	5 30 23	5 36 17	1 29 42		
	4 7 26	18 52 0	19 1 10	5 32 1	5 37 55	1 30 29		
	4 8 14	18 50 30	18 59 40	5 32 39	5 38 33	1 30 19		
	4 9 23	18 49 0	18 58 10	5 33 15	5 39 9	1 29 46		

At 12ʰ by the Watch, mean Time at the Ship, 1ʰ 29′ 55″ . . . . . 1ʰ 29′ 55″

At Greenwich, by the Watch, 12 13 54 by Kendal, 12 6 52

Difference of Meridians, 1 16 1 — 1 23 3

Longitude of the Ship, 19° 0′ 15″ E — 20° 45′ 45″

Obſervations

Obfervations for finding the Longitude by the Time-keepers.

At Smeerenberg, Lat. 79° 44′
By the Aftronomical Quadrant, Correction for Error of Quadrant—32″

Day of the Month.	Time by the Watch.			Alt. of the fun's lower Limb.			Alt. of the Sun's Center.			Apparent Time.			Mean Time.			Watch too flow.		Eq. Time.		Co. Decl.		
	h	′	″	°	′	″	°	′	″	h	′	″	h	′	″	′	″	′	″	°	′	″
Aug. 14. P.M.	5	38	30	12	24	0	12	35	0	6	30	21	6	34	31	56	1	4+	10	75	50	30
	5	47	37	12	0	0	12	11	0	6	39	31	6	43	41	56	4					
	6	1	15	11	24	0	11	34	40	6	53	24	6	57	34	56	19					
	6	2	39	11	21	0	11	31	40	6	54	59	6	59	9	56	30			75	50	50
	6	5	2	11	15	0	11	25	40	6	56	54	7	1	4	56	2					
	6	6	8	11	12	0	11	22	40	6	58	4	7	2	14	56	6					
	6	7	24	11	9	0	11	19	40	6	59	15	7	3	25	56	1					
	6	8	39	11	6	0	11	16	40	7	0	0	7	4	9	55	30	4+	9			
	6	9	45	11	3	0	11	13	40	7	1	31	7	5	40	55	55					
	6	11	3	11	0	0	11	10	40	7	2	42	7	6	51	55	48					
	6	15	44	10	48	0	10	58	30	7	7	23	7	11	32	55	48			75	51	0

Obfervations

Observations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.	Eq. Time.	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
Aug. 14. P. M.	6 16 41	10 45 0	10 55 30	7 8 41	7 12 50	56 9		
	6 17 51	10 42 0	10 52 30	7 9 54	7 14 3	56 12		
	6 19 10	10 39 0	10 49 20	7 11 8	7 15 17	56 7		
	6 20 22	10 36 0	10 46 20	7 12 20	7 16 29	56 7		
15, A.M.	4 56 57	13 6 0	13 17 20	5 48 53	5 52 50	55 53	3+57	75 59 20
	4 59 20	13 12 0	13 23 20	5 51 9	5 55 6	55 46		
	5 2 26	13 21 0	13 32 20	5 54 32	5 58 29	56 3		
	5 3 35	13 24 0	13 35 20	5 55 43	5 59 40	56 5		
	5 4 46	13 27 0	13 38 20	5 56 55	6 0 52	56 6		75 59 30
	5 7 6	13 33 0	13 44 20	5 59 5	6 3 2	55 56		
	5 8 19	13 36 0	13 47 20	6 0 12	6 4 9	55 50		
	5 9 12	13 39 0	13 50 30	6 1 24	6 5 21	56 9		
	5 10 23	13 42 0	13 53 30	6 2 31	6 6 28	56 5		
	5 11 34	13 45 0	13 56 30	6 3 41	6 7 38	56 4		

Observations

Obſervations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.	Eq. Time.	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	′ ″	° ′ ″
Aug. 15, A. M.	5 12 43	13 48 0	13 59 30	6 4 49	6 8 46	56 3		
	5 13 49	13 51 0	14 2 30	6 5 56	6 9 53	56 4		
	5 20 42	14 9 0	14 20 40	6 12 44	6 16 41	55 59		75 59 40
	5 22 56	14 15 0	14 26 40	6 14 59	6 18 56	56 0		
	5 24 2	14 18 0	14 29 40	6 16 5	6 20 2	56 0		
	5 27 25	14 27 0	14 38 40	6 19 28	6 23 25	56 0		
18, A. M.	4 57 8	12 15 0	12 26 0	5 50 51	5 54 19	57 11	3+28	76 56 50
	5 0 31	12 24 0	12 35 0	5 54 13	5 57 41	57 10		
	5 1 46	12 27 0	12 38 0	5 55 21	5 58 49	57 3		
	5 2 51	12 30 0	12 41 0	5 56 29	5 59 57	57 6		
	5 3 57	12 33 0	12 44 0	5 57 35	6 1 3	57 6		
	5 6 11	12 39 0	12 50 10	5 59 51	6 3 19	57 8		
	5 7 20	12 42 0	12 53 10	6 1 2	6 4 30	57 10		
	5 11 52	12 54 0	13 5 10	6 5 35	6 9 3	57 11		76 57 0

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.	Eq. Time,	Co. Decl.
	h ' "	° ' "	° ' "	h ' "	h ' "	' "	' "	° ' "
Aug. 18, A. M.	5 13 6	12 57 0	13 8 10	6 6 42	6 10 10	57 4		
	5 15 15	13 3 0	13 14 20	6 9 0	6 12 28	57 13		
	5 16 32	13 6 0	13 17 20	6 10 8	6 13 36	57 4		
	5 17 39	13 9 0	13 20 20	6 11 15	6 14 43	57 4		
	5 19 50	13 15 0	13 26 20	6 13 29	6 16 57	57 7		
	5 20 55	13 18 0	13 29 20	6 14 37	6 18 5	57 10		
	5 22 5	13 21 0	13 32 20	6 15 48	6 19 16	57 12		76 57 10
	5 24 24	13 27 0	13 38 20	6 18 3	6 21 31	57 7		
	5 25 35	13 30 0	13 41 20	6 19 11	6 22 39	57 4		
	5 27 43	13 26 0	13 47 30	6 21 29	6 24 57	57 14		
	5 28 55	13 39 0	13 50 30	6 22 36	6 26 4	57 9		
	5 37 58	14 3 0	14 14 40	6 31 44	6 35 11	57 13	3+27	76 57 20
	5 41 23	14 12 0	14 23 40	6 35 44	6 39 11	57 48		
	5 42 28	14 15 0	14 26 40	6 36 19	6 39 46	57 18		

Obſervations

Obfervations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.	Eq. Time.	Co. Decl.
	h ' "	° ' "	° ' "	h ' "	h ' "	' "	' "	° ' "
Aug. 18, A.M.	5 43 39	14 18 0	14 29 40	6 37 27	6 40 54	57 15		6 57 30
	5 45 49	14 24 0	14 35 40	6 39 1	6 42 28	56 39		
	5 47 4	14 27 0	14 38 40	6 40 49	6 44 16	57 12		
	5 48 13	14 30 0	14 41 40	6 42 1	6 45 28	57 15		
	5 49 21	14 33 0	14 44 40	6 43 9	6 46 36	57 15		76 57 40
	5 59 39	15 0 0	15 11 50	6 53 27	6 56 54	57 15		
	6 0 53	15 3 0	15 14 50	6 54 37	6 58 4	57 11		
	6 1 58	15 6 0	15 17 50	6 55 45	6 59 12	57 14		
	6 3 8	15 9 0	15 20 50	6 56 53	7 0 20	57 12		
	6 4 17	15 12 0	15 23 50	6 58 3	7 1 30	57 13		
	6 5 29	15 15 0	15 26 50	6 59 12	7 2 39	57 10		76 57 50
	6 6 36	15 18 0	15 29 50	7 0 24	7 3 51	57 15		
	6 7 42	15 21 0	15 32 50	7 1 33	7 5 0	57 18		
	6 11 19	15 30 0	15 41 50	7 5 1	7 8 28	57 9		

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Obſervations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.	Eq. Time	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	′ ″	° ′ ″
Aug. 18	6 13 32	15 36 0	15 47 50	7 7 19	7 10 46	57 14		
A. M.	6 14 49	15 39 0	15 51 0	7 8 33	7 12 0	57 11		
	6 16 1	15 42 0	15 54 0	7 9 43	7 13 10	57 9		
18, P.M.	5 10 49	12 18 0	12 29 0	6 4 21	6 7 42	56 53	3+21	77 6 50
	5 12 55	12 12 0	12 23 0	6 6 35	6 9 56	57 1		
	5 14 6	12 9 0	12 20 0	6 7 43	6 11 4	56 58		
	5 15 14	12 6 0	12 17 0	6 8 51	6 12 12	56 58		
	5 16 16	12 3 0	12 14 0	6 9 58	6 13 19	57 3		
	5 17 22	12 0 0	12 11 0	6 11 5	6 14 26	57 4		
	5 18 40	11 57 0	12 8 0	6 12 13	6 15 34	56 54		
	5 19 35	11 54 0	12 5 0	6 13 21	6 16 42	57 7		
	5 20 48	11 51 0	12 1 50	6 14 27	6 17 48	57 0		
	5 21 51	11 48 0	11 58 50	6 15 40	6 19 1	57 10		

Obſervations for finding the Longitude by the Time-keepers.

	I. Aug. 14, P.M.	II. Aug. 15, A.M.	III. Aug. 18, A.M.	IV. Aug. 18, P.M.
	h ′ ″	h ′ ″	h ′ ″	h ′ ″
At 12h by Watch, mean Time at Smeerenberg,	12 56 2	12 56 0	12 57 11	12 57 1
At Greenwich, by Watch,	12 16 45	12 17 35	12 17 35	12 17 35
Difference of Meridians,	0 39 17	0 39 15	0 39 36	0 39 26
Longitude of Smeerenberg,	9° 49′ 15″	9° 48′ 45″	9° 54′ 0″	9° 51′ 30″
Mean of the 1ſt, 2d, and 4th, 9° 49′ 40″; of all, 9° 50′ 45″ E.				
	h ′ ″	h ′ ″	h ′ ″	h ′ ″
At 12h by Watch, mean Time at Smeerenberg,	12 56 2	12 67 0	12 57 11	12 57 1
At Greenwich, by Kendal,	12 5 21	12 5 21	12 6 31	12 6 33
Difference of Meridians,	0 50 41	0 50 39	0 50 40	0 50 28
Longitude of Smeerenberg,	12° 40′ 15″	12° 39′ 45″	12° 40′ 0″	12° 37′ 0″
Mean, 12° 39′ 15″ E.				

From comparing the 1ſt with the 3d, the Watch loſes in a Day, 19,7″
4th, ... 14,8
2d . . . 3d, ... 23,7
4th, ... 17,4
Mean of all four, ... 18,9

Obfervations for finding the Longitude by the Time-keepers.

August 31, P. M.

Time by the Watch	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			° ′ ″
6 1 54	4 35 0	4 36 10	6 35 43	6 35 31	33 37		Lat.	68 46 0
6 4 31	4 23 0	4 23 50	6 38 1	6 37 49	33 18		Co. Decl.	81 37 10
6 6 20	4 10 0	4 10 30	6 40 33	6 40 21	34 1	Mean 33′ 51″	Eq. Time,	0—12
6 7 40	4 2 0	4 2 10	6 42 7	6 41 55	34 15			
6 10 1	3 51 0	3 50 50	6 44 16	6 44 4	34 3			
6 11 33	3 44 0	3 43 30	6 45 39	6 45 27	33 54			

	h ′ ″		h ′ ″
At 12° by the Watch, mean Time at the Ship,	12 33 51	. . . .	12 33 51
At Greenwich, by the Watch,	12 20 15	by Kendal,	12 7 57
Difference of Meridians,	0 13 36		0 25 54
Longitude of the Ship,	3° 24′ 0″ E		6° 28′ 30″

Obfervations

Obſervations for finding the Longitude by the Time-keepers.

Sept. 3, P. M.

Time by the Watch	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
5 14 0	7 50 0	7 55 30	5 46 31	5 45 25	31 25		Lat. 65 31 0
5 16 30	7 30 0	7 35 20	5 48 52	5 47 46	31 16		Co. Decl. 82 41 20
5 17 7	7 24 30	7 29 30	5 49 34	5 48 28	31 21		Eq. Time 1—6
5 18 20	7 20 0	7 25 0	5 50 5	5 48 59	30 39	Mean 30′ 41″	
5 18 55	7 16 30	7 21 30	5 50 30	5 49 24	30 29		
5 19 40	7 13 0	7 18 0	5 50 55	5 49 49	30 9		
5 20 50	7 4 30	7 9 20	5 52 16	5 51 10	30 20		
5 21 50	6 58 0	7 2 50	5 52 43	5 51 37	29 47		

	h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 30 41	. . . .	12 30 41
At Greenwich, by the Watch,	12 20 51	by Kendal,	12 8 38
Difference of Meridians,	0 9 50		0 22 3
Longitude of the Ship,	2° 27′ 30″ E		5° 30′ 45″

Obfervations for finding the Longitude by the Time-keepers.

Sept. 6, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Lat. 62° 50′ 0″
8 56 25	26 50 0	27 0 10	9 22 57	9 20 59	24 34	Mean 24′ 22″	Co.Decl. 83 41 30
8 58 27	26 58 0	27 8 10	9 24 36	9 22 38	24 11		Eq. Time 1—58

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 24 22	. . . .	12 24 22
At Greenwich, by the Watch,	12 21 28	by Kendal,	12 9 22
Difference of Meridians,	0 2 54		0 15 0
Longitude of the Ship,	0° 43′ 30″ E		3° 45′ 0″

Obfervations

Obſervations for finding the Longitude by the Moon.

Sept. 6, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
4 44 14	10 35 0	10 42 10	5 15 17	5 13 14	29 0		Lat. 61 57 0
4 45 54	10 26 0	10 33 0	5 16 35	5 14 32	28 38		Co. Dec. 83 49 0
4 47 29	10 13 0	10 20 0	5 18 27	5 16 24	28 55	Mean 28′ 49″	Eq. Time, 2—3
4 48 59	10 4 0	10 10 50	5 19 45	5 17 42	28 43		
4 50 0	9 56 0	10 1 50	5 21 2	5 18 59	28 59		
4 52 36	9 39 0	9 45 40	5 23 20	5 21 17	28 41		

	h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 28 49	. . . .	12 28 49
At Greenwich, by the Watch,	12 21 28	by Kendal,	12 9 22
Difference of Meridians,	0 7 21		0 19 27
Longitude of the Ship,	1° 50′ 15″ E		4° 51′ 45″

Obfervations for finding the Longitude by the Time-keepers.

Sept. 14, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		° ′ ″
2 54 41	22 39 0	22 48 50	3 30 55	3 26 8	31 27		Lat. 55 32 0
2 55 40	22 36 0	22 45 50	3 31 21	3 26 34	30 54		Co. Decl. 86 50 0
2 56 34	22 29 0	22 38 50	3 32 17	3 27 30	30 56	Mean 31′ 12″	Eq. Time 4—47
2 57 41	22 18 0	22 27 50	3 33 48	3 29 1	31 20		
2 58 52	22 10 0	22 19 50	3 34 52	3 30 5	31 13		
3 2 24	21 43 0	22 52 50	3 38 31	3 33 44	31 20		

	h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 31 12	. . . .	12 31 12
At Greenwich, by the Watch,	12 23 6	by Kendal,	12 10 31
Difference of Meridians,	0 8 6		0 20 41
Longitude of the Ship,	2° 1′ 30″ E		5° 10′ 15″

Obfervations

Observations for finding the Longitude by the Time-keepers.

Sept. 25, A. M. in Hosely Bay.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Lat. 52° 6′ 0″
9 22 47	30 54 0	31 4 40	9 58 47	9 50 17	28 30	Mean, 28′ 16″	N.Poi. dist. 91 1 10
9 24 17	31 5 0	31 15 40	10 0 49	9 52 19	28 2		Eq. Time, 8—30

	h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 28 16	. . . .	12 28 16
At Greenwich, by the Watch,	12 25 21	by Kendal,	12 14 37
Difference of Meridians,	0 2 55		0 13 39
Longitude of the Ship,	0° 43′ 45″ E		3° 24′ 45″

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Obſervations for finding the Longitude by the Moon.

June 13, A. M.

Time by Arnold.	Alt. of the ſun's lower Limb.	Alt. of the Moon's lower Limb.	Diſt. of Sun and Moon's neareſt limbs	True Diſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
10 16 17	49 39 0	21 17 0	74 37 0	74 30 53	22 17 17	22 20 37	3 20	0 50 0 E
10 20 17	49 55 0	20 54 0	74 37 0	74 30 39	22 17 47	22 24 8	6 21	1 35 15
10 25 35	50 18 0	20 20 0	74 37 0	74 30 22	22 18 23	22 29 27	11 4	2 46 0
							Mean	1 43 45

June 14, A. M.

Correction for Error of the Sextant, —3′ 46″

Time by Arnold.	Alt. of the ſun's lower Limb.	Alt. of the Moon's lower Limb.	Diſt. of Sun and Moon's neareſt limbs	True Diſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
9 44 32	45 57 0	30 42 0	63 47 30	63 45 45	21 52 12	21 43 56	8 16	2 4 0 W
9 48 41	46 21 0	30 26 0	63 44 0	63 41 54	22 0 42	21 48 20	12 22	3 5 30
9 52 53	46 41 0	30 10 0	63 41 30	63 39 3	22 6 59	21 52 4	14 55	3 43 45
							Mean	2 57 45 W

Obſervations

Obſervations for finding the Longitude by the Moon.

June 15, A. M.

Time by Arnold.	Alt. of the ſun's lower Limb.	Alt. of the Moon's lower Limb.	Diſt. of Sun and Moon's neareſt limbs	True Diſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
10 30 36	49 50 0	34 20 0	52 35 0	52 37 41	22 32 3	22 32 10	0 9	0 2 15 E
10 32 4	49 54 0	34 20 0	52 34 45	52 37 23	22 34 56	22 33 40	1 16	0 19 30 W
10 34 33	50 3 0	34 10 0	52 32 0	52 34 26	22 39 17	22 36 9	3 8	0 47 0
10 36 23	50 9 0	34 4 0	52 32 0	52 34 18	22 39 35	22 37 59	1 36	0 24 0
10 39 54	50 18 0	33 51 0	52 31 15	52 33 20	22 41 14	22 41 30	0 14	0 3 30
10 41 34	50 28 0	33 40 0	52 31 0	52 32 51	22 42 47	22 42 10	0 37	0 9 15
							Mean	0 17 0 W

June 25, P. M.

Time by Arnold.	Alt. of the ſun's lower Limb.	Alt. of the Moon's lower Limb.	Diſt. of Sun and Moon's neareſt limbs	True Diſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
7 49 2	12 54 0	11 40 0	65 58 0	66 21 55	7 30 23	8 22 13	51 50	12 57 30 E

Obſervations for finding the Longitude by the Moon.

June 26, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Alt. of Moon's lower Limb.	Alt. of Moon's Center.	Diſt. of Sun and Moon's neareſt limbs	TrueDiſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′	° ′	° ′ ″	° ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
1 24 25	. . .	36 18	. . . .	12 51	75 39 30	75 41 30	1 25 1	2 4 15	39 50	9 57 30 E
1 28 14	35 58	. . .								
1 29 48	. . .	. . .	12 50 0							
1 32 5	. . .	36 1	. . . .	13 6	75 43 0	75 45 13	1 32 5	2 11 55	39 50	9 57 30
1 34 3	. . .	. . .	12 58 30							
1 36 9	35 41									

Obſervations for finding the Longitude by the Moon.

July 11, A. M.

Arnold too ſlow for Apparent Time 47′ 35″. Correction for Error of the Sextant, +4′ 24″

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Alt. of the Moon's lower Limb.	Diſt. of Sun and Moon's neareſt limbs	True Diſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
3 28 15		17 20 10	13 6 0	95 44 0	96 3 35	15 32 47	16 15 50	45 3	10 45 45
3 30 12	17 25								
3 32 22		17 39 20	13 9 0	95 40 0	95 59 20	15 41 58	16 19 57	37 59	9 29 45
3 34 7	17 34								
3 38 48		17 54 30	13 13 0	95 36 0	95 55 8	15 51 3	16 26 23	35 20	8 50 0
3 40 24	17 50								
								Mean,	9 42 0 E

Obſervations

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Obſervations for finding the Longitude by the Moon.

Sept 1, P. M. Moon's Diſtance obſerved from Aldebaran.

Time by the Watch	Computed Alt. of Aldebaran.	Alt. of the Moon's lower Limb	Diſtance of the Moon from Aldebaran.	True Diſt. of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
11 45 15	17 49 0	17 3 0	76 57 neareſt limb	77 0 59	11 56 7	12 22 44	26 37	6 39 15 E
12 7 43	20 45 0	17 10 0	77 18 farth. limb	76 48 53	12 19 29	12 45 12	25 43	6 25 30
12 22 44	22 8 0	17 6 0	76 44 neareſt limb	76 44 15	12 27 33	13 0 13	32 40	8 10 0

Sept. 3, P. M. Moon's Diſtance obſerved from Aldebaran.

Time by the Watch.	Computed Alt. of Aldebaran.	Alt. of the Moon's lower Limb	Diſt. of Moon's W. Limb from Aldebaran.	True Diſt. of Moon's Center from Aldeb.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
11 30 35	17 47 0	24 47 0	39 39 0	39 57 5	11 30 43	11 55 47	25 4	6 16 0 E

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Time by the Watch.			Alt. of Jupiter		Alt. of the Moon's lower Limb.			Distance of piter and Moon's ther Lim	
h	'	"	°	'	°	'	"	°	'
8	51	33	10	25	9	0	0	32	55
9	3	27	10	59	9	36	0	32	47
9	32	45	13	19	10	55	0	32	29
9	51	54	14	40	11	36	0	32	22
10	38	25	17	45	12	49	0	31	58
11	43	18	20	52	13	6	0	31	28
1	35	37	22	45	9	55	0	30	33

Time by the Watch.			Alt. of Jupiter		Alt. of the Moon's lower Limb.			Distance o piter an Moon's ther Li	
h	'	"	°	'	°	'	"	°	'
11	59	20	21	55	7	8	0	18	8

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