RUT 613

Remarks, Instructions, and Examples

RELATING TO THE

LATITUDE & LONGITUDE;

ALSO,

The Variation of the Compass,

&c. &c. &c.

To which is Annexed,

A GENERAL CHART OF THE GLOBE,

WHERE THE ROUTE MADE BY THE AUTHOR, IN DIFFERENT SHIPS UNDER HIS COMMAND,

TO THE

CAPE of GOOD HOPE, BATAVIA, CANTON in CHINA, the different parts of INDIA, EUROPE, and the CAPE DE VERDE ISLANDS *are marked*, for the purpose of shewing the best *Tract* of Sea to meet the most favourable Winds, and avoid those perplexing *Calms* which too often attend Asiatic Voyages:

TOGETHER

With a Short, but General Account

OF

VARIABLE WINDS, TRADE-WINDS, MONSOONS, HURRICANES, TORNADOES, TUFFOONS, CALMS, CURRENTS,

AND

PARTICULAR WEATHER MET WITH IN THOSE VOYAGES,

&c. &c. &c.

RAREBOOK
VK
565
T7
1794

By Thomas Truxtun.

PHILADELHPIA,
PRINTED BY T. DOBSON, AT THE STONE-HOUSE, SOUTH SECOND-STREET.
M,DCC,XCIV.

1794

National Oceanic and Atmospheric Administration

Rare Books from 1600-1800

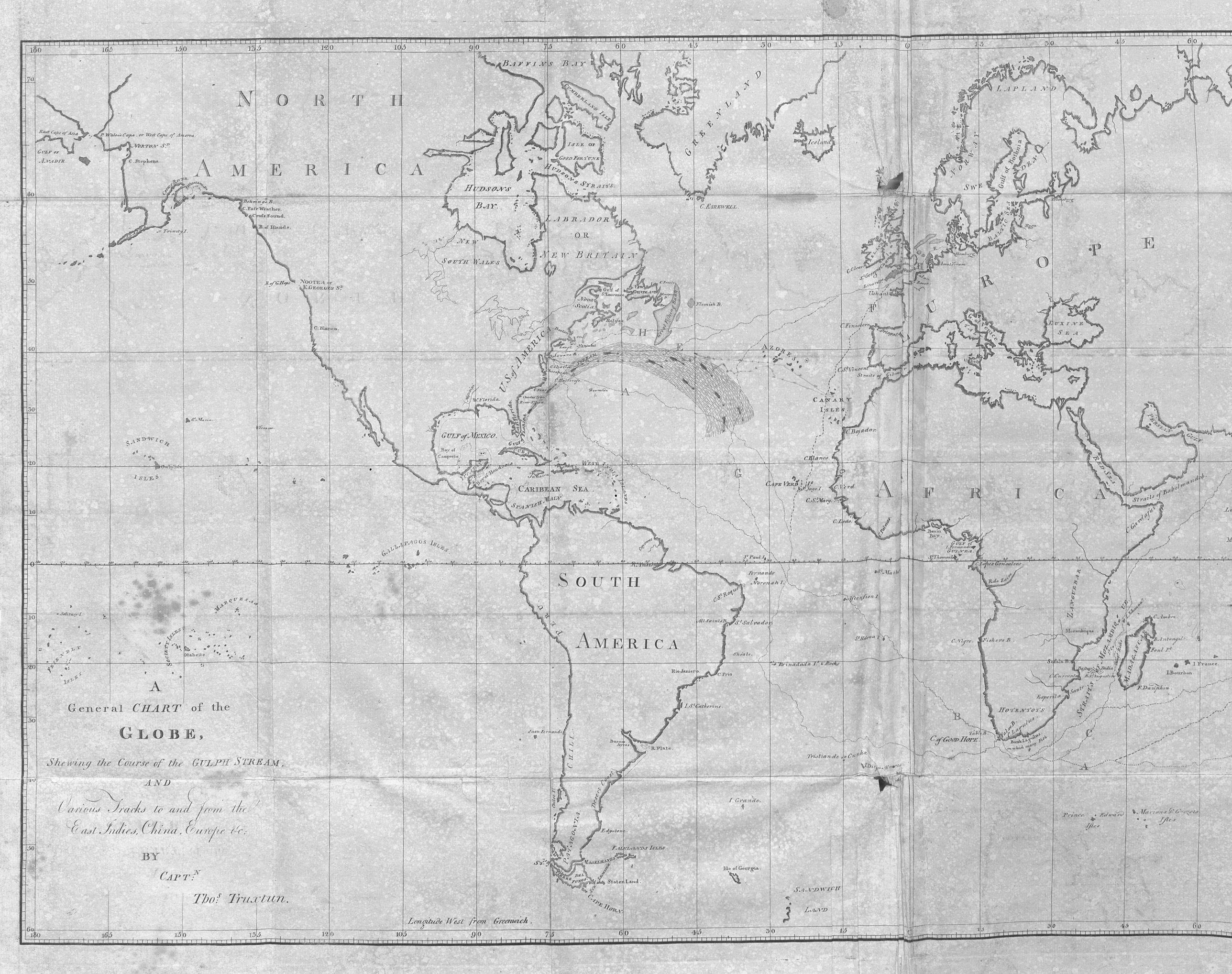
ERRATA NOTICE

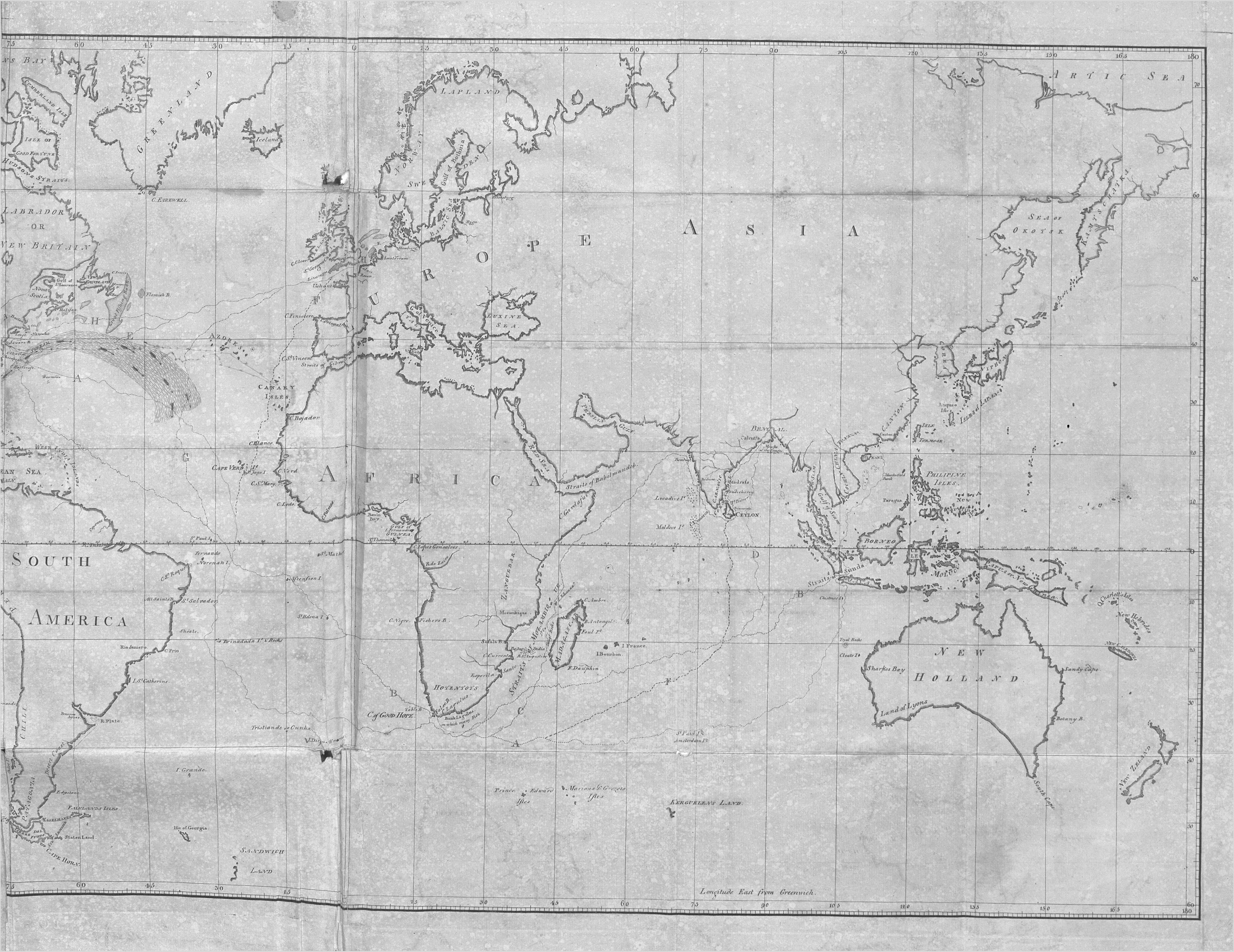
One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library, the Climate Database Modernization Program, National Climate Data Center (NCDC) and the NOAA 200th Celebration. To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or at Library.Reference@noaa.gov

HOV Services
Imaging Contractor
12200 Kiln Court
Beltsville, MD 20704-1387
April 14, 2008


A General CHART of the GLOBE,
Shewing the Course of the GULPH STREAM,
AND
Various Tracks to and from the East Indies, China, Europe &c.
BY
CAPT.N
Thos. Truxtun.
NORTH AMERICA
SOUTH AMERICA
EUROPE
AFRICA
BAFFIN'S BAY
GREENLAND
LAPLAND
HUDSONS BAY
LABRADOR OR NEW BRITAIN
NEW SOUTH WALES
GULF of MEXICO
CARIBEAN SEA
SPANISH MAIN
WEST INDIA ISLANDS
GULF STREAM
AZORES
CANARY ISLES
CAPE VERD ILS
HOTENTOTS
C. of GOOD HOPE
SANDWICH ISLES
GALLAPAGOS ISLES
FRIENDLY ISLES
SOCIETY ISLES
MARQUESAS
CAPE HORN
STATEN LAND
FALKLANDS ISLES
ISLE OF GEORGIA
SANDWICH LAND
Longitude West from Greenwich.


GREENLAND
Iceland
LAPLAND
NORWAY
SWEDEN
Gulf of Bothnia
Baltic Sea
Hamburg
Riga
Amsterdam
Hague
Leyden
Utrecht
Antwerp
Brussels
Paris
Rouen
Calais
Dieppe
Havre
Nantes
Bordeaux
Rochelle
Bayonne
Lisbon
Madrid
Cadiz
Gibraltar
Malta
Genoa
Venice
Naples
Rome
Vienna
Constantinople
Smyrna
Aleppo
Cairo
Alexandria
Tripoli
Algiers
Tunis
Fez
Mequinez
Morocco
Tangier
Salee
Canary Isles
Azores
Cape Verd Isles
Madeira
Canaries
Bermudas
Flemish B.
Nova Scotia
Gulf of St Lawrence
Newfoundland
Hudson's Straits
Isle of Good Fortune
Cumberland Isle
Labrador or New Britain
C. Farewell
C. Finisterre
C. St Vincent
Straits of Gibraltar
C. Bojador
C. Blanco
C. Verd
C. St Mary
C. Lodo
C. Palmas
Benin Bay
Gulf of Guinea
St Thomas I.
Fernando Po
Princes I.
Cape Lopez Gonsalves
R. de Zaire
C. Negro
Fishers B.
Mozambique
Sofala B.
C. Corrientes
Esperita
Sante
Straits of Madagascar
Madagascar
C. Ambre
B. Antongil
Bonl Pt.
I. France
I. Bourbon
F. Dauphin
Hottentots
Table B.
C. of Good Hope
Hole B.
Lagulhas
Bank Lagulhas in which many Fish
Tristian de Cunha
V. Diego Alvarez
St Paul I.
Amsterdam I.
Prince Edward Isles
Marions & Crozets Isles
Kerguelens Land
Sandwich Land
Ile of Georgia
Staten Land
Cape Horn
Falkland's Isles
Magellan's Straits
Patagonia
Desert Coast
Chili
Buenos Ayres
R. Plate
I. Grande
Edystone
Rio Janeiro
C. Frio
I. St Catherine
St Salvador
All Saints B.
C. St Roque
Fernando Noronah I.
Ascension I.
St Helena I.
Brinadada I.
V. Rocks
Sheals
St Mathe
Sierra Leone
Gambia
Senegal
Bermudas
Delaware R.
Chesapeake
Charleston
Savannah
Cape Fear
Cape Hatteras
Cape Cod
Boston
Halifax
Quebec
Hudson's Bay
Cape Farewell
Asia
Europe
Euxine Sea
Caspian Sea
Persian Gulf
Red Sea
Straits of Babelmandeb
Bombay
Madras
Pondicherry
Ceylon
Maldive Is.
Laccadive Is.
Bengal
Calcutta
Mouths of the Ganges
Canton
Canton River
Chinese Wall
Pekin
Japan
Isles of Japan
Liquco Isle
Isle Formosa
Philippine Isles
Manila
Paragua
Borneo
Molucca Isles
Sunda Straits
Celebes
Papua or New Guinea
New Holland
Sharkes Bay
Land of Lyons
Sandy Cape
Botany B.
South Cape
New Zealand
New Hebrides
Q. Charlotte's Isles
Tyal Rocks
Cleats I.
Chistmas I.
Arctic Sea
Sea of Okotsk
Kamtschatka
Longitude East from Greenwich.

OB
T874

PHILADELPHIA, *August* 9, 1794.

SIR,

FROM your eminent abilities, and universal knowledge of most scientific branches, and particularly that of Astronomy, I wish to submit to your perusal, examination, and judgment, and to receive your candid opinion on, various observations of the heavenly bodies, which I have made on different parts of the globe, to ascertainthe latitude, longitude, variation of the compass, &c. as well as my Remarks and Instructions as to the making and working them, in every situation, and at all times, by night or day. I have also caused a chart to be engraved, at a great expence, on which I have placed several of my routes to and from India, China, Europe, &c. as well as the general course, strength, and extent of the Flo rida Gulph Sream; and many other matters, intended to be useful to navigation and trade, by enlightening the path of the young sea officer, through the immense seas and oceans of this globe: by which means the dangers incident to foreign voyages may be lessened, both as to life and property; and, finally, to excite an emulation among our young fellow citizens in the sea service, to excel, in becoming early in life complete masters of their profession, in this as well as in all its other branches.

Authors are very remiss in their publications, in not showing a sufficient number and variety of examples; and teachers in general of the mathematics and navigation, treat young pupils in the sea line, who come to them to learn practical lessons, as if they were acquainted with theory; consequently after getting only a smattering, or superficial knowledge, of these arts, they consider themselves acquainted with them thoroughly; when in fact they know nothing whatever of either science, which they themselves discover after getting to sea, and altering their situation on the globe: the consequence then is, that they become puzzled, and often give up the application of their studies (as they seldom have any one to correct and instruct them) under an idea of there being no dependence to be placed in the art; where-

 as,

as, as you very well know, a maſter of it may always fix his latitudeto the greateſt poſſible minuteneſs, with a good inſtrument, and his longitude within a very few miles, (often within five miles, and always within fifteen.)

As to the variation of the compaſs, with good inſtruments, care, and attention, it may always be found at ſea more than ſufficiently near to direct the courſe of the ſhip, but never near enough to fix the longitude, ſo as to be generally ſerviceable, as Mr Churchman, in his maze of extravagance, endeavours to aſſert.

I have been actuated in forming this work, by a deſire of being uſeful to the public, and not from any pecuniary or other motive; and have therefore avoided every ſort of dedication, or fulſome addreſs; and my only wiſh is, that by its ſimplicity, the elucidations of ſeveral queſtions, &c. it may be the means of nautical information being more generally diffuſed, and more clearly underſtood by the preſent riſing generation of ſeamen, in theſe United States.

I am, SIR,

With much reſpect, and great regard,

(Copy.) Your very obedient and humble ſervant,

THOMAS TRUXTUN.

To the Rev. Doctor Ewing, Preſident of the Univerſity of Pennſylvania, Fellow of the Philoſophical Society of Philadelphia, &c. &c. &c.

PHILADELPHIA, *August* 31, 1794.

DEAR SIR,

I HAVE received your's of the 9th inſtant, and having ſeen and peruſed your intended publication, about the method of finding the longitude at ſea, by obſervations of the ſun and moon, or ſtars, for the benefit of mariners, I cannot but heartily approve of the benevolence of the deſign, and the happy tendency that it may have, to promote the important art of navigation. It is not to be expected, however, that the approbation of a theoriſt, whoſe inveſtigations are confined to his own chambers, without the benefit of practical experiment, ſhould add any thing to the obſervations and inſtructions of a gentleman of experience, in every ſituation of ſeas, wind, and weather; and who has juſtly acquired the character of the firſt navigator that has ever ſailed from the ports of the United States.

I am ſenſible of the imperfection of moſt books of navigation, in the ſmall number of their examples, and the inattention of teachers, to accommodate their inſtructions to the low apprehenſion of their pupils, who generally have not time to teach them the principles and demonſtrations of the art, and are therefore obliged to commit them to their future induſtry, for a ſufficient acquaintance with their profeſſion, on which the property of their owners, and their own ſupport, ſo much depend: and I very well know the indolence of maſters of veſſels, and their averſion to the trouble of calculation, when they apprehend themſelves able, by the common mechanical mode of conducting a veſſel, after many circuitous windings, to reach an intended port.

I am therefore glad to ſee ſo many particular and minute directions given to our inexperienced mariners, with reſpect to the care and *adjuſtment* of their inſtruments, their *quality*, the *manner* of uſing them, the mode of ma-

king the obſervations neceſſary for finding the longitude at ſea, and the *accuracy* with which they are wrought; and I cannot but hope that the publication of them will have a deſirable tendency to promote the uſeful and important art of navigation.

I am, dear Sir,

(Copy.) Your moſt obedient humble ſervant,

JOHN EWING.

THOMAS TRUXTUN, Eſq. Commander in the Navy of the United States of America.

Explanation of the CHART.

A :::::::::::::: Shews Capt. Truxtun's route going from the river Delaware to the Cape of Good Hope, Batavia, and Canton in China, laid down from Nautical and Aſtronomical obſervations made from time to time by himſelf.

B ======== Shews his route returning from Canton in China to the river Delaware.

C -.-.-.-.-.-.-.- Shews his route from the Cape of Good Hope to the iſland Johannah, near the north part of Madagaſcar, and from thence to Bombay, Madras, and Calcutta in Bengal, through the Inner paſſage.

D ><><><><><><><> Shews his route returning from Calcutta to Philadelphia.

E ---------- Shews his route from the river Delaware to London.

F ++++++++++++ Shews his route from London and Oſtend to India, by the outer paſſage.

G .-..-..-..-.. Shews his route from Madras to the Downs, after croſſing the Equator in the Atlantic ocean.

H ========== Shews his route from the Downs to Hamburg, and back to London, and afterwards to the Bay of Delaware.

Here is one continued route marked on the chart from the Capes of Delaware Bay, to the Cape of Good Hope, Batavia, and Canton in China; and the route returning from Canton, and going to, and returning from, other parts of India, *&c.* which are not continued, comes into, or goes out of, the ſaid tract; from which ſtation there is but little variation from the old route, except what may be cauſed by adverſe winds and currents. To have continued each route ſeparately all the way, or to have added the route of other Aſiatic voyages, would have marked too many lines on the chart; indeed it was unneceſſary, as the route laid down is ſufficient, from the experience and choice made of four Aſiatic tracts, to ſhow the beſt place to croſs the equator, as well as the beſt tract of ſea to keep in generally to avoid calms, and find the moſt favourable winds, in going or returning from India and China.

I would have marked on the chart ſeveral routes to and from the Iſlands in the Weſt Indies, *&c.* but the navigation of thoſe ſeas, as well as the Atlantic generally, and North Sea, *&c.* are too well known to render it, in the ſmalleſt degree, neceſſary.

The variation of the compaſs is marked down, as it was obſerved by me, by azimuths, as well as amplitudes, taken on each ſide of the meridian, by the beſt of inſtruments, as alſo the latitudes and longitudes :—hence it is, that the different routes marked on the chart may be depended on to the greateſt minuteneſs.

The

The direction or course of the Florida Gulph Stream may also be relied on, as I often tried its rate of going, by anchoring a boat in a calm (with a rope made fast to an iron pot, the rope from 150 to 200 fathoms in length, and the pot from 18 to 25 inches in diameter, according to the size of the boat) and heaving the log, whereby its rate of going was ascertained, and found to be seldom less than one knot, and never more than two knots and a half per hour; that is to the northward of Cape Hatteras; but to the southward and westward of that Cape, it no doubt often runs much stronger; and the nearer the channel between Florida and the Bahamas, the stronger of course. The width of this stream I have fixed also, by trying the current; and, when opportunities offered, in passing or repassing it, by making observations of the heavenly bodies: add to which, I have been attentive in ascertaining the temperature of the water, and comparing it with that of the air, as recommended by that great philosopher, the late Dr Franklin. The temperature of the air and water, without the stream, is generally about the same; that is, the difference seldom exceeds two or three degrees: sometimes the air is the warmest; at other times the water.

In the stream, the water is always much warmer than the air; indeed, I have known it ten degrees warmer; but so soon as you get within the stream, the water becomes colder than the air; and the more so, as you get on soundings, and approach the shore. If mariners, who have not the opportunity of determining their longitude by celestial observations, will only carry with them a good thermometer, and try the temperature of the water, and compare it with that of the air every two hours, they may always know when they come into, or go out of, the gulph stream: indeed, I always made a practice, when at sea, of comparing the temperature of the air and water daily, and often very frequently throughout the day during my voyage; whereby I immediately discovered any thing of a current that was going; and afterwards found its strength and direction by observations for the latitude and longitude. It is of the utmost consequence, in making a passage to and from Europe, to be acquainted with this gulph stream; as by keeping in it, when bound eastward, you shorten your voyage; and by avoiding it when returning to the westward, you facilitate it inconceivably; so much so, that I have frequently when bound from Europe to this country, spoke European ships, unacquainted with the strength and extent of it, off the banks of Newfoundland, and been in port a very considerable time before them, by keeping out of the stream; whereas they lengthened their passage by keeping in it. The general course of the gulph stream being marked on the chart, I would advise those who make the northern passage from Europe, never to come nearer the inner line of it by choice than 10 or 15 leagues; and then the probability will be, that their passage will be assisted by the help of a counter current, which often runs within it. In coming off a voyage from the southward, be sure to steer NW. when approaching the stream, if the wind will permit you, and continue that course until you are within it, which may be easily known by the temperature of the water, as before mentioned. I have always considered it of the utmost consequence when bound in, to cross the gulph stream as speedily as possible, lest I should be visited by calms or adverse winds, and by that means drove far out of my way, which would prolong the voyage considerably, especially in the winter season.

CONTENTS.

CHAPTER I. Page.

RULES and Instructions for finding the latitude; having the sun's zenith distance, and his declination, &c. - - - - 5

CHAPTER II.

Of double altitudes of the sun for determining the latitude at sea in any part of the globe, independent of meridional observations, - - - 6

CHAPTER III.

For finding the sun's declination for any time, under any meridian, - 8

CHAPTER IV.

Method of finding the moon's declination for any time, under any meridian, by inspection, - - - - - - - 16

CHAPTER V.

Method of finding the moon's semidiameter and horizontal parallax at the time of making an observation on any meridian, east or west of Greenwich, 21

CHAPTER VI.

Method of finding the sun's right ascension in time, for any meridian east or west of Greenwich, or for any time under any meridian, by inspection, 23

CHAPTER VII.

An example for discovering the distance from the land, useful in finding the latitude, when the horizon is obstructed by land intervening, - 26

CHAPTER VIII.

Of meridional observations in the open sea with a Hadley's octant or quadrant, as also when the land intervenes or obstructs the horizon, 27

CHAPTER IX.

Observations by two altitudes of the sun, for determining the latitude, - 28

CHAPTER X.

Meridional observations of the moon, for ascertaining the latitude of the ship, 43

CHAPTER XI.

Observations for ascertaining the variation of the compass, by azimuths, 44

CHAPTER XII.

Observations for ascertaining the variation of the compass by amplitudes, 46

CHAPTER XIII.

A Table of latitudes and longitudes of several places in the route to and from India and China, - - - - - - 47

CHAPTER XIV.

For finding the altitude of the sun, independent of an assistant to observe the same, when a distance is taken for determining the longitude, - 48

CHAPTER XV.

For finding the altitude of the moon, independent of an assistant to observe the same, when a distance is taken between the sun and moon for determining the longitude, - - - - - - - 49

CHAPTER

CHAPTER XVI. Page.

Calculation to find the altitude of the stars, by two examples of the stars Regulus and Antares, - - - - - 61

CHAPTER XVII.

Method of finding the true apparent time at the ship, by which the watch is regulated, - - - - - - - 63

CHAPTER XVIII.

Tables of the variation of the compass, observed in different years, - 67

CHAPTER XIX.

A general account of variable winds, particular weather, calms, &c. &c. 72

REMARKS and Instructions relating to the making of lunar observations, - - - - - - 3

A Time Table, &c. *to assist the completing of lunar observations,* - 11

Lunar observations for determinnig the longitude at sea, - - 12

APPENDIX.

LETTER respecting the masting of ships of war, - i

Remarks, - - - - - - - - ii

Calculation of the masts, yards, and spars of a frigate of 44 *guns,* - iii

General proportions of masts, spars, &c. *for a frigate of* 44 *guns,* - iv

Of mast-heads and yard-arms in men of war, - - - v

Of placing of masts in men of war, - - - - - ib.

Of the rake of masts, &c. - - - - - - vi

Dimensions of the masts, yards, and spars of a frigate of 36 *guns.* - vii

A short account of the several general duties of officers of ships of war, - xi

---

ERRATA.

CHAPTER VIII.	Page 27,	EXAMPLE I.	read *Observation in the open sea, with no land,* &c. *to obstruct the horizon.*
do.	27,	II.	read *Observation when the horizon is obstructed by land,* &c.
IX.	28,	I.	Line 5, for Longitude per account, read *Latitude* per account.
do.	35,	VIII.	1, for 23° read 32°.
do.	39,	XII.	1, for SEbS read *SEbE.*
XIII.	47,	—	8, for Trinidada, read *Four rocks to the eastward of ditto.*
do.	47,	—	9, for Four rocks to the eastward of Trinidada, read *Trinidada.*
XV.	52,	III.	3, for 12′ read 22′.

Instructions for Lunar Observations.

Page 5,	-		Line 30, for them, read *him.*
6,	-		18, for it, read *is.*
18,	EXAMPLE IV.		4, for 58′, read 55′.
18,		do.	5, for 35′, read 38′.
29,		XII.	in last line for 28′ read 18′.

RULES & INSTRUCTIONS

FOR

Finding the Latitude.

HAVING THE *SUN's* ZENITH DISTANCE, AND HIS DECLINATION, &c.

CHAPTER I.

I.

IF the ſun's zenith diſtance is north, and his declination ſouth, their ſum is the latitude ſouth.

II.

If the ſun's zenith diſtance is north, and declination north, ſubtract the leſſer from the greater, and the remainder is the latitude; and to know whether the latitude is north or ſouth, obſerve this general rule: If the declination is greater than the zenith diſtance, the latitude is north; but if leſs, it is ſouth.

III.

If the ſun's zenith diſtance is ſouth, and his declination north, their ſum is the latitude north.

IV.

If the ſun's zenith diſtance is ſouth, and declination ſouth, ſubtract the leſſer from the greater, and the reſult is the latitude; and to know whether the latitude be north or ſouth, obſerve this general rule: If the declination is greater than the zenith diſtance, the latitude is ſouth; but if leſs, it is north.

V.

If the altitude be north, or if a north ſun make noon, call the zenith diſtance north; but if the altitude be ſouth, or ſouth ſun make noon, call the zenith diſtance ſouth; as the zenith diſtance is here conſidered to bear the ſame name as the altitude.

CHAPTER II.

OF DOUBLE ALTITUDES OF THE *SUN* FOR DETERMINING THE LATITUDE AT SEA IN ANY PART OF THE GLOBE, INDEPENDENT OF MERIDIONAL OBSERVATIONS.

IT is quite unneceſſary for me to enter largely on giving inſtructions, or of making lengthy obſervations on this very important and uſeful problem; the utility of which muſt be obvious to every ſea-officer; particularly as the rules laid down in the ſecond edition of the Requiſite Tables, publiſhed by order of the Commiſſioners of Longitude in Great Britain, are ſo very plain, that it ſeems almoſt impoſſible to make them appear more ſimple; but plain and ſimple as they are, they muſt be very nicely attended to.

As different ſituations require different precepts, I have annexed a number of examples (which are all proved by meridional obſervations, made on the ſame days) for the young mariner's government; ſo that if he attends to the rules already mentioned, and theſe examples, he cannot err, and ſeldom be without having it in his power to know his preciſe ſituation with reſpect to the latitude. Whenever the ſhip alters her ſituation between taking the firſt and ſecond altitudes, the ſun's bearing, (which is to be taken when the firſt altitude is obſerved) with the ſhip's courſe, and diſtance ſailed between the altitudes, are brought into the operation, care muſt then be taken to enter the tables of difference of latitude and departure, with the number of points making the angle, and the diſtance ſailed between the altitudes; and take out the *difference of latitude* for ſuch number of points, making the angle and diſtance ſo ſailed between the altitudes; and not, by miſtake, to take out the departure, as I have known ſome to do, from a want of knowing the principles on which the calculation is made; for let the courſe ſteered and diſtance ſailed between the altitudes be what it may, the angle of difference given from the ſun's bearing, and ſuch courſe, with the diſtance, is what the tables of difference of latitude and departure muſt be entered with; and the *difference of latitude* correſponding thereto, taken out and applied to the firſt altitude obſerved, according to the rules laid down, and the accompanying examples, the departure has nothing whatever to do with it.

Whenever

Whenever either or both of the ſun's altitudes are under 44° or thereabouts, ſo as to cauſe the difference of the ſun's refraction and parallax to be nearly = to or about 1′, ſuch difference of refraction and parallax muſt be deduced from ſuch altitudes, and care muſt be taken of the application of the index-error, by adding or deducing it, as the ſame may be found according to the rules laid down in my inſtructions for making lunar obſervations, for aſcertaining the longitude. In many of the following examples, the inſtrument was without any index-error (which is a very rare thing); conſequently as my eye was about 18 feet above the ſurface, the dip for 4′ was deduced from the ſun's ſemidiameter for 16′, ſo that 12′ remained to be added to the altitude of the ſun's lower limb, to obtain the altitude of his center. In other examples again you find the index-error various, which is applied accordingly. The latitude by account, uſed in the operation, and ſun's declination, ſhould always be calculated for the time of taking the ſecond altitude. The logarithms in column of half elapſe time, in column of middle time, and that of log riſing, are laid down for every ten ſeconds of a minute, which is near enough for this kind of work, as far as it reſpects determining the latitude; but if you wiſh to find the time from noon to the neareſt ſecond, ſo as to regulate your watch, you muſt proportion for the intermediate ſeconds, in the ſame way that you find the logarithm anſwering to the difference of natural ſines; but even then it will be neceſſary to go over the operation a ſecond time, uſing the latitude laſt found, inſtead of the latitude by account firſt made uſe of, as the latitude by account, which in all probability would prove erroneous, would cauſe the time given from noon to be proportionably ſo; therefore I recommend the true apparent time at the ſhip for regulating the watch, to be found at ſea by an altitude of the ſun taken three or four points at leaſt from the meridian, by which the true horary angle may be aſcertained with great exactneſs; and on ſhore, or in any harbour or bay where the ſtation is the ſame, equal altitudes of the ſun is a very excellent method, the firſt taken in the morning when the ſun is about 3 or 4 points from the meridian, and the other in the afternoon, as per examples of equal altitudes.

CHAPTER

CHAPTER III.

THE ſun's declination, laid down in the Britiſh nautical almanac, being calculated for the meridian of Greenwich at noon, any ſituation eaſt or weſt of that meridian, will cauſe a difference; to correct which, turn to T. VI. (of requiſite tables) and in column under your longitude; and againſt the day of the month you will find what the difference is, which muſt be taken out, and applied to the declination found, as above recited. Thus:

If your ſituation is to the eaſtward of Greenwich, and the ſun's declination is increaſing, deduce the difference found in T. VI. from the declination given in the nautical almanac, and the reſult is the true declination in your ſituation at noon: but if the ſun's declination is decreaſing, you muſt add this difference to the declination given in the nautical almanac, and the reſult is the ſun's true declination as aforeſaid at noon.

If your ſituation is to the weſtward of Greenwich, and the ſun's declination is increaſing, add the difference found in T. VI. as abovementioned. But if the ſun's declination is decreaſing, you muſt deduce the difference, and the reſult will be the ſun's true declination at noon.

It muſt be obſerved, that the ſun's declination in the nautical almanac, is laid down for noon at Greenwich only; therefore if you want to find his declination for any other hour at Greenwich, ſee what the declination increaſeth or decreaſeth in 24h. and apply the proportion accordingly. But if you are to the eaſtward or weſtward of Greenwich, calculate the ſun's declination for the ſame hour at Greenwich that you want to find at the ſhip; and take the difference out of T. VI. as abovementioned, which being carefully applied, gives you the ſun's declination at the hour you require it, in any part of the world. Or for a more eaſy method, attend to the various examples inſerted in this book for finding the ſun's declination.

The

The importance of calculating, or finding with exactness for any meridian, east or west of Greenwich in Great Britain, at the moment of making an observation on any part of the globe, the sun and moon's semidiameter, the moon's right ascension, the sun and moon's declination, the sun's right ascension in time, and the moon's horizontal parallax, with the augmentation of her semidiameter, and the refraction and parallax of the objects in altitude, &c. is such that every observation so made, will be imperfect, without the greatest attention to the application of these corrections, according as the observation requires them wholly or only in part.

The different kind of examples in this book will shew the corrections wanted, and the manner of finding and applying them. The sun's semidiameter is laid down in the nautical almanac for every sixth day, which is sufficiently near: the moon's semidiameter and horizontal parallax is laid down for every noon and midnight; and the augmentation of her semidiameter is taken outof Table IV. of the second edition of requisite tables. The moon's declination is also laid down for every noon and midnight; and the sun's declination and his right ascension in time for every noon: the sun's refraction and parallax are taken out of Tables I. and III. of abovementioned requisite tables; the correction of moon's altitude out of T. VIII. and the eye's altitude or dip of the horizon out of T. II. for the open sea; and out of T. V. when the sun is between the observer and the land. The books wanted, and from which all the following observations are made, are the Nautical Almanac, the second edition of the Requisite Tables, with Shepherd's tables; all of which are published by order of the Commissioners of Longitude in Great Britain; and a table of difference of latitude and departure. These books are all absolutely necessary for the making nautical observations, (besides the books wanted for other purposes) at sea.

EXAMPLE I.

FOR FINDING THE SUN'S DECLINATION FOR ANY TIME UNDER ANY MERIDIAN.

Longitude East. A. M.

SUPPOSE the sun's declination is wanted on the 12th of June 1793, at 8 A. M. in the longitude of 60° east from Greenwich in Great Britain.

Apparent time at the ship - - -	8^h	00′	00″	
As 15° is to 1^h of time, so 60° is to - -	4	00	00	
Reduced time, or time at Greenwich, -	4	00	00	
⊙ Declination at noon at Greenwich, 11th June -	23^h	9′	00″	N.
⊙ Ditto do. 12th do. -	23	12	44	N.
Difference of ⊙ declination in 24 hours	0	3	44	

Then say, As 24^h is to 3′ 44″, so I find by the rule of three, that 16^h, the time from noon of the 11th, which is 4 A. M. on the 12th, is to 2′ 29″, which I add to the sun's declination of the 11th, and the result is 23° 11′ 29″ N, which is the sun's true declination at 8 A. M. at the given time and place as above. As the sun's declination is increasing, the above difference of 2′ 29″ is added to the declination of the 11th at noon at Greenwich; but had the sun's declination been decreasing, it would have been subtracted from the declination of the 11th, and the result would have been the sun's declination at the given time.

Example II. P. M. *Longitude East.*

SUPPOSE the sun's declination is wanted on the 12th of June 1793, at 4 P. M. in the longitude of 60 east.

Apparent time at the ship - - - -	4^h	00′	00″	
As 15° is to 1^h of time, so 60 is to - - -	4	00	00	
Reduced time, or the time at Greenwich, -	0	00	00	Noon.

By the reduced time we find it was only noon at Greenwich when it was 4 P. M. at the ship, in the longitude of 60° east; hence it must follow, that the sun's declination as laid down in the nautical almanac, 23° 12′ 44″ N. for noon at Greenwich on the 12th of June, was the sun's true declination at 4 P. M. at the given time and place, as above.

Example

Example III. A. M. *Longitude West.*

SUPPOSE the sun's declination is wanted on the 12th of June, 1793, *at* 8 A. M. *in longitude* 60° *west.*

Apparent time at the ship - - - -	8^h	00′	00″	
As 15° is to 1^h, so 60 is to - - -	4	00	00	
Reduced time, or time at Greenwich -	12	00	00	Noon.
⊙ Declination on the 11th at noon at Greenwich,	23°	09′	00″	N.
⊙ Ditto, 12th do. - -	23	12	44	N.
Difference of ⊙ declination in 24 hours, -	0	3	44	

Now as it was noon at Greenwich when it was only 8 A. M. at the ship, or in longitude 60° west. I add the difference of sun's declination in 24^h to his declination on the 11th, and the result is 23° 12′ 44″, and the same as is laid down for noon on the 12th at Greenwich, which is right, because it was evidently noon at Greenwich when it was only 8 A. M. at the given meridian as abovementioned.

Example IV. P. M. *Longitude West.*

SUPPOSE the sun's declination is wanted on the 12th of June, 1793, *at* 4 P. M. *in longitude* 60° *west.*

Apparent time at the ship - - -	4^h	00′	00″	
As 15° is to 1^h, so 60 is to - - - -	4	00	00	
Reduced time, or time at Greenwich, -	8	00	00	P. M.
⊙ Declination at noon at Greenwich on the 12th, -	23°	12′	44″	N.
⊙ Ditto, do. do. 13th, -	23	16	03	N.
Difference of ⊙ declination in 24 hours, -	0	3	19	

As 24^h is to 3′ 19″ so I find by the rule of three, that 8^h is to 1′ 6″ which must be added to the sun's declination at noon at Greenwich on the 12th, and the result 23° 15′ 50″ N. is the sun's true declination at 4 P. M. at the given time and place.

N. B. In the calculations marked A. M. which ascertains the sun's declination before noon at any given meridian, the sun's declination for the preceding noon at Greenwich, and the noon of the day on which it is wanted, is made use of. But in those marked P. M. the sun's declination for the following noon, and the noon of the day on which it is wanted, is made use of.

The

The preceding examples ſhow the beſt method of aſcertaining the declination of the ſun at any time, or at any meridian different from that of Greenwich; and by the ſame mode the moon's declination is alſo found; but to ſave trouble and prevent miſtakes by thoſe who are not very expert in figures, I have annexed a number of examples, which ſhow how to aſcertain the declination of the ſun by inſpection. As per example.

With the longitude of the ſhip or place, and the day of the month, you enter the T. VI. and under the former, and againſt the latter, you take out the correction, which is deduced from the ſun's declination laid down for noon at Greenwich, if the longitude is eaſt, and his declination is increaſing; but it is added when his declination is decreaſing. Again, if the longitude is weſt, and his declination is increaſing, this correction is added as aforeſaid; but deduced when his declination is decreaſing. The reſult of theſe gives the ſun's declination at noon at any given place.

But if the ſun's declination is wanted either before or after noon at any given place, then the T. VI. muſt be entered a ſecond time, with the time from noon, and day of the month, and the correction taken out and applied according as you are eaſt or weſt of Greenwich, and as the ſun's declination is increaſing or decreaſing. As per the examples following:

Example I. M. *Longitude Eaſt.*

SUPPOSE the ſun's declination is wanted when it is increaſing, on the 12th day of June, 1793, at noon, in longitude 60° eaſt.

☉ Declination 12th June at Greenwich at noon is -	23°	12′	44″	N.
With 12th June and longitude 60° enter T. VI. -		—	40	
☉ Declination at the given time and place -	23	12	04	N.

Example II. M. *Longitude Eaſt.*

SUPPOSE the ſun's declination is wanted when it is decreaſing, on the 12th day of July, 1793, at noon, in longitude 60° eaſt.

☉ Declination at noon at Greenwich, 12th July is -	21°	54′	17″	N.
With 12th July and longitude 60° enter T. VI. -	+	1	30	
☉ Declination at the given time and place -	21	55	47	N.

Example III. M. *Longitude West.*

SUPPOSE the sun's declination is wanted when it is increasing, on the 12th of June, 1793, at noon in longitude 60° west.

⊙ Declination 12th June at Greenwich at noon is -	23°	12′	44″	N.
With 12th June and longitude 60° enter T. VI. -	+		40	
⊙ Declination at the given time and place -	23	13	24	N.

Example IV. M. *Longitude West.*

SUPPOSE the sun's declination is wanted when decreasing on the 12th of July, 1793, at noon in longitude 60° west.

⊙ Declination 12th July at noon at Greenwich is -	21°	54′	17″	N.
With 12th July and longitude 60° enter T. VI. -	—	01	30	
⊙ Declination at the given time and place -	21	52	47	N.

N. B. The letters A. M. stand for Anti Meridian, or any time before noon. P. M. for Post Meridian, or any time after noon. And, M. for Meridian.

Example V. A. M. *Longitude East.*

SUPPOSE the sun's declination is wanted when it is increasing, on 12th June, 1793, at 6^h 40′ A. M. *in longitude 60° east.*

⊙ Declination on the 12th June at noon at Greenwich is		23°	12′	44″	N.
With 12th June and longitude 60° enter T. VI. -		—		40	
		23	12	04	
Enter T. VI. again with 12th June, and 6^h 40′ deducted from 12^h which gives the time from noon	5^h 20′	—		53	
⊙ Declination at the given time and place -		23	11	11	N.

Example VI. A. M. *Longitude East.*

SUPPOSE the sun's declination is wanted when it is decreasing, on the 12th of July, 1793, at 6^h 20′ A. M. *in longitude* 60° *east.*

☉ Declination on 12th July at noon at Greenwich is -		21°	54′	17″	N.
With 12th July and longitude 60° enter T. VI. -		+	1	30	
		21	55	4	
Enter T. VI. again with 12th July, and 6^h 20′ deduced from 12^h which gives the time from noon	5^h 40′	+	2	7	
☉ Declination at the given time and place -		21	57	54	N.

Example VII. P. M. *Longitude East.*

SUPPOSE the sun's declination is wanted when it is increasing, on the 12th of June, 1793, at 6^h 40′ P. M. *in longitude* 60° *east.*

☉ Declination on 12th June at noon at Greenwich is		23°	12′	44″	N.
With 12th June and longitude 60° enter T. VI. -		—		40	
		23	12	4	
Enter T. VI. again with 12th June, and 6^h 40′ which is the time from noon - - -		+	1	6	
☉ Declination at the given time and place -		23	13	10	N.

Example VIII. P. M. *Longitude East.*

SUPPOSE the sun's declination is wanted when it is decreasing, on 12th July, 1793, at 6^h 20′ P. M. *in longitude* 60° *east.*

☉ Declination on 12th July at noon at Greenwich is -		21°	54′	17″	N.
With 12th July and longitude 60° enter T. VI. -		+	1	30	
		21	55	47	
Enter T. VI. again with 12th July, and 6^h 20′ which is the time from noon - - -		—	2	22	
☉ Declination at the given time and place -		21	53	25	N.

Example

Example IX. A. M. *Longitude West.*

SUPPOSE the sun's declination is wanted when it is increasing, on the 12th of June, 1793, *at* 6^h 30′ A. M. *in longitude* 60° *west.*

⊙ Declination at noon at Greenwich on 12th June is		23°	12′	44″	N.
With 12th June and longitude 60° enter T. VI. -		+		40	
		23	13	24	
Enter T. IV. again with 12th June, and 6^h 30′ deduced from 12^h which gives the time from noon	5 30′	—		54½	
⊙ Declination at the given time and place -		23	12	29½	N.

Example X. A. M. *Longitude West.*

SUPPOSE the sun's declination is wanted when it is decreasing, on the 12th of July, 1793, *at* 6^h 10′ A. M. *in longitude* 60° *west.*

⊙ Declination at noon at Greenwich on 12th July is		21°	54′	17″	N.
With 12th July and longitude 60° enter T. VI. -		—	1	30	
		21	52	47	
Enter T. VI. again with 12th July, and 6^h 10′ deduced from 12^h which gives the time from noon	5^h 50′	+	2	11	
⊙ Declination at the given time and place -		21	54	58	N.

Example XI. P. M. *Longitude West.*

SUPPOSE the sun's declination is wanted when it is increasing, on the 12th of June, 1793, *at* 6^h 30′ P. M. *in longitude* 60° *west.*

⊙ Declination at noon at Greenwich on 12th July is		23°	12′	44″	N.
With 12th June and longitude 60° enter T. VI. -		+		40	
		23	13	24	
Enter T. VI. again with 12 h June and 6^h 30′, which is the time from noon		+	1	4½	
⊙ Declination at the given time and place -		23	14	28½	N.

Example

Example XII. P. M. *Longitude West.*

SUPPOSE the sun's declination is wanted when it is decreasing, on the 12th of July, 1793, *at* 6^h 10′ P. M. *in longitude* 60° *west.*

⊙ Declination at noon at Greenwich, on 12th July is	21°	54′	17″	N.
With 12th July and longitude 60° enter T. VI.	—	1	30	
	21	52	47	
Enter T. VI. again with 12th July and 6^h 10′ which is the time from noon . .	—	2	18½	
⊙ Declination at the given time and place	21	50	28½	N.

CHAPTER IV.

METHOD OF FINDING THE *MOON's* DECLINATION FOR ANY TIME UNDER ANY MERIDIAN, BY INSPECTION.

IN finding the moon's declination, Table XXII. is made use of; it is entered with the variation of moon's declination between noon and midnight preceding, if the longitude is east; and between noon and midnight following, if the longitude is west: and under the former, and opposite the latter, is the correction which must be applied to the moon's declination of the noon of that day, at Greenwich, according as the declination is increasing or decreasing, or as the longitude is either east or west of the meridian of Greenwich; and the result will be the moon's declination at the meridian required at noon. But whenever the moon's declination is wanted for any time different from that of noon or midnight, which is most commonly the case, you enter Table XXII. a second time, with the variation of the moon's declination, in 12^h as above, and the time from noon instead of the longitude, and apply the two corrections according as your situation is east or west of Greenwich, and as the declination is on the increase or the decline; as per the examples herewith inserted, to which have particular reference.

Example I. M. *Longitude East.*

SUPPOSE the moon's declination is wanted when it is increasing on the 5th of June, 1793, at noon, in longitude 60° east.

☾ Declination at noon at Greenwich, 5th of June is -		9° 59′ N.
Variation of ☾ declination between noon and midnight preceding, is 114′, with which and longitude 60° enter Table XXII.		— 38
☾ Declination at the given time and place -		9 21 N.

Example II. M. *Longitude East.*

SUPPOSE the moon's declination is wanted when it is decreasing, on the 12th of June, 1793, at noon, in longitude 60° east.

☾ Declination at noon at Greenwich, 12th of June is -		16° 12′ N.
Variation of ☾ declination between noon and midnight preceding, is 56′, with which and longitude 60° enter Table XXII.		+ 18
☾ Declination at the given time and place -		16 30 00 N.

Example III. M. *Longitude West.*

SUPPOSE the moon's declination is wanted when it is increasing, on the 16th of August, 1794, at noon, in longitude 60° west.

☾ Declination at noon at Greenwich on 16th of August is		8° 21′ N.
Variation of ☾ declination between noon and midnight following is 128′, with which and longitude 60° enter Table XXII.		+ 43
☾ Declination at the given time and place - -		9 4 N.

Example IV. M. *Longitude West.*

SUPPOSE the moon's declination is wanted when it is decreasing, on the 25th of August, 1794, at noon, in longitude 60° west.

☾ Declination at noon at Greenwich on 25th of August is	11° 55′ N.	
Variation of ☾ declination between noon and midnight following is 103′, with which and longitude 60° enter Table XXII.	— 34	
☾ Declination at the given time and place -	11 21 N.	

Example V. A. M. *Longitude East.*

SUPPOSE the moon's declination is wanted when it is increasing, on the 16th of August, 1794, at 6^h 20′ A. M. *in longitude 60° east.*

☾ Declination at noon at Greenwich on 16th of August is	8° 21′ N.	
Variation of ☾ declination between noon and midnight preceding is 137′, with which and longitude 60° enter Table XXII.	— 46	
	7 35	
6^h 20′ deduced from 12^h is 5^h 40′ from noon, enter Table XXII. again with 137′ variation and 5^h 40′ the time from noon	— 1 5	
☾ Declination at the given time and place - -	6 30 N.	

Example VI. A. M. *Longitude East.*

SUPPOSE the moon's declination is wanted when it is decreasing, on the 12th of June, 1793, at 6^h 20′ A. M. *in longitude 60° east.*

☾ Declination at noon at Greenwich on 12th June is -	16° 12′ N.	
Variation of ☾ declination between noon and midnight preceding is 56′, with which and longitude 60° enter Table XXII.	+ 18	
	16 30	
6^h 20′ deduced from 12^h is 5^h 40′ from noon, enter Table XXII. again with 56′ variation and 5^h 40′ the time from noon	+ 26½	
☾ Declination at the given time and place -	16 56½ N.	

Example

Example VII. P. M. *Longitude East.*

SUPPOSE the moon's declination is wanted when it is increasing, on the 5th of June, 1793, *at* 6^h 40′ P. M. *in longitude* 60° *east.*

☾ Declination at noon at Greenwich on 5th of June is -	9° 59′ N.	
Variation of ☾ declination between noon and midnight following is 106′, with which and longitude 60° enter Table XXII.	— 35	
	9 24	
6^h 40′ P. M. is 6^h 40′ from noon, enter Table XXII. again with 106′ variation and 6^h 40′ the time from noon -	+ 58½	
☾ Declination at the given time and place -	10 22½	N.

Example VIII. P. M. *Longitude East.*

SUPPOSE the moon's declination is wanted when it is decreasing, on the 12th of June, 1793, *at* 6^h 20′ P. M. *in longitude* 60° *east.*

☾ Declination at noon at Greenwich on 12th of June is	16° 12′ N.	
Variation of ☾ declination between noon and midnight following is 65′, with which and longitude 60° enter Table XXII.	+ 22	
	16 34	
6^h 20′ P. M. is 6^h 20′ from noon enter Table XXII. again with 65′ variation, and 6^h 20′ the time from noon -	— 34	
☾ Declination at the given time and place - -	16 00	N.

Example IX. A. M. *Longitude West.*

SUPPOSE the moon's declination is wanted when it is increasing, on the 5th of June, 1793, *at* 6^h 30′ A. M. *in longitude* 60° *west.*

☾ Declination at noon at Greenwich on 5th of June is -	9° 59′ N.	
Variation of ☾ declination between noon and midnight preceding is 114′, with which and longitude 60° enter Table XXII.	+ 38	
	10 37	
6^h 30′ A. M. deduced from 12^h is 5^h 30′ from noon enter Table XXII. again with variation 114′, and 5^h 30′ time from noon	— 53	
☾ Declination at the given time and place - -	9 44	N.

Example

Example X. A. M. *Longitude West.*

SUPPOSE the moon's declination is wanted when it is decreasing, on the 12th of June, 1793, *at* 6^h 10′ A. M. *in longitude* 60° *west.*

☾ Declination at noon at Greenwich on 12th of June is -	16°	12′	N.
Variation of ☾ declination between noon and midnight preceding is 56′, with which and longitude 60° enter Table XXII.	—	18	
	15	54	
6^h 10′ A. M. deduced from 12^h is 5^h 50′ from noon, enter Table XXII. again with variation 56′ and 5^h 50′ the time from noon	+	27	
☾ Declination at the given time and place - -	16	21	N.

Example XI. P. M. *Longitude West.*

SUPPOSE the moon's declination is wanted when it is increasing, on the 5th of June, 1793, *at* 6^h 30′ P. M. *in longitude* 60° *west.*

☾ Declination at noon at Greenwich on 5th of June is -	9°	59′	N.
Variation of ☾ declination between noon and midnight following is 106′, with which and longitude 60° enter Table XXII.	+	35	
	10	34	
6^h 30′ P. M. is 6^h 30′ from noon, enter Table XXII. again with variation 106′ and 6^h 30′ the time from noon -	+	57	
☾ Declination at the given time and place - -	11	31	N.

Example XII. P. M. *Longitude West.*

SUPPOSE the moon's declination is wanted when it is decreasing, on the 12th of June, 1793, *at* 6^h 10′ P. M. *in longitude* 60° *west.*

☾ Declination at noon at Greenwich on 12th June is -	16°	12′	N.
Variation of ☾ declination between noon and midnight following is 65′ with which and longitude 60° enter Table XXII.	—	22	
	15	50	
6^h 10′ P. M. is 6^h 10′ from noon, enter Table XXII. again with variation 65′ and 6^h 10′ the time from noon -	—	33¼	
☾ Declination at the given time and place -	15	16¾	N.

CHAPTER V.

METHOD OF FINDING THE *MOON's* SEMIDIAMETER AND HORIZONTAL PARALLAX AT THE TIME OF MAKING AN OBSERVATION ON ANY MERIDIAN, EAST OR WEST OF GREENWICH.

☞ *THE same method will show how to find the moon's right ascension at any time, east or west of said meridian; therefore no further explanation is necessary on that head. In finding the sun's right ascension in time, Table* XXIII. *may be made use of, as per examples herewith; and it will save time, and the trouble of calculation.*

Example I.

SUPPOSE the moon's semidiameter and horizontal parallax are wanted on the 22d of June, 1793, *at* 8^h 30′ A. M. *in longitude* 60° *east.*

As 15° is to 1^h of time, so 60° is to - -	4^h	00′	00″	
True apparent time at the ship - - -	8	30	00	A. M.
Reduced time, or the time it was at Greenwich, when it was 8^h 30′ at the ship -	4	30	00	A. M.
☾ Semidiameter at noon at Greenwich 22d June -		16	10	
☾ Ditto at midnight preceding - - -		16	4	
Difference of ☾ semidiameter in 12 hours -			6	
☾ Horizontal parallax at noon at Greenwich the 22d June		59	20	
☾ Ditto at midnight preceding - -		58	56	
Difference of ☾ horizontal parallax in 12 hours			24	

Then say, As 12^h is to 6″ increase of moon's semidiameter, so the reduced time 4^h 30′ is to 2″ which 2″ added to the moon's semidiameter the preceding midnight as above, gives the moon's semidiameter at 8^h 30′ A. M. in longitude 60° east, the given time and place as above, to be 16′ 6″; which semidiameter, with that of the augmentation, according to the moon's altitude, taken out of Table IV. and added thereto, is the moon's true semidiameter to be applied in all nautical observations that require her semidiameter. As 12^h is to 24″ increase of moon's horizontal parallax, so the reduced time 4^h 30′ is to 9″; which 9″ added to the

 moon's

moon's horizontal parallax the preceding midnight, as above, gives the moon's true horizontal parallax at 8^h 30′ A. M. in longitude 60° eaſt, the given time and place as above, to be 59′ 5″, which horizontal parallax muſt be applied in the obſervations as aforeſaid.

N. B. Had the moon's ſemidiameter and horizontal parallax been decreaſing in the proportion they were increaſing in the forenoon, the 2″ of the moon's ſemidiameter, and the 9″ of horizontal parallax, muſt have been deduced from thoſe of the preceding midnight, as above, and the remainder would have been the moon's ſemidiameter and horizontal parallax required.

Example II.

SUPPOSE the moon's ſemidiameter and horizontal parallax is wanted on the 22d of June, at 6^h 10′ P. M. *in longitude* 60° *eaſt.*

As 15° is to 1^h of time, ſo 60° is to - -	4^h	00′	00″
True apparent time at the ſhip - - -	6	10	00
Reduced time, - - - -	2	10	00
☾ Semidiameter at noon at Greenwich 22d June -		16	10
☾ Do. at midnight following - -		16	16
Difference of ☾ ſemidiameter in 12 hours -			6
☾ Horizontal parallax at noon at Greenwich 22d June		59	20
☾ Do. at midnight following - -		59	42
Difference of ☾ horizontal parallax in 12 hours			22

Then ſay, As 12^h is to 6″ increaſe of moon's ſemidiameter, ſo is the reduced time 2^h 10′ to 1″; which 1″ added to the moon's ſemidiameter at Greenwich at noon, as above, gives the moon's ſemidiameter at the time required to be 16′ 11″, to which add augmentation according to altitude, and the reſult is the moon's true ſemidiameter. As 12^h is to 22″ increaſe of moon's horizontal parallax, ſo is the reduced time 2_h 10′ to 4″; which 4″ added to the moon's horizontal parallax at Greenwich at noon, gives the moon's true horizontal parallax 59′ 24″ at the time required as above.

N. B. Had the moon's ſemidiameter and horizontal parallax been decreaſing in the afternoon, the 1″ of moon's ſemidiameter, and the 4″ of moon's horizontal parallax

parallax found as above muſt have been deduced from that laid down for noon at Geenwich as above, and the remainder would have been the moon's ſemidiameter and horizontal parallax at the time required.

Theſe two examples, with the inſtructions following each of them, are fully ſufficient for the government of the mariner in every ſituation at ſea, for finding the moon's ſemidiameter and horizontal parallax; only he is to obſerve that in longitude weſt from Greenwich, the reduced time is found by adding the time at the ſhip, to the time found from the longitude, which is quite the reverſe to the two preceding examples. See how the reduced time is found for weſt longitude. in Examples III. and IV. of the firſt method of finding the ſun's declination.

CHAPTER VI.

METHOD OF FINDING THE *SUN's* RIGHT ASCENSION IN TIME, FOR ANY MERIDIAN EAST OR WEST OF GREENWICH, OR FOR ANY TIME UNDER ANY MERIDIAN, BY INSPECTION.

Example I.

SUPPOSE the ſun's right aſcenſion in time is wanted on the 12th of June, 1793, at noon, in longitude 60° eaſt.

☉ Right aſcenſion in time at noon at Greenwich 16th of June	5^h	24′	28″
Longitude 60° and daily variation 4′ 9″ between noon and noon preceding, enter Table XXIII.	—		41
☉ Right aſcenſion in time at the given time and place -	5	23	47

Example

Example II.

SUPPOSE the ſun's right aſcenſion in time is wanted on the 12th of June, 1793, at noon, in longitude 60° weſt.

☉ Right aſcenſion in time at noon at Greenwich 12th of June	5^h	24′	28″
Longitude 60° and daily variation 4′ 19″ between noon and noon following enter Table XXIII.	+		41
☉ Right aſcenſion in time at the given time and place -	5	25	9

Example III.

SUPPOSE the ſun's right aſcenſion in time is wanted on the 12th of June, 1793, at 6^h 30′ A. M. *in longitude 60° eaſt.*

☉ Right aſcenſion in time at noon at Greenwich 12th of June	5^h	24′	28″
Longitude 60° and daily variation 4′ 9″ between noon and noon preceding, enter Table XXIII.	—		41
	5	23	47
6^h 30′ A. M. is 5^h 30′ from noon, with which and daily variation 4′ 9″ enter TableXXIII. again	—		57
☉ Right aſcenſion in time at the given time and place -	5	22	50

Example IV.

SUPPOSE the ſun's right aſcenſion in time is wanted on the 12th of June, 1793, at 6^h 30′ P. M. *in longitude 60° weſt.*

☉ Right aſcenſion in time at noon at Greenwich 12th of June	5^h	24′	28″
Longitude 60° and daily variation 4′ 9″ between noon and noon preceding, enter Table XXIII.	—		41
	5	23	47
6^h 30′ P. M. is the ſame from noon, with which and daily variation 4′ 9″ enter Table XXIII.	+	1	7
☉ Right aſcenſion in time at the given time and place -	5	24	54

Example V.

SUPPOSE the ſun's right aſcenſion in time is wanted on the 12th of June, 1793, *at* 6^h 30′ A. M. *in longitude* 60° *weſt.*

☉ Right aſcenſion in time at noon at Greenwich 12th of June	5^h	24′	28″
Longitude 60° and daily variation 4′ 9″ between noon and noon preceding, enter Table XXIII.	+		41
	5	25	9
6_h 30′ A. M. is 5^h 30′ from noon, with which and daily variation 4′ 9″, enter Table XXIII.	—		57
☉ Right aſcenſion in time at the given time and place -	5	24	12

Example VI.

SUPPOSE the ſun's right aſcenſion in time is wanted on the 12th of June, 1793, *at* 6^h 30′ P. M. *in longitude* 60° *weſt.*

☉ Right aſcenſion in time at noon at Greenwich 12th June	5^h	24′	28″
Longitude 60° and daily variation 4′ 9″ between noon and noon following, enter Table XXIII.	+		41
	5	25	9
6^h 30′ P. M. is the ſame from noon, with which and daily variation 4′ 9″ enter again Table XXIII.	+	1	7
☉ Right aſcenſion in time at the given time and place -	5	26	16

CHAPTER VII.

Example I.

I am now ſuppoſing to ſail along a coaſt, with the land between me and the ſun, at a time I want much to know my latitude, and by a fore obſervation made with a Hadley's octant or quadrant; but before I can make this obſervation with certainty, I muſt firſt aſcertain how far I am from the ſea ſhore of this land that obſtructs the horizon: to do which I proceed thus; ſend a perſon with a quadrant or octant to the main-top-maſt head, to take the altitude of the ſun, the very ſame moment I obſerve it with another octant or quadrant off the quarter-deck: the height of the upper obſerver's eye is here ſuppoſed to be 90 feet, and that of the lower obſerver 22 feet from the ſurface of the water, and the difference of the obſerved altitudes is ſuppoſed to be 12′.

The upper obſerver's eye 90 feet.				
The lower obſerver's do. 22 do.			10,00000	
Difference 68	Enter T. XVIII. and take out the correſponding log		1,83251	
	This is the logarithm compliment		8,16749	
Sum of the two elevations of the obſervers' eyes 112 feet	enter T. XVIII.	log.	2,04922	
Difference of obſerved altitudes - - 12	enter T. XIX.	ſine	7,54291	
			7,75962 is the ſine of	0° 19′ 46″
			Difference of obſerved altitudes	0 12 00
Half ſum 15′ 53″ cotangent - - - -	2,33533		Sum - -	0 31 46
Height of maſt head 90 feet, with which enter T. XVIII.	1,95424		Half ſum -	0 15 53
	4,28957	Natural number is 19479		

Natural number 19479 divided by 6120, the number of feet in a nautical mile, gives the diſtance from the land to be 3 & $\frac{1119}{6120}$ parts of a mile. Having now the diſtance from the land, you may proceed to work your obſervation according to example for that kind of ſituation.

CAAPTER

CHAPTER VIII.

OF MERIDIONAL OBSERVATIONS IN THE OPEN SEA WITH A HADLEY'S OCTANT OR QUADRANT, AND THE LAND BETWEEN THE SUN AND THE SHIP.

Example I.

Observed the ☉ lowest limb at noon - - -		79°	3′	00″	S.
Index-error to be deduced - - -		—	3	00	
☉ Lowest limb corrected - - -		79	00	00	
☉ Semidiameter this 2d of June, 1793, is		+	15	48	
Apparent altitude of ☉ centre -		79	15	48	
Eye's altitude or dip of the horizon for 15 feet in the open sea		—	3	42	
Apparent altitude corrected for the dip		79	12	6	
☉ Refraction in altitude 0′ 11″ / ☉ Parallax in altitude 2	Difference	—		9	
True altitude of the ☉ centre - -		79	11	57	
		90	00	00	
☉ True zenith distance - - -		10	48	3	S.
Longitude 45° west correction of ☉ declination from Table VI. 1′ 1″ to be added to 22° 17′ 20″ the ☉ declination at noon at Greenwich	+	22	18	21	N.
Latitude of ship at noon 2d of June 1793		33	6	24	N.

Example II.

In this example the sun is supposed to be between the vessel and the land, and the shore of the land at the distance of one-fourth of a mile; therefore as the observation is a fore one, Table V. for 15 feet must be made use of for the dip instead of Table II.

Observed the ☉ lowest limb at noon - - - -		80°	3′	00″	S.
Index-error to be deduced - -			3	00	
☉ Lowest limb corrected - -		80	00	00	
☉ Semidiameter this 2d of June, 1793, is		+	15	48	
Apparent altitude of ☉ centre -		80	15	48	
Eye's alt. or dip of the horizon for 15 feet, the land being one-fourth of a mile distant		—	34	00	
Apparent altitude corrected for the dip		79	41	48	
☉ Refraction in altitude 0′ 11″ / ☉ Parallax in do. 0 2	Difference	—		9	
True altitude of ☉ centre - - -		79	41	39	
		90	00	00	
☉ True zenith distance - - -		10	18	21	S.
Longitude 45° west, correction of ☉ declination for Table VI. 1′ 1″ to be added to 22° 17′ 20″ N. the ☉ declination at noon at Greenwich	+	22	18*	21	N.
Latitude of the ship at noon 2d of June 1793		32	36	42	N.

N. B. *I have frequently proved this method with the back observations, and find they agree.*

CHAPTER

CHAPTER IX.

OBSERVATIONS BY TWO ALTITUDES OF THE *SUN*, FOR DETERMINING THE LATITUDE.

Example I.

MAY *16th*, 1790.

At 9^h 2′ 00″ A. M. obſ. ⊙ l. lim. 44° 15′ add 12′ and his corr. is 44° 27′ Nat.S. 70029
At 10 27 00 do. 62 45 do. 62 57 Nat. S. 89061
1 25 00 Elapſe time. Difference of natural ſines - 19032
42 30 Half elapſe time.

Longitude per account	3° 20′ 00″ North.	Secant leſs radius		0,00074	
⊙ Declination -	19 10 00 North.	Secant leſs radius		0,02477	
		Sum is log ratio -		0,02551	
Difference of natural ſines 19032 its log is - - -				4,27949	
The half elapſe time 42′ 30″ its log is - - -				0,73429	
		This ſum of logs -		5,03929	in col.
	Of middle time is a log = to 2^h 12′ 40″				
	Deduce half elapſe time	0 42 30			
Time from noon when the greateſt altitude was taken		1 30 10			which in col. riſing
		gives a log of -		3,88309	
		Deduce the log ratio		0,02551	
		Difference		3.85758	is the
Logarithm of this natural number - - - - -				7204	
Add the natural ſine of ⊙ greateſt altitude as above - -				89061	
		Sum -		96265	this is
The natural ſine of the ⊙ meridional altitude - -			74° 17′ 00″		N.
			90 00 00		
	⊙ Zenith diſtance		15 43 00		N.
	⊙ Declination as above		19 10 00		N.
	Latitude of the ſhip		3 27 00		N.

This obſervation was made when the ſhip was becalmed, to the ſouthward of the ſun, in the Arabian ſea; conſequently the latitude was the ſame when both altitudes were obſerved: but whenever the ſhip alters her poſition between the altitudes, the ſun's bearing when the firſt altitude is obſerved muſt be taken, and the courſe and diſtance ſailed between the altitudes brought into the operation, as per the following examples: The reſult of the work will then be the latitude when the ſecond altitude was obſerved.

Example II.

Ship's course NNE ¾E. 2¾ points.
⊙ Bearing N*b*E¼E. 1¼ do.

Angle of diff. is 1½ points and distance sailed between the altitudes 9′ gives difference of latitude 9′ to be added to first alt. observed.

MAY 27*th*, 1790.

At 11h 48′ A.M. obs. ⊙ l. li. 81° 46′ add corr. 12′ & dif. l. 9′ giv. 82° 7′ its N.S 99055

At 1 56 P. M. do. 60 48 - 12 do. 61 00 do. 87462

2 8 Elapse time. Difference of natural sines - 11593

1 4 Half elapse time.

Latitude per acc. when the 2d alt. was obs. 13° 45 N. Secant less radius 0,01263

⊙ Declination - - - 21 22 N. Secant less radius 0,03093

Sum is log ratio 0,04356

Difference of N. S. 11593 gives a common log of - - - 4,06421

In table col. half elapse time 1h 4′ gives a log of - - 0,55966

This sum of logs 4,66743 in col.

Of middle time is = to 0h 53′ 50″

Deduce half elapse time 1 4 00

Time from noon when the greatest alt. was taken 0 10 10 which in

Col. rising gives a log of - - 1,99289

Deduce the log ratio - - - 0,04356

1,94933 this is

The logarithm of a natural number found to be - - - 89

Add the natural sine of ⊙ greatest altitude - - - 9,9055

9,9144 this is

The natural sine of ⊙ meridional altitude thus - - 82° 30′ 00″

90 00 00

⊙ Zenith distance - - 7 30 00 N.

⊙ Declination - - - 21 22 00 N.

Latitude of the ship when the second altitude was observed 13 52 00 N.

Example III.

June 6th, 1792.

At 10h 11′ A. M. Observed ⊙ lower limb -		26°	3′	00″	
⊙ Semidiameter add - -		+	15	48	
		26	18	48	
Dip for 24 feet deduce	4′ 40″	—	6	27	
Diff. of ⊙ ref. &. paral. in alt.	1 47				
		26	12	21	Natural sine 44151
At 11h 18′ A. M. Observed ⊙ lower limb -		30	46	00	
⊙ Semidiameter add - -		+	15	48	
		31	1	48	
Dip for 24 feet deduce	4′ 40″	—	6	7	
Diff. of ⊙ ref. &. paral. in alt.	1 27				
		30	55	41	Natural sine 51404

1 7 00 Elapse time. Difference of natural sines - 7253

0 33 30 Half elapse time.

Latitude by acct. when the 2d alt. was obs. 35° 18′ S. Secant less radius 0,08824

⊙ Declin. at the meridian of the ship same time 22 44 N. Secant less radius 0,03512

Sum is the log ratio - 0,12336

Difference of natural sines 7253 gives a common log of - 3,86052

The half elapse time 33′ 30″ gives a log of - - - 0,83669

Sum of logs - - 4,82057 in

Col. of middle time gives 1h 17′ 10″

Deduce the half elapse time 0 33 30

True appar. time from noon when greatest alt. was obs. 0 43 40 which in col. rising

Gives a log of - - - 3,25759

Deduce the log ratio - - 0,12336

3,13423 this is

The logarithm of a natural number found to be - - 1362

Add the natural sine of the ⊙ greatest altitude - - - 51404

Sum - 52766 this is

The natural sine of the ⊙ meridional altitude - -	31°	51′	00″	
	90	00	00	
⊙ Zenith distance - -	58	9	00	N.
⊙ Declination as above -	22	44	00	N.
Latitude of the ship when the 2d altitude was observed	35	25	00	S.

N. B. In the above case the ship altered her situation very little between the first and second altitudes.

Example IV.

⊙ Bearing ENE¼E. 6¼ points. } { Two points the angle of differ. as the ship made
Ship's course NE¼E. 4¼ do. } { no lee way, and the distance sailed between the altitudes 15′, which gives 14′ difference latitude in the traverse table, to be added to the first altitude.

MAY 22*d*, 1790.

At 9^h 46′ A. M. by watch obs. ⊙ l. limb 56° 49′
Diff. of ⊙ semidiameter and dip + 12
57 1
Diff. of latitude as above + 14
Corrected centre 57 15 Natural sine 84104

At 11 46 A. M. by watch obs. ⊙ l. limb 77 9 add 12′ & cen. is 77° 21′ N. S. 97573
2 00 Elapse time. Difference of natural sines - 13469
1 00 Half elapse time.

Latitude by account - 7° 54′ N.	Secant less radius -	0,00414	
⊙ Declination - 20 27 N.	Secant less radius -	0,02827	
	Sum is log ratio -	0,03241	
Difference of natural sines 13469 its log is - - - -		4,12934	
The half elapse time 1^h its log is - - - -		0,58700	
	Sum of logs	4,74875	in

Col. of middle time is a log = to 1_h 5′ 10″
Deduce the half elapse time - 1 00 00
Time from noon when the greatest altitude was observed 0 5 10 which in col.
Rising gives a log of - - - 1,40501
Deduce the log ratio - - - 0,03241
Difference - 1,37260 this is
The logarithm of a natural number found to be - - 24
Add the natural sine of the ⊙ greatest altitude as above - 97573
Sum - 97597 this is
The natural sine of ⊙ meridional altitude - - - 77° 25′ 00″ N.
90 00 00
⊙ Zenith distance - - - 12 35 00 N.
⊙ Declination as above - 20 27 00 N.
Latitude of the ship when the 2d altitude was taken - 7 52 00 N.

Example

Example V.

⊙ Bearing N ¼ E. ½ point, } { Four points the angle of differ. as the ship made
Ship's course NE ¼ E. 4½ do. } { no lee way, and the distance sailed between the altitudes 15′, which gives 14′ diff. latitude in the traverse table to be added to the first altitude.

MAY 22d, 1790.

At 11^h 46′ A. M. by watch obs. ⊙ l. limb 77° 9′

Diff. of ⊙ semidiameter and dip + 12

77 21

Diff. of latitude as above - 10

Corrected centre - 77 31 Natural sine - 97636

At 14 12 which is 2^h 12′ P. M. obs. ⊙ l. li. 53 48 add 12′ & corr. is 54° Nat.S. 80902

2 26 Elapse time. Difference of natural sines - 16734

1 13 Half elapse time.

Latitude by account 7° 54′ 00″ N. Secant less radius - 0,00414

⊙ Declination - 20 28 00 N. Secant less radius - 0,02832

Sum is the log ratio 0,03246

Difference of natural sines 16734 its log is - - - 4,22360

The half elapse time 1^h 13′ its log is - - - - 0,50423

Sum of logs 4,76029 in

Col. of middle time is a log = to 1^h 7′ 00′

Deduce the half elapse time - 1 13 00

Time from noon when the greatest altitude was taken - 0 6 00 which in

Col. rising gives a log of - - 1,53488

Deduce the log ratio - - 0,03246

Difference 1,50242 is

The logarithm of this natural number - - - - 31

Add the natural sine of ⊙ greatest altitude as above - - 97636

Sum - 97667 this is

The natural sine of ⊙ meridional altitude - - - 77° 36′ 00″ N.

90 00 00

⊙ Zenith distance - - - 12 24 00 N.

⊙ Declination - - - 20 28 00 N.

Latitude of the ship when the 2d altitude was observed - 8 4 00 N.

Example VI.

⊙ bearing NW¼W. is 4¼ points. } Nine points the angle of diff. as the ship made
Ship's course NE¼E. 4¼ do. } no lee way, which deduce from 16 points,
leaves 7 points, and the distance sailed between the altitudes 9′ which gives difference of latitude 2′ in the traverse tables to be deduced from the first altitude.

MAY 23*d*, 1790,

At 1h 00′ P. M. by watch observed ⊙ l. limb	71° 00′		
Diff. of ⊙ semidiameter and dip -	+ 12		
	71 12		
Difference of latitude as above - -	— 2		
Corrected centre - - - -	71 10	Nat. Sines.	94646
At 2 00 P. M. obs. ⊙ l. li. 58° 13′ add 12′ & his corr. is	58 25	Nat. Sines.	85188
1 00 Elapse time.		Difference of Nat. Sines	9458
0 30 Half elapse time.			

Latitude by account 9° 7′ 00″ N.	Secant less radius -	0,00552	
⊙ Declination - 20 39 00 N.	Secant less radius -	0,02884	
	Sum is log ratio -	0,03436	
Log ratio brought down - - - - - -		0,03436	
Difference of natural sines 9458 its log is - - -		3,97580	
The half elapse time 0h 30′ 00″ its log is - -		0,88430	
	Sum of logs	4,89446	in

Col. of middle time is a log = to	1h	32′	20″	
Deduce the half elapse time	0	30	00	
Time from noon when the greatest altitude was observed	1	2	20	which in

Col. rising gives a log of - -	3,56537	
Deduce the log ratio - - -	0,03436	
Difference	3,53101	is
The logarithm of this natural number - - -	3396	
Add the natural sine of ⊙ greatest altitude as above - -	94646	
Sum -	98042	this is

The natural sine of ⊙ meridional altitude - - -	78°	39′	00′	N.
	90	00	00	
⊙ Zenith distance - - -	11	21	00	N.
⊙ Declination - - -	20	39	00	N.
Latitude of the ship when the 2d altitude was observed -	9	18	00	N.

Example VII.

⊙ Bearing NbE¼E. is 1¼ points. } One and one half points the angle of differ-
Ship's course NNE¼E. is 2¼ do. } ence, as the ship made no lee way, and the distance sailed between the altitudes 9′ which gives difference of latitude 9′ in the traverse table, to be added to the first altitude.

MARCH 27*th*, 1790.

At 11h 48′ A. M. by watch obs. ⊙ l. lim.	81° 46′		
Diff. of ⊙ semidiamer and dip	+ 12		
	81 58		
Diff. of latitude as above -	+ 9		
	82 7	Nat. Sine	99055
At 13 56 which is 1h 56′ P. M. obs. ⊙ l. lim.	60 48 add 12′ is 61°	Nat. Sin.	87462
2 8 Elapse time.	Difference of natural sines		11593
1 4 Half elapse time.			

Latitude per account 13° 45′ North.	Secant less radius	0,01263
⊙ Declination - 21 22 North.	Secant less radius	0,03093
	Sum is the log ratio -	0,04356
Difference of natural sines 11593 its log is - - -		4,06419
The half elapse time 1h 4′ its log is - - -		0,55966
	Sum of logs -	4,66741 in

Col. of middle time is a log = to 0h 53′ 50″
Deduce half elapse time 1 4 00
Time from noon when the greatest alt. was observed 0 10 10 which in col. rising

gives a log of -	1,99289	
Deduce the log ratio	0,04356	
Difference	1,94933	is the
Logarithm of this natural number - - - - -	89	
Add the natural sine of ⊙ greatest altitude as above - -	99055	
Sum -	99144	is the
Natural sine of the ⊙ meridional altitude - - -	82° 30′ 00″	N.
	90 00 00	
⊙ Zenith distance	7 30 00	N.
⊙ Declination -	21 22 00	N.
Latitude of the ship when the 2d altitude was observed -	13 52 00	N.

Example

Example VIII.

JUNE 7th, 1792.

At 0^h 36′ P. M. Observed ⊙ lower limb -		23°	1′	00″	
⊙ Semidiameter add - -		+	15	48	
		32	16	48	
Dip for 24 feet deduce	4′ 40″	—	6	2	
Diff. of ⊙ ref. & par. in alt. ded.	1 22				
		32	10	46	Natural sine 53263
At 1^h 28′ P. M. Observed ⊙ lower limb -		29	1	00	
⊙ Semidiameter add - -		+	15	48	
		29	16	48	
Dip for 24 feet deduce	4′ 40″		6	13	
Diff. of ⊙ ref. & par. in alt. ded.	1 33				
		29	10	35	Natural sine 48761
0 52 00 Elapse time.		Difference of natural sines -			4502
0 26 00 Half elapse time.					

Latitude by acct. when the 2d alt. was obs. 34° 15′ S. Secant less radius 0,08271

⊙ Decli. at the meridian of the ship same time 22 50 N. Secant less radius 0,03544

This sum is the log ratio 0,11815

Difference of natural sines 4502 gives a common log of - 3,65341

The half elapse time 26′ gives a log of - - - 0,94614

Sum of logs - - 4,71770 in

Col. of middle time gives a log = to 1^h 00′ 30″

Deduce the half elapse time - 0 26 00

True appar. time from noon when greatest alt. was obs. 0 34 30 which in col. rising

Gives a log of - - - 3,05542

Deduce the log ratio - - 0,11815

Difference 2,93527 this is

The logarithm of a natural number found to be - - 861

Add the natural sine of the ⊙ greatest altitude - - - 53263

Sum - 54124 this is

The natural sine of the ⊙ meridional altitude - -	32°	46′	00′	
	90	00	00	
⊙ Zenith distance - -	57	14	00	N.
⊙ Declination as above -	22	50	00	N.
Latitude of the ship when the 2d altitude was observed	34	24	00	S.

N. B. In the above case the ship altered her situation very little between the first and second altitudes.

Example

Example IX.

Ship's course NNE. } { Angle of difference is one point, and the distance sailed be-
⊙ Bearing NE*b*N. } { tween the altitudes is 14′, which in the tables gives difference of latitude 14′ to be added to the first altitude.

JUNE 12*th*. 1792.

At 9h 18′ A. M. observed ⊙ lower limb		27° 57′ 00″	
Above diff. lat. between the alt. add		+ 14 00	
		28 11 00	
⊙ Semidiameter add		+ 15 47	
		28 26 47	
Deduce dip for 22 feet	4′ 28″	— 6 7	
Diff. of ⊙ ref. & paral. in alt.	1 39		
		28 20 40	Natural sine 47486
At 11 10 A. M. observed ⊙ lower limb		37 35 00	
⊙ Semidiameter add		+ 15 47	
		37 50 47	
Deduce dip for 22 feet	4′ 28″	— 5 34	
Diff. of ⊙ ref. & paral. in alt.	1 6		
1 52 Elapse time.		37 45 13	Natural sine 61222
0 56 Half elapse time.			Difference of natural sines 13736

Lat. by account when the 2d alt. was obs. 28° 37′ S. Secant less radius 0,05658
⊙ Declin. at the merid. of ship same time 23 13 N. Secant less radius 0,03667
This sum is the log ratio 0,09325
Difference of natural sines gives a common log of - - - - 4,13786
The half elapse time 56′ gives a log of - - - - 0,61632
Sum of logs 4,84743 in

Col. of middle time gives 1h 22′ 20″
Deduce the half elapse time 0 56 00

True app. time from noon when the greatest alt. was taken 0 26 20 which in col.

Rising gives a log of - - 2,81914
Deduce the log ratio - - 0,09325
2,72589 this is

The logarithm of a natural number found to be - - 532
Add the natural sine of the ⊙ greatest altitude - - 61222
61754 this is

The natural sine of the ⊙ meridional altitude - - 38° 8′ 00″
90 00 00
⊙ Zenith distance - - - 51 52 00 N.
⊙ Declination as above - 23 13 00 N.
Latitude of the ship when the 2d altitude was observed - 28 39 00 S.

Example X.

Ship's true course NNE. } Angle of difference is one point, and distance sailed be-
⊙ Bearing NbE. } tween the altitudes is 12′ which in the table gives difference of latitude 12′ to be added to the first altitude.

JUNE 12*th*, 1792.

At 11h 10′ A. M. observed ⊙ lower limb		37° 35′ 00″	
Above diff. of lat. between the alt. add		+ 12 00	
		37 47 00	
⊙ semidiameter add - -		+ 15 47	
		38 2 47	
Deduce dip for 22 feet	4′ 28″	— 5 34	
Diff. of ⊙ ref. & parallax in alt.	1 6		
		37 57 13	Natural Sine 61497
At 1 21 P. M. observed ⊙ lower limb -		32 21 00	
⊙ Semidiameter add - -		+ 15 47	
		32 36 47	
Deduce dip for 22 feet -	4′ 28″	— 5 47	
Diff. of ⊙ ref. & parallax in alt.	1 19		
		32 31 00	Natural Sine 53754
2 11 Elapse time.		Difference of Natural Sines -	7743
1 5 30″ Half elapse time.			

Latitude by acc. when the 2d alt. was obs. 28° 26′ S. Secant less radius 0,05583
⊙ Declin. at the merid. of ship same time 23 13 N. Secant less radius 0,03667
This sum is the log ratio 0,09250

Difference of Natural Sines 7743 gives a common log of - - 3,88891
The half elapse time 1h 50′ 30″ gives a log of - - 0,54987
Sum of logs 4,53128 in

Column of middle time gives - 0h 39′ 10″
Deduce the half elapse time - 1 5 30

True app. time from noon when the greatest alt. was obs. 0 26 20 which in

Col. rising gives a log of - - - 2,81914
Deduce the log ratio - - . - 0,09250
2,72664 this is

The logarithm of a natural number found to be - - - 532
Add the natural sine of ⊙ greatest altitude - - - 61497
62029 this is

The natural sine of ⊙ meridional altitude - - - 38° 20′ 00″
90 00 00

⊙ Zenith distance - - - 51 40 00 N.
⊙ Declination as above - - 23 13 00 N.
Latitude of the ship when the second altitude was observed 28 27 00 S.

Example XI.

☉ Bearing SbE. is 1 point. } { Four points the angle of difference as the ship
Ship's course SWbS. 3 do. } { made no lee way, and the distance sailed between
the altitudes 11′, which gives difference of latitude 8′ in the traverse table to be added to the first altitude.

JUNE 5th, 1793.

At 11^h 48′ A. M. by watch obs. ☉ l. limb 82° 00′

Diff. of ☉ semidiameter and dip	+ 12		
	82 12		
Diff. of latitude as above -	+ 8		
	82 20		
Index error - -	+ 1		
Centre of ☉ altitude -	82 21	Natural sine -	99110

At 13 41 which is 1^h 41′ P. M. obs. ☉ l. li. 66 10 add 13′ for corr. & his centre is 66° 23′ Nat. Sine } 91625

1 53 Elapse time. Difference of natural sines - 7485

0 56 30″ Half elapse time.

Latitude by account 29° 50′ N.	Secant less radius -	0,06174	
☉ Declination - 22 39 N.	Secant less radius -	0,03486	
	Sum is the log ratio	0,09660	
Difference of natural sines 7485 its log is - - -		3,87419	
The half elapse time 56′ 30″ its log is - - - -		0,61254	
	Sum of logs	4,58333	in
Column of middle time gives	0^h 44′	10″	
Deduce the half elapse time -	0 56	30	
Time from noon when the greatest altitude was observed	0 12	20	which in
Col. rising gives a log of - -		2,16066	
Deduce the log ratio - -		0,09660	
	Difference	2,06406	this is
The logarithm of a natural number found to be - -		115	
Add the natural sine of ☉ greatest altitude - - -		99110	
	Sum -	99225	this is
The natural sine of ☉ meridional altitude - - -	82°	52′ 00″	S.
	90	00 00	
☉ Zenith distance - - -	7	8 00	S.
☉ Declination - - -	22	39 00	N.
Latitude of the ship when the 2d altitude was observed -	29	47 00	N.

Example

Example XII.

☉ Bearing SE*b*S. is 5 points from South. } { Sixteen points, the angle of differ-
Ships course NW*b*W. is 11 do. from do. } { ence as the ship made no lee way,
and the distance sailed between the altitudes 10′. This angle of difference gives you the whole distance sailed, to be deduced from the first altitude, as may be seen from the following principle. Suppose the angle of difference had been 15¼ points, you would have deduced 15¼ points, from 16 points, and there would have remained one-fourth of a point to have entered with the distance of 10′ (sailed as above) the tables of difference of latitude and departure; and there you would have found 10′ difference of latitude to have been deduced from the first altitude, as the angle was above eight points; and this must appear very clear to every one of common understanding, as the ship was sailing directly from the very point on which the sun bore. Now had the ship been steering SE*b*E. when the sun bore SE*b*E. the angle of difference would have been nothing; consequently as the ship was sailing from the sun, the distance of 10′ sailed between the altitudes is deduced from the first altitude observed, and the result gives the same as it would have been if it had been observed in the very spot where the second altitude was. And this we will prove again from the same principle. Suppose the sun had bore SE*b*E. and the ship's course had been SE¼E. the angle of difference would have been one-fourth of a point; which, with the distance of 10′ sailed between the altitudes, the table of difference of latitude and departure must be entered, where you will find 10′ difference of latitude to have added to the first altitude, as the angle was under eight points; so that in sailing directly towards the sun, you add the distance sailed between the altitudes to the first altitude; and in sailing from him you deduce the the said distance from the first altitude.

If the sun had bore SE. or ESE. instead of SE*b*E. and the course NW*b*W. in either of which cases the angle of difference would have been 15 points; for had the sun bore ESE. you would have counted the number of points round to the eastward, *&c.* to the course you was steering; and on the contrary, had the sun bore SE. you would have counted the number of points round to the southward, *&c.* on the course you was steering; in either of which cases the angle would have been 15 points; which 15 points being deduced from 16 points, would leave one point to enter with the distance sailed of 10′ between the altitudes; the tables of difference of latitude and departure, where the difference of latitude would be found 9′$\frac{8}{10}$ equal to 10′ to be deduced from the first altitude; so that in all cases you find the angle of difference from that half the compass containing the smallest number of points between the sun's bearing and ship's course; for if the sun had bore from the same rules again east, and the course had been NW*b*W. the angle of difference would have been 13 points; consequently had it bore SSE. and the course NW*b*W. the angle would have been also 13 points; which 13 points deduced from 16 points, would have left 3 points to have entered with the distance the

the tables of X latitude and departure as aforesaid, and the difference of latitude corresponding thereto, would be 8′ $\frac{3}{10}$ to be deduced from the first altitude as before. But suppose an observation is made when the sun bears SW. at the taking of the first altitude, and the course made good between the altitudes NW. and the distance sailed 10′; as the angle of difference is 8 points, it is evident there is nothing either to add to or deduce from the first altitude; for had the course steered been NW$\frac{1}{4}$W. the angle of difference would have been 7$\frac{1}{4}$ points, which in table of difference of latitude and departure gives only $\frac{1}{10}$ of a minute difference of latitude: So by the same rule an angle of 8 points would give nothing.

A common compass will answer to take the bearing of the sun, when the first altitude is observed; but it is better to make use of either the amplitude or the azimuth-compass for this purpose: I have placed no observations of two altitudes of the sun as examples in this book, but what I have proved by meridional observations, made the same day; and here are examples of observations made both to the northward and southward of the sun, where his course appeared from the eastward towards the northward, when a north sun made noon; and from the eastward to the southward when a a south sun made noon. Indeed I have never found in perhaps some thousands of observations which I have made of this kind, any errors arise from the tables made use of (the Requisite Tables, second edition) that would amount to 3′ of latitude, when the operation was performed a second time, making use of the latitude found by the first observation, as the latitude by account in the second operation instead of the latitude by account used in the first operation: and by being thus enabled to ascertain my latitude, especially on the coast of Europe, in the winter time, when the days are short, and the weather almost constantly dark or hazy, when the sun is rarely to be seen exactly at noon, I have been enabled to run on and gain my port of destination, when I should otherwise have been obliged to hove too, and perhaps have lost an opportunity of getting in before an unfavourable change of wind came on, which often keeps ships out several weeks.

June

JUNE 24th, 1793,

At 10h 42′ A. M. by watch observed ⊙ lower limb	69° 38′		
Diff. of ⊙ ſemidiameter and dip -	+ 12		
	69 50		
Difference of latitude - - -	— 10		
Centre of ⊙ altitude - - -	69 40	Nat. Sine	93769
At 11 42 A. M. obſ. ⊙ lower limb 81° 39′ add correction 12′		Nat. Sine	98990
1 00 Elapſe time.		Difference of Nat. Sines	5221
0 30 Half elapſe time.			

Latitude by account 29° 5′ 00″ N.	Secant leſs radius -	0,05853
⊙ Declination - 23 25 00 N.	Secant leſs radius -	0,03733
	Sum is the log ratio -	0,09586
Difference of natural ſines 5221 its log is	- - -	3,71775
The half elapſe time 0h 30′ 00″ its log is	- -	0,88430
	Sum of logs	4,69791 in

Col. of middle time is a log = to	0h 57′ 50″	
Deduce the half elapſe time	0 30 00	
Time from noon when the greateſt altitude was taken -	0 27 50	which in
Col. riſing gives a log of - -	2,86720	
Deduce the log ratio - - -	0,09586	
Difference	2,77134	this is
The logarithm of a natural number found to be - -	590	
Add the natural ſine of the ⊙ greateſt altitude - - -	98990	
Sum -	99580	this is

The natural ſine of ⊙ meridional altitude - - -	84° 45′ 00″	S.
	90 00 00	
⊙ Zenith diſtance - - -	5 15 00	S.
⊙ Declination - - -	23 25 00	N.
Latitude of the ſhip when the 2d altitude was obſerved -	28 40 00	N.

Example XIII.

⊙ Bearing ESE. } Eight points the angle of difference, as the ship made no lee
Ship's course SSW. } way, and the distance sailed between the altitudes 4′, which gives nothing for difference of latitude to be added or deduced, because the angle of difference was exactly 8 points.

JULY 8*th*, 1793.

At 9^h 50′ A. M. by watch obs. ⊙ lower limb	57°	4′	00″		
Diff. of ⊙ semidiamer and dip	+	12	00		
	57	16	00		
Diff. of ⊙ refract. & parallax in alt.	—		32		
Centre of ⊙ altitude -	57	15	28	Nat. Sine	84111

At 11 2 A. M. obs. ⊙ l. lim. 68° 43′ add corr. 12′ & his centre is 68° 55′ N. S. 93306
1 12 Elapse time. Difference of Natural Sines 9195
0 36 Half elapse time.

Latitude per account	39°	7′	North.	Secant less radius	0,11022
⊙ Declination -	22	25	North.	Secant less radius	0,03412
				Sum is the log ratio -	0,14434
Difference of natural sines 9195 its log is				- - -	3,96355
The half elapse time 36′ 00″ its log is				- - -	0,80567
				Sum of logs -	4,91356 in

Col. of middle time is a log = to 1^h 36′ 40″
Deduce half elapse time 36′ 0 36 00
Time from noon when the greatest alt. was observed 1 00 40 which in col. rising

Gives a log of -	3,54197	
Deduce the log ratio	0,14434	
Difference	3,39763	this is
The logarithm of a natural number found to be - - -	2498	
Add the natural sine of ⊙ greatest altitude - - -	93306	
Sum -	95804	this is

The natural sine of the ⊙ meridional altitude - -	73°	21′	00″	S.
	90	00	00	
⊙ Zenith distance	16	39	00	S.
⊙ Declination -	22	25	00	N.
Latitude of the ship when the 2d altitude was taken -	39	4	00	N.

CHAPTER X.

MERIDIONAL OBSERVATIONS OF THE *MOON*, FOR ASCERTAINING THE LATITUDE OF THE SHIP.

Example I.

APRIL 28*th*, 1787.

At 9^h 35′ 00″ P. M. Observed app. alt. of the ☾ lower limb	59°	25′	00″	
Correction from refraction deduce -	—		11	
	59	24	49	
☾ Semidiameter add - - - - -	+	15	11	
	59	40	00	
Augmentation of ☾ semidiameter in altitude add	+		14	
	59	40	14	
Eye's altitude for 17½ feet deduce -	—	3	57	
	59	36	17	
☾ Horizontal parallax 55′ 43″ correction add	+	27	45	
☾ True meridian altitude - - -	60	4	2	
☾ Zenith distance - - - -	29	55	58	S.
Longitude 64½° W. ☾ declination at the ship calculated from the meridian of Greenwich by help of Table XXII.	5	15	00	S.
Latitude of the ship - - -	24	40	58	N.

Example II.

MARCH 9*th*, 1790.

At 7^h 5′ 00″ A. M. observed merid. alt. of the ☾ lower limb	74°	10′	00″	N.
☾ Semidiameter and augmentation add -	+	15	28	
	74	25	28	
Correction from refraction 0′ 16″ / Eye's altitude or dip for 24 feet 4 40 } deduce	—	4	56	
	74	20	32	
☾ Horizontal parallax 56′ 47″ correction add	+	15	5	
☾ True meridional altitude - -	74	35	37″	
☾ True zenith distance - - -	15	24	23	N.
Longitude 17¼ E. ☾ declination at the ship calculated from the meridian of Greenwich by help of Table XXII.	19	12	30	S.
Latitude of the ship at the above time -	34	36	53	S.

Table XXII. for reducing the moon's declination, as set down in the Nautical Almanac for Greenwich to any other meridian is used the same as Table VI. for reducing the sun's declination, as set down in the Nautical Almanac to any other meridian, only you enter Table XXII. with the moon's variation of declination in 12^h, and the ship's longitude, instead of the day of the month and ship's longitude, as already shewn by various examples.

CHAPTER

CHAPTER XI.

OBSERVATIONS FOR ASCERTAINING THE VARIATION OF THE COMPASS, BY AZIMUTHS.

Example I.

In latitude 24° 15′ S. and longitude 77 E. on Thursday, 14th June, 1792; Magnetic azimuth observed in the morning, N. 70° 35′ E. when the sun's lower limb was 3° 39′; add difference between his semidiameter and dip, and it makes the centre of his altitude 3° 50′.

Lat. of the ship	24° 15′ S.	⊙ Declination	23° 18′ N.	Centre of ⊙ alt. as above			3° 50′
Co.-latitude	65 45	⊙ Polar dist.	113 18	Co. altitude -			86 10
Polar distance	113 18	Secant less radius of the latitude			24°	15′	0,04012
Co. altitude	86 10	Secant less radius of the altitude			3	50	0,00097
Sum	265 13	Sine of half the sum	-		132	36	9,86693
Half sum	132 36	Sine of the difference	-		19	18	9,51919
Polar distance	113 18			Sum of logs			19,42721
Difference	19 18			Half sum of logs			9,71360 is

Cosine of 58° 52′ which doubled is the azimuth 117° 44′ from the South, deduce the same from 180° and it leaves from the North - 62° 16′
Magnetic azimuth observed from the North as above - 70 35
Variation per morning azimuth - - - - 8 19 West.

Example II.

In latitude 23° 56′ S. and longitude 55° E. Monday, 12th Novem. 1792, magnetic azimuth observed in the morning, South 59° 30′ East, when the sun's lower limb was observed to be 13° 37′ add difference between his semidiameter and dip, and it makes the centre of his altitude 13° 49′.

Latitude of the ship	23° 56′ S.	⊙ Declination	17° 53′ S.	Centre of ⊙ altitude			13° 49′
Co. latitude	66 4	Polar distance	72 7	Co. altitude			76 11
Polar distance	72 7	Secant less radius of latitude			23°	56′	0,03905
Co. altitude	76 11	Secant less radius of altitude			13	49	0,01275
Sum	214 22	Sine of half the sum	-		107	11	9,98017
Half sum	107 11	Sine of the difference	-		35	4	9,75931
Polar distance	72 7			Sum -			19,79128
Difference	35 4			Half sum			9,89564 is

Cosine of 38° 9′ which doubled is the ⊙ azimuth 76° 18′ from the South.
Magnetic azimuth observed - - - 59 30 from the South.
Variation per morning azimuth - - 16 48 West.

Example III.

In latitude 30¼° South, longitude 40¼ East, November 19th, 1792, magnetic azimuth observed in the afternoon North 81° West, when the centre of sun's altitude was 8° 12′.

Latitude	30° 15′	⊙ Declination	19° 45′ S.	⊙ Altitude	8° 12′
Co. latitude	59 45	Polar distance	70 15	Co. altitude	81 48
Polar distance	70 15				
Co. altitude	81 48	Secant less radius of latitude			0,06357
Sum	211 48	Secant less radius of altitude			0,00446
Half sum	105 54	Sine of half sum - -			9,98306
Polar distance	70 15	Sine of Difference -			9,76554
Difference	35 39			Sum -	19,81663
				Half sum	9,90831 is

The cosine of 35° 56′, which doubled is the ⊙ azimuth 71° 52′ from the South, deduce the same from 90° and it leaves 18° 8′. Again: Deduce the magnetic azimuth observed as above from 90° and it leaves 9°; add this West 9° North to the above West 18° 8′ South, and the sum is 27° 8′ West variation.

Example IV.

In latitude 36° 50′ North, longitude 51°¼ West, April 3d, 1794, magnetic azimuth observed in the afternoon, North 84° 30′ West, when the centre of sun's altitude was 15°.

Latitude	36° 50′ N.	⊙ Declination	5° 38′ N.	⊙ Altitude	15° 00′
Co. latitude	53 10	Polar distance	84 22	Co. altitude	75 00
Polar distance	84 22				
Co. altitude	75 00	Secant less radius of latitude			0,09670
Sum	212 32	Secant less radius af the alt.			0,01557
Half sum	106 16	Sine of half the sum -			9,98226
Polar distance	84 22	Sine of the difference			9,57170
Difference	21 54			Sum -	19,66623
				Half sum	9,83311½ is

The cosine of 47° 5′ which doubled is 94° 10′ the ⊙ true azimuth from the North,
magnetic azimuth observed - 84 30 from the North.
Variation of the compass 9 40 West.

CHAPTER XII.

OBSERVATIONS FOR ASCERTAINING THE VARIATION OF THE COMPASS, BY AMPLITUDES.

Example I.

In latitude 29½° South, longitude 41½ East, November 18th, 1792, in the evening.

Secant less radius of latitude - - -			29°	30′	0,06030
Sine of ☉ declination (at sun set) - -			19	32	9,52421
				Sum	9,58451 is the
Sine of the ☉ true amplitude	22°	36′	00″	South.	
Magnetic amplitude observed - -	4	30	00	North.	
Variation -	27	6	00	West.	

CHAPTER

CHAPTER XIII.

A TABLE OF LATITUDES AND LONGITUDES OF SEVERAL PLACES IN THE ROUTE TO INDIA AND CHINA.

The Longitudes are laid down from the Meridian of Greenwich in Great Britain; and moſt of them from Aſtronomical Obſervations.

Names of Places.		Latitudes.	Longitudes.	Variation of the Compaſs.
Cape Henlopen,	America.	38° 47′ N.	75° 13′ W.	
Bermudas,	St. Georgetown.	32 25	64 54	None in 1787.
St. Jago,	Atlantic Ocean.	14 53½	23 35	13°½ Weſt in 1792.
St. Pauls,	Ditto.	0 45	30 30	
Ferdinando Noranho,	Ethiopic Ocean.	3 56½ S.	32 33	1½ W. in 1775.
Aſcenſion,	ditto.	7 57	13 30	10¾ W. in 1775.
St. Helena,	ditto.	15 55	5 49	13¾ W. in 1775.
Trinidada,	ditto.	20 5	29 10	2¼ W. in 1788.
Four Rocks to the Eaſtward of	ditto.	20 30	29 55	
Triſtan de Acuna,	ditto.	37 10	14 10	
Cape Good Hope		34 24	18 23¼ E.	23¼ W. in 1786.
Madagaſcar,	St. Auguſtines.	23 35	43 15	
St. Pauls,	Indian Ocean.	37 51	77 48	19 W. in 1788.
Cloat's Iſland,	ditto.	22 6	110 30	
Trial Rocks,	ditto.	19 30	105 30	
Cocos, or Killing Iſland,	ditto.	12 00	98 30	
Chriſtmas Iſland,	ditto.	10 22	105 15	
Java Head,	Iſland of Java.	6 50	105 15	54′ W. in 1786.

CHAPTER

CHAPTER XIV.

FOR FINDING THE ALTITUDE OF THE *SUN*, INDEPENDENT OF AN ASSISTANT TO OBSERVE THE SAME, WHEN A DISTANCE IS TAKEN FOR DETERMINING THE LONGITUDE.

Example I.

MARCH 28*th*, 1792.

At 1^h 37′ 44″ P. M. true apparent time at ship and from noon log. rising 3,95151

Latitude - -	14° 53′ 00″ N.		
Co. latitude -	75 7 00	Sine	9,98518
☉ Declination on the ship's meridian at above time, found as per examples for that purpose	3 26 1	N. Cosine	9,99922
		Sum of logs	3,93591
☉ Meridional altitude - - -	78 33 1	Nat. Sine	98010
Sum of logs 3,93591 its natural number is - - - -			8628
		Difference	89382 is
The natural sine of ☉ true altitude - - - -		63° 21′ 29″.	
Difference of ☉ refraction and parallax in altitude add -		+ 25	
Centre of ☉ apparent altitude -		63 21 54	

N. B. These operations bring out the true altitude of objects, therefore if the appareat altitude is wanted, which is most generally the case, the difference of sun's refraction and parallax must be added to the true altitude of the sun, found by calculation (which is done above); and the refraction must be added to the true altitude of a star, and the correction from Table VIII. of the Requisite Tables, must be deduced from the true altitude of the moon thus found, to obtain their respective apparent altitudes.

CHAPTER XV.

FOR FINDING THE ALTITUDE OF THE *MOON*, INDEPENDENT OF AN ASSISTANT TO OBSERVE THE SAME, WHEN A DISTANCE IS TAKEN BETWEEN THE SUN AND MOON FOR DETERMINING THE LONGITUDE.

Example I.

☾ Horizontal parallax 54′ 30″

MARCH 28*th*, 1792.

At 1h 37′ 44″ P. M. true apparent time at the ship. ☾ Southing or passage over the meridian of Greenwich the 28th is at - - - -	4h	35′	00″
With daily variation 47′ and longitude 24° W. enter Table XXI.	+	3	00
☾ Passage over the meridian of the ship - - - -	4	38	00
True apparent time at the ship as above - - -	— 1	37	44
Difference -	3	00	16
With daily variation 47′ and difference 3h 00′ 16″ turned into degrees, enter Table XXI. - -	—	6	00
☾ Distance from the meridian of the ship - - -	2	54	16

☾ Distance from the meridian of the ship 2h 54′ 16″ log. rising - 4,44000

☾ Declination on the ship's meridian at above time, found as per examples for that purpose } 17° 45′ Cosine 9,97882

Latitude -	14° 53′ North.		
Co. Latitude	75 7	Sine -	9,98518
☾ Declination	17 45 N.	Sum of logs	4,40400
	92 52 which		
Deduce from	180 00		
☾ Meridional alt.	87 8	its natural sine - - -	99875
Sum of logs 4,40400		the natural number is - - -	25351
		Difference -	74524 is the

Natural sine of the centre of the ☾ true altitude -	48°	11′	00″
Correction from Table VIII. - - -		36	00
Apparent altitude of ☾ centre - - -	47	35	00

N. B. The daily variation of the moon's passing the meridian is found by taking the difference between her passing the meridian of Greenwich on the proposed day, and the day following if the longitude is West; but if the longitude is East, take the difference between the proposed day and that preceding it. It is proper also to observe, that both the corrections taken out of Table XXI. are to be deduced in East longitude; and in West longitude from Greenwich the first correction must be added, and the second deduced.

Example II.

For finding the altitude of the SUN, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

MAY 28*th*, 1792.

At 3h 33′ 50″ P. M. true appar. time at the ship and from noon, log rising 4,60701

Latitude - -	37°	53′	00″ S.		
Co. latitude -	52	7	00	Sine -	9,89722
⊙ Declin. on the ship's merid. at above time found per example for that purpose	21	37	16 N.	Cosine	9,96832
				Sum of logs	4,47255
⊙ Meridional altitude - - -	30	29	44	Natural Sine	50754
Sum of logs 4,47255 its natural number is		-	-	-	29683
		Difference		-	21071 is

The natural sine of ⊙ true altitude - - -	12°	9	00″
Difference of ⊙ refraction and parallax in altitude add -	+	4	10
Centre of ⊙ apparent altitude - - - - - -	12	13	10

Example

Example II.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon, for determining the longitude.*

☾ Horizontal parallax 55′ 31″

MAY 28*th*, 1792.

At 3^h 33′ 50″ P. M. true apparent time at the ship. ☾ Southing or passage over the meridian of Greenwich the 28th is at - - 5^h 56′ 00

With daily variation 45′ and longitude 38° East enter Table XXI. — 5 00

☾ Southing or passage over the meridian of the ship - - 5 51 00

True apparent time at the ship - - - - - - - 3 33 50

Difference - 2 17 10

With daily variation 45′ and difference 2^h 17′ 10″ turned into degrees, enter Table XXI. — 4 00

☾ Distance from the meridian of the ship - - - - 2 13 10

☾ Distance from the meridian of the ship 2^h 13′ 10″ Log rising. 4,21514

☾ Declination on the ship's meridian at above time, found as per examples for that purpose } 8° 33′ 10″ N. Cosine 9,99514

Latitude -	37°	53′	00″	South.		
Co. latitude -	52	7	00	- -	Sine -	9,89722
☾ Declination	8	33	10	North.	Sum of logs	4,10750
☾ Meridional altitude	43	33	50		Natural Sine	68920

Sum of logs 4,10750 the natural number is - - - 12800

Difference - 56120 is the

Natural sine of the centre of ☾ true altitude - -	34°	8′	30″
Correction from Table VIII. - - - -		44	36
Apparent altitude of ☾ centre - - - -	33	23	54

Example

Example III.

For finding the altitude of the SUN, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

NOVEMBER 10*th*, 1792.

At 9^h 38′ 4″ A. M. true apparent time at the ship, and from

noon 2^h 21′ 56″ - -				Log rising	4,26924
Latitude -	22°	12′	00″ S.		
Co. Latitude	67	38	00	Sine	9,96603
⊙ Declination on the ship's meridian at above time, found as per example for that purpose - -	17	22	38 S.	Cosine	9,97971
				Sum of logs	4,21498
⊙ Meridional altitude - -	85	00	38	Nat. Sine	99622
Sum of logs 4,21498 its natural number		-	-	-	16405
			Difference	-	83217 is the
Natural sine of ⊙ true altitude - - -			56° 20′ 00″		
Difference of ⊙ refraction and parallax add		-	+	34	
Centre of ⊙ apparent altitude - - -			56 20 34		

Example III.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon, for determining the latitude.*

☾ Horizontal parallax 56′ 19″

NOVEMBER 10*th*, 1792.

At 9^h 38′ 4″ A. M. true apparent time at the ship. ☾ Southing or passage over the meridian of Greenwich the 9th is at - - - -	20^h	45′	00″
With daily variation 45′ and longitude 59° East, enter Table XXI.	—	7	00
☾ Southing or passage over the meridian of the ship. - -	20	38	00
True apparent time at the ship 9^h 38′ 4″ A. M. add 12^h and it gives the time from noon of the 9th to be	21	38	4
Difference -	1	00	4
With difference 1^h 0′ 4″ turned into degrees and daily variation 45′ enter Table XXI. -	—	2	00
☾ Distance from the meridian of the ship - - -	0	58	4

☾ Distance from the meridian of the ship 58′ 4″	Log rising -		3,50438
☾ Declination on the ship's meridian at above time found as per example for that purpose	1° 59′ 00″ N.	Cosine	9,99974
Latitude - -	22° 22′ South.		
Co. latitude -	67 38	Sine	9,96603
☾ Declination -	1 59 North.	Sum of logs	3,47015
☾ Meridional altitude	65 39	Nat. Sine	91104
Sum of logs 3,47015 its natural number - - -			2952
Difference -			88152 is the

Natural sine of the centre of the ☾ true altitude - -	61°	50′	00″
Correction from Table VIII. - - - - - -		26	00
Apparent altitude of ☾ centre - - - -	61	24	00

Example IV.

For finding the altitude of the SUN, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

NOVEMBER 11*th*, 1792.

At 7^h 1′ 57″ A. M. true apparent time at the ship and from noon 4^h 58′ 3″ - - - -				Log rising	4,86510
Latitude - - - - - -	22°	57′	00″ S.		
Co. latitude - - -	67	3	00	Sine -	9,96419
☉ Declination on the ship's meridian at above time found as per example for that purpose - -	17	37	27 S.	Cosine	9,97912
				Sum of logs	4,80841
☉ Meridional altitude - -	84	40	27	Nat. Sine	99568
Sum of logs 4,80841 its natural number - - - -					64330
			Difference -		35238 is the
Natural sine of the ☉ true altitude - - -				20° 38′ 00″	
Difference of ☉ refraction and parallax add - -				+ 2 23	
Centre of ☉ apparent altitude -				20 40 23	

Example IV.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

☾ Horizontal parallax 57′ 1″

NOVEMBER 11*th*, 1792.

At 7^h 1′ 57″ A. M. true apparent time at the ship. ☾ Southing or passage over the meridian of Greenwich the 10th is at - -	21^h	32′	00″
With daily variation 47′ and longitude 57° E. enter Table XXI.	—	7	00
☾ Southing or passage over the meridian of the ship -	21	25	00
True apparent time at the ship 7^h 1′ 57″ A. M. add 12^h and it gives the time from the 10th at noon	19	1	57
Difference	2	23	3
With difference 2^h 23′ 3″ turned into degrees and daily variation 47′ enter Table XXI.	—	4	00
☾ Distance from the meridian of the ship - -	2	19	3
☾ Distance from the meridian of the ship 2_h 19′ 3″ Log rising -		4,25162	
☾ Declination on the ship's meridian at above time found as per examples for that purpose, 1° 39′ 1″ South.	Cosine	9,99982	

Latitude - - - -	22°	57′	00″ S.		
Co. latitude - - -	67	3	00	Sine -	9,96419
☾ Declination - -	1	39	1 S.	Sum of logs	4,21563
☾ Meridional altitude - -	68	42	1	Nat. Sine	93169
Sum of logs 4,21563 Natural number - -					16430
Difference					76739 is the
Natural sine of the ☾ true altitude - - -				50° 7′ 00″	
Correction from Table VIII. deduce - -				36 00	
Apparent altitude of ☾ centre - -				49 31 00	

Example

Example V.

To find the altitude of the SUN, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

DECEMBER 19*th*, 1792.

At $1^h\ 8'\ 32''$ P. M. true apparent time at the ship and the same from noon, Log rising - - 3,64717

Latitude of the ship - -	22°	41′	00″	S.	
Co. Latitude - - -	67	19	00	Sine -	9,96504
☉ Declination on the ship's meridian at above time, found as per example for that purpose - - -	23	27	14	S. Cosine	9,96255
				Sum of logs	3,57476
	90	46	14	Deduce this	
from	180	00	00		
☉ Meridional altitude -	89	13	46	Nat. Sine	99991
Sum of logs 3,57476 gives a natural number of - -					3756
					96235 is the

Natural sine of ☉ true altitude - -	74°	13′	00″
Difference of ☉ refraction and parallax in altitude add	+		13
Centre of ☉ apparent altitude by calculation -	74	13	13

N. B. Whenever the compliment of latitude, and the sun or moon's declination when added together, exceed 90°, as in the above case, deduce the same from 180°, and the result is the sun or moon's meridional altitude.

Example V.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

☾ Horizontal parallax 60′ 14″

NOVEMBER 17*th*, 1792.

At 11^h 19′ 44″ A. M. true apparent time found at the ship. ☾ Southing or passage over the meridian of Greenwich this day is at -	P. M.	3^h	3′	00″
With daily variation 60′ and longitude 45° East, enter Table XXI.		—	7	00
☾ Southing or passage over the meridian of the ship -		2	56	00
True apparent time at the ship 11^h 19′ 44″ A. M. which is from noon of this day -		+	40	16
Sum -		3	36	16
With sum 3^h 36′ 16″ and daily variation 60′ enter Table XXI.		—	9	00
☾ Distance from the meridian of the ship - -		3	27	16

☾ Distance from the meridian of the ship 3^h 27′ 16″ Log rising - 4,58186

☾ Declination on the ship's meridian at above time, found as per example for that purpose } 18° 24′ 46″ Cosine 9,97718

Latitude of the ship	28°	2′	00″ S.		
Co. latitude -	61	58	00	- Sine	9,94580
☾ Declination -	18	24	46 S.	Sum of logs	4,50484
☾ Meridional altitude	80	22	46	Nat. Sine	98594
Sum of logs 4,50484				Natural number	31977
				Difference	66617 is the

Natural sine of ☾ true altitude -	41°	46′	00″
Correction from Table VIII. deduce -	—	44	00
Apparent altitude of ☾ centre -	41	2	00

N. B. When you want to know the altitude of the moon in the morning, and she passes the meridian in the afternoon, as in the above case, and as in Example VII. and VIII. subtract the time for which you want to know the altitude from noon, and add the same to the moon's southing, or time of passing the meridian of the ship, and use the sum the same as the difference is done in other cases to find the second correction from Table XXI. which must be applied as per the different examples shown here, according as your longitude is east or west of Greenwich.

Example VI.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon, for determining the longitude.*

☾ Horizontal parallax 58′ 3″

JANUARY *7th*, 1793,

At 10^h 33′ 56″ A. M. true apparent time found at the ship. ☾ Southing or passage over the meridian of Greenwich the 6th is at - - 19^h 15′ 00″

With daily variation 52′ and longitude 26°½ West enter Table XXI. + 3 00

☾ Southing or passage over the meridian of the ship - - 19 18 00

True appar. time at the ship 10_h 33′ 56″ add 12_h and it gives the time from noon of the 6th - - — 22 33 56

Difference - 3 15 56

With difference 3^h 15′ 56″ turned into degrees, and daily variation 52′ enter Table XXI. - — 7 00

☾ Distance from the meridian of the ship - - - - 3 8 56

☾ Distance from the meridian of the ship 3^h 8′ 56″ Log rising 4,50648

☾ Declination on the ship's meridian at above time, found as per example for that purpose 11° 22′ 00″ Cosine 9,99140

Latitude of the ship	3°	36′	00″	North.		
Co. latitude -	86	24	00	- -	Sine -	9,99914
☾ Declination	11	22	00	South.	Sum of logs	4,49702
☾ Meridional altitude	75	2	00		Natural Sine	96608
Sum of logs 4,49702					Natural number	31406
					Difference -	65202 is the

Natural sine of ☾ true altitude - - - -	40°	42′	00″
Correction from Table VIII. deduce - - -	—	43	00
Apparent altitude of ☾ centre - - - -	39	59	00

Example VII.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

☾ Horizontal parallax 55′ 56″

JANUARY *9th*, 1791.

At 10^h 55′ 44″ A. M. true apparent time at the ship. ☾ Southing or passage over the meridian of Greenwich this day is at - -	3^h	58′	00″
With daily variation 45′ and longitude 38° East, enter Table XXI.	—	4	30
☾ Southing or passage over the meridian of the ship -	3	53	30
True appar. time at ship 10^h 55′ 44″ which is from noon of this day	+ 1	4	16
Sum -	4	57	46
With sum 4^h 57′ 46″ turned into degrees and daily variation 45′ enter Table XXI. -	—	8	46
☾ Distance from the meridian of the ship - -	4	49	00

☾ Distance from the meridian of the ship 4^h 49′ 00″ Log rising 4,84207

☾ Declination on the ship's meridian at above time found as per example for that purpose } 2^h 8′ 00″ Cosine 9,99970

Latitude of the ship - -	30°	54′	00″ S.		
Co. latitude - - -	59	6	00	Sine -	9,93352
☾ Declination - -	2	8	00 S.	Sum of logs	4,77529
☾ Meridional altitude - - -	61	14	00	Natural Sine	87659
Sum of logs 4,77529 - - -				Natural number	59606
			Difference -		.28053 is

The natural sine of ☾ true altitude - - -	16°	17′	00″
Correction from Table VIII. deduce - - -	—	50	00
Apparent altitude of ☾ centre - - - -	15	27	00

Example

Example VIII.

For finding the altitude of the MOON, *independent of an assistant to observe the same, when a distance is taken between the Sun and Moon for determining the longitude.*

☾ Horizontal parallax 54′ 20″

MARCH *9th*, 1791.

At 10^h 35′ 33″ A. M. true apparent time found at the ship. ☾ Southing or passage over the meridian of Greenwich this day is at - -	3^h	23′	00″
With daily variation 46′ and longitude 60° W. enter Table XXI.	+	7	00
☾ Southing or passage over the meridian of the ship - -	3	30	00
True appar. time at ship 10^h 35′ 33″ which is from noon of this day	+ 1	24	27
Sum -	4	54	27.
With sum 4^h 54′ 27″ turned into degrees, and daily variation 46′ enter Table XXI. -	—	9	00
☾ Distance from the meridian of the ship - - -	4	45	27

☾ Distance from the meridian of the ship 4^h 45′ 27″		Log. rising	4,83278
☾ Declination on the ship's meridian at above time, found as per example for that purpose	13° 48′ 8″ N.	Cosine	9,98727
Latitude of the ship -	14° 40′ 00″ North.		
Co. Latitude - -	75 20 00	- - Sine	9,98561
☾ Declination - -	13 48 8 N.	Sum of logs	4,80566
☾ Meridional altitude -	89 8 8	Natural sine	99989
Sum of logs gives a natural number of - - - -			63923
Difference -			36066 is the
Natural sine of the ☾ true altitude thus - -		21° 8′ 00″	
Correction from Table VIII. deduce - -		— 48 00	
Apparent altitude of ☾ centre - - -		20 20 00	

CHAPTER XVI.

CALCULATION TO FIND THE ALTITUDE OF THE STAR *REGULUS*, APRIL 13*th*, 1794.

Example I.

At 8^h 11′ 55″ P. M. true apparent time. ⊙ Right ascension at the same time on the ship's meridian, found by Table XXIII. as per examples inserted for that purpose				1^h 29′ 30″
Apparent time found at the ship as above				8 11 55
Right ascension of mid-heaven				9 41 45
* Right ascension found by Table VII.				9 57 23
Distance of star from the meridian				15 38
* Distance from the meridian 0^h 15′ 38″			Log rising	2,36839
Declination of the * Regulus found by T. VII. 12° 58′ N.			Cosine	9,98878
Latitude 36° 33′ N.	Co. Latitude is	53 27 N.	Sine	9,90490
			Sum of logs	2,26207
* Regulus's meridional altitude		66 25	Nat. Sine	91648
Sum of logs 2,26207 the natural number is				182
		Difference		91466 is
Natural sine of the * true altitude		66° 9′ 27″		
* Refraction in altitude		+ 25		
Apparent altitude of * Regulus		66 9 52		

Example II.

CALCULATION TO FIND THE ALTITUDE OF THE STAR *ANTARES*, APRIL 16*th*, 1794.

At 4^h 39′ 34″ A. M. true apparent time. ⊙ Right ascension at the same time on the ship's meridian, found by Table XXIII. as per examples inserted for that purpose - - - - - - 1^h 38′ 34″

Apparent time found at the ship as above - -	4	39	34
Right ascension of mid-heaven - - -	6	18	8
* Right ascension in time found by Table VII. is 16^h 16′ 48″ which is in the morning -	4	16	48
Distance of the * from the meridian of the ship - -	2	1	20

* Distance from the meridian of the ship 2^h 1′ 20″		Log. rising	4,13640
Declin. of * Antares found by T. VII. is 25° 57′ 30″ S.	-	Cosine	9,95381
Latitude 37° 45′ N. Co. latitude 52 15 00 N.	-	Sine	9,89801
* Antares Meridional altitude 26 17 30 N. S.	44294	S. of logs	3,98822
Sum of logs 3,98822 the natural number is -	9731		
Difference	34563 is the		

Natural sine of the * true altitude -	20°	13′	00″
* Refraction in altitude - -	+	2	35
Apparent altitude of * Antares -	20	15	35

Example

CHAPTER XVII.

METHOD OF FINDING THE TRUE APPARENT TIME AT THE SHIP BY WHICH THE WATCH IS REGULATED.

Example I.

JANUARY *2d*, 1788.

At 8^h 15′ 00″ A. M. per watch obſerved ⊙ lower limb to be				15°	53′	00″
Index error of quadrant deduce			-	—	1	00
Altitude of ⊙ lower limb			- -	15	52	00
⊙ Semidiameter -	16′	19″	Difference	+	12	22
Eye's altitude 17¼ feet	3	57				
				16	4	22
⊙ Refraction in altitude	3	17	Difference	—	3	9
⊙ Parallax in do.		8				
Centre of ⊙ true altitude			- -	16	1	13
⊙ Zenith diſtance - - -				73	58	47
Latitude per account when the altitude was obſerved -				28	00	00 N.
Complement of the latitude - - - -				62	00	00
⊙ Declination on the ſhip's meridian when the altitude was obſerved, found as per examples for that purpoſe				22	56	29 S.
				90	00	00
⊙ Polar diſtance - -				112	56	29

Complement of lat.	62°	00′	00″	Co. ſecant	0,05407
Polar diſtance	112	56	29	Co. ſecant	0,03579
Zenith diſtance	73	58	47		
Sum -	248	55	16		
Half ſum -	124	27	38	Sine	9,91619
Zenith diſtance	73	58	47		
Difference	50	28	51	Sine	9,88729
				Sum of logs.	19,89334
				Half ſum of logs.	9,94667 is half ſine of the horary angle

From midnight thus 62° 11′ 00″
2
124 22 00 is the true horary angle which turned into time gives the true time at the ſhip to be 8^h 17′ 28″ A. M.

Apparent time at the ſhip as above by watch - 8 15 00 A. M.
Watch to ſlow - - 2 28

Example

Example II.

JANUARY 13*th*, 1788.

At 2^h 34′ 56″ P. M. per watch, observed the ⊙ lower limb to be			37°	46′	00″
Index error of sextant deduce			—	1	00
Altitude of ⊙ lower limb			37	45	00
⊙ Semidiameter	16′ 18″	Difference add +		12	21
Eye's altitude 17½ feet	3 57				
			37	57	21
⊙ Refraction in altitude	1 13	Differ. deduce —		1	6
⊙ Parallax in do.	7				
Centre of ⊙ true altitude			37	56	15
⊙ Zenith distance			52	3	45
Latitude of the ship per account when the altitude was observed			15	27	00 N.
Complement of the latitude			74	33	00
⊙ Declination on the ship's meridian when the altitude was observed, found as per examples for that purpose			21	27	18 S.
			90	00	00
⊙ Polar distance			111	27	18

Complement of lat.	74° 33′ 00″	Co. secant	0,01598
Polar distance	111 27 18	Co. secant	0,03118
Zenith distance	52 3 45		
Sum	238 4 3		
Half sum	119 2 1	Sine	9,94168
Zenith distance	52 3 45		
Difference	66 58 16	Sine	9,96393
		Sum of logs.	19,95277
		Half sum of logs.	9,97638 is half cosine of the horary angle

From noon thus 18° 43′ 30″
2

37 27 00 this is the true horary angle which turned into time gives the true time at the ship to be 2^h 29′ 48″ P. M.

Apparent time at the ship as above by watch	2	34	56 P. M.
Watch too fast		5	8

Example III.

MARCH 3*d*, 1788.

At 9^h 50′ 00″ A. M. per watch, obſerved ☉ lower limb to be		49°	49′	00″
Index error of ſextant deduce -		—	1	00
Altitude of ☉ lower limb . -		49	48	00
☉ Semidiameter - 16′ 10″ } Differ. add		+	11	36
Eye's altitude for 23 feet 4 34 }				
		49	59	36
☉ Refraction in altitude 0 48 } Diff. deduce			—	42
☉ Parallax in do. 0 6 }				
Centre of ☉ true altitude . - -		49	58	54
☉ Zenith diſtance - - -		40	1	6
Latitude of the ſhip when the altitude was obſerved -		33	9	00 S.
Complement of the latitude - - - -		56	51	00
☉ Declination on the ſhip's meridian when the altitude was obſerved, found as per examples for that purpoſe		6	27	7 S.
		90	00	00
☉ Polar diſtance - .		83	32	53

Complement of lat.	56° 51′ 00″	Co. ſecant	0,07715
Polar diſtance	83 32 53	Co. ſecant	0,00276
Zenith diſtance	40 1 6		
Sum -	180 24 59		
Half ſum	90 12 29	Sine	9,99999
Zenith diſtance	40 1 6		
Difference	50 11 23	Sine	9,88542
		Sum of logs	19,96532
		Half ſum of logs	9,98266 is half ſine of the horary angle

From midnight thus 73° 55′ 00″
2
147 50 00 this is the true horary angle which turned into time gime gives the true time at the ſhip thus 9^h 51′ 20″ A. M.

Apparent time at the ſhip as above by watch - -	9	50	00	A. M.
Watch too ſlow -		1	20	

Example IV.

MARCH 7*th*, 1788.

At 2^h 35′ 00″ P. M. per watch, observed ⊙ lower limb to be	43°	6′	00″
⊙ Semidiameter - 16′ 9″ } Differ. add	+	11	35
Eye's altitude for 23 feet 4 34 }			
	43	17	35
⊙ Refraction in altitude 1 1 } Diff. deduce	—		54
⊙ Parallax in do. 0 7 }			
Centre of ⊙ true altitude -	43	16	41
⊙ Zenith distance - -	46	43	19
Latitude of the ship per account when the altitude was observed	34	8	00 S.
Complement of the latitude - - - -	55	52	00
⊙ Declination on the ship's meridian when the altitude was observed, found as per examples for that purpose	4	49	47 S.
	90	00	00
⊙ Polar distance - - -	85	10	13

Complement of lat.	55° 52′ 00″	Co. secant	0,08211
Polar distance	85 10 13	Co. secant	0,00755
Zenith distance	46 43 19		
Sum -	187 45 32		
Half sum	93 52 46	Sine	9,99900
Zenith distance	46 43 19		
Difference	47 9 27	Sine	9,86524
		Sum of logs.	19,94790
		Half sum of logs.	9,97395 is cosine of the horary angle from

Noon thus 19° 38′ 47″
2
39 17 34 this is the true horary angle which turned into time gives the true time at the ship thus - 2^h 37′ 10″ P. M.

Apparent time at the ship as above by watch - -	2	35	00	P. M.
Watch too slow - - -		2	10	

N. B. Whenever you are in one hemisphere, and the sun in the other, or in other words, when you are in north latitude, and the sun has south declination, as in Examples first and second, you add the declinatiod to 90°, and the sum is the sun's polar distance, or distance he is from the north pole: And if you were in south latitude, and the sun had north declination, you would add the declination to 90°, and the sum would be the polar distance, or distance from the south pole; but when you are in north latitude, and the sun has north declination, or when you are in south latitude, and the sun has south declination, as in Examples third and fourth, you deduce the declination from 90°, and the remainder is the sun's polar distance, or distance from the pole of that hemisphere which you are in; and the true apparent time is always found by the sine of the horary angle if the altitude is observed in the forenoon, and by the cosine of the horary angle, if the altitude is observed in the afternoon, as in the foregoing examples.

A TABLE OF THE VARIATION OF THE COMPASS, OBSERVED IN 1786.

Latitudes.			Longitudes *.			Variation of the Compass.					
9°	10′	N	18°	47′	W	Evening Amplitude	12°	00′	W	in	1786.
2	21	N	13	27	W	Morning Do.	11	55	W		do.
3	00	S	18	36	W	do. do.	11	00	W		do.
7	5	S	21	33	W	Evening do.	7	41	W		do.
11	00	S	22	15	W	do. do.	7	00	W		do.
13	22	S	22	00	W	Morning Azimuth	6	7	W		do.
14	23	S	22	10	W	Evening do.	6	00	W		do.
17	50	S	22	00	W	Morning Amplitude	5	00	W		do.
20	23	S	21	45	W	Evening Azimuth	4	30	W		do.
22	47	S	21	00	W	Morning do.	5	7	W		do.
26	13	S	20	55	W	do do.	4	33	W		do.
27	43	S	20	24	W	Evening Amplitude	4	30	W		do.
28	57	S	20	30	W	Morning Azimuth	2	45	W		do.
29	17	S	20	00	W	Evening do.	2	40	W		do.
30	11	S	19	40	W	do. do.	2	30	W		do.
31	5	S	17	57	W	do. do.	3	5	W		do.
32	5	S	16	00	W	Morning Amplitude	3	38	W		do.
33	13	S	13	15	W	do. do.	5	12	W		do.
34	20	S	10	00	W	Evening do.	6	40	W		do.
34	35	S	7	00	W	Morning Azimuth	7	30	W		do.
34	42	S	5	10	W	Evening Amplitude	8	40	W		do.
34	53	S	4	00	W	do. do.	10	00	W		do.
35	22	S	2	40	W	do. do.	10	14	W		do.
35	45	S	1	5	E	do. do.	12	40	W		do.
35	37	S	2	00	E	do. do.	12	50	W		do.
35	32	S	2	26	E	do. do.	14	00	W		do.
36	34	S	6	31	E	Morning do.	15	6	W		do.
36	20	S	11	5	E	Evening do.	17	4	W		do.
35	20	S	14	15	E	Morning Azimuth	18	2	W		do.
34	53	S	16	30	E	Evening do.	21	0	W		do.
34	44	S	16	53	E	Morning do.	22	8	W		do.
34	10	S	17	50	E	Evening do.	22	16	W		do.
34	00	S	18	23	E	do. do.	22	58	W	At anc. in Table Bay, Cape of Good Hope.	
36	35	S	25	00	E	do. do.	25	13	W		do.
36	53	S	35	40	E	do. do.	27	17	W		do.
38	15	S	43	10	E	do. Amplitude	28	19	W		do.
37	58	S	50	45	E	do. do.	28	00	W		do.
38	15	S	54	35	E	Morning Azimuth	27	20	W		do.
37	42	S	60	30	E	Evening Amplitude	25	30	W		do.
37	40	S	63	23	E	do. do.	24	00	W		do.
37	42	S	69	30	E	do. do.	21	00	W		do.
37	40	S	77	30	E	do. Azimuth	19	6	W		do.
37	50	S	80	30	E	do. Amplitude	17	50	W		do.
37	48	S	83	00	E	do. do.	16	40	W		do.
37	20	S	86	00	E	Morning do.	16	20	W		do.
36	30	S	89	00	E	do. Azimuth	15	28	W		do.
34	00	S	92	40	E	Evening do.	11	11	W		do.
13	15	S	107	30	E	do. Amplitude	2	44	W		do.
7	50	S	107	15	E	Morning do.	1	45	W		do.

Variation by Evening Amplitude in Welcome Bay, Straights of Sunday, 52′ 39″ West, and in latitude 6° 20′ North, longitude 105° 55′ East, variation by Evening Azimuths 50′ 00″ West, in 1786; and throughout the China seas the variation is too trifling to affect the course by compass.

* *Longitudes are laid down from Greenwich in Great Britain.*

Variation observed in 1787.

Latitude.	Longitude.	Variation of the Compass.		
23° 15′ S	64° 30′ E	Evening Amplitude	12° 41′ W	in 1787
23 54 S	61 00 E	do. do.	14 44 W	—
25 27 S	58 20 E	do. do.	16 1 W	—
26 5 S	57 20 E	Morning do.	17 45 W	—
26 57 S	56 00 E	do. do.	19 25 W	—
28 40 S	51 00 E	Evening Azimuth	20 13 W	—
30 50 S	45 40 E	Morning do.	24 20 W	—
31 30 S	44 00 E	Evening do.	25 11 W	—
33 50 S	40 00 E	do. Amplitude	27 36 W	—
34 46 S	38 00 E	Morning do.	27 43 W	—
35 20 S	33 00 E	do. do.	28 21 W	—
34 54 S	32 15 E	Evening Azimuth	27 00 W	—
34 14 S	30 39 E	do. Amplitude	26 49 W	—
34 44 S	29 00 E	do. do.	26 47 W	—
35 30 S	21 30 E	do. do.	23 30 W	—
34 10 S	17 00 E	Morning do.	21 30 W	—
29 10 S	9 25 E	do. do.	20 00 W	—
21 2 S	3 33 W	do. Azimuth	14 35 W	—
16 50 S	10 00 W	do. do.	13 21 W	—
15 40 S	12 20 W	Evening do.	12 00 W	—
14 36 S	13 30 W	do. do.	11 1 W	—
12 20 S	16 00 W	Morning do.	10 27 W	—
11 15 S	17 16 W	Evening do.	10 21 W	—
10 00 S	18 30 W	do. do.	9 54 W	—
8 22 S	20 18 W	do. do.	8 40 W	—
5 20 S	23 40 W	do. do.	7 51 W	—
3 33 S	25 23 W	do. do.	7 29 W	—
2 28 S	26 30 W	do. do.	7 14 W	—
0 5 S	28 26 W	do. do.	5 20 W	—
1 20 N	29 30 W	do. do.	4 57 W	—
2 30 N	30 25 W	do. do.	4 37 W	—
14 30 N	49 38 W	do. do.	00 16 E	—
22 9 N	62 00 W	do. do.	00 54 E	—
32 22 N	70 00 W	do. do.	00 47 W	—
37 35 N	74 45 W	do. do.	2 57 W	—

Variation observed in 1788.

Latitude.	Longitude.	Variation of the Compass.		
16° 00′ N	31° 00′ W	Evening Amplitude	8° 30′ W	in 1788
11 5 N	29 8 W	do. do.	9 6 W	—
5 9 S	25 14 W	do. do.	6 35 W	—
6 30 S	25 48 W	do. do.	6 10 W	—
11 30 S	29 00 W	Morning do.	2 45 W	—
27 17 S	27 6 W	do. do.	1 33 W	—
32 15 S	23 7 W	do. do.	0 13 E	—
33 00 S	17 34 W	Evening Azimuth	2 52 W	—
35 15 S	8 4 W	do. do.	8 18 W	—
36 2 S	1 11 E	do. do.	12 45 W	—
35 45 S	6 35 E	Morning Amplitude	15 57 W	—
34 42 S	15 30 E	Evening do.	20 9 W	—
34 00 S	18 23 E	do. Azimuth	22 47 W	At anchor in Table Bay, Cape of Good Hope.

Variation observed in 1788.

Latitude.	Longitude.	Variation of the Compass.			
36° 31′ S	25° 50′ E	Evening	Amplitude	25° 30′ W	in 1788
38 00 S	70 35 E	do.	do.	21 10 W	—
29 7 S	95 45 E	do.	do.	9 20 W	—
23 20 S	100 31 E	do.	do.	3 45 W	—
17 10 S	102 30 E	do.	do.	3 35 W	—
8 12 S	105 40 E	do.	do.	00 54 W	—
6 44 S	105 30 E	do.	do.	00 49 W	Near Java Head, Straights of Sunda.

Variation observed in 1789.

Latitude.	Longitude.	Variation of the Compass.			
12° 11′ S	103° 00′ E	Evening	Amplitude	1° 56′ W	in 1789.
14 00 S	100 30 E	do.	do.	2 11 W	—
18 00 S	83 15 E	do.	do.	3 2 W	—
20 30 S	74 00 E	do.	do.	6 35 W	—
24 5 S	63 00 E	Morning	do.	11 9 W	—
27 00 S	55 30 E	do.	do.	18 54 W	—
30 41 S	47 5 E	Evening	Azimuth	24 20 W	—
35 00 S	35 15 E	do.	do.	28 29 W	—
35 3 S	27 15 E	do.	Amplitude	27 37 W	—
35 20 S	25 00 E	do.	do.	25 50 W	—
35 30 S	23 32 E	do.	do.	24 23 W	—
31 00 S	10 28 E	do.	do.	19 41 W	—
21 30 S	2 2 W	do.	do.	15 48 W	—
18 23 S	7 1 W	do.	do.	13 20 W	—
15 00 S	13 00 W	do.	do.	12 00 W	—
12 40 S	15 55 W	do.	do.	10 52 W	—
9 30 S	20 00 W	do.	do.	8 20 W	—
15 5 N	51 4 W	Morning	do.	00 59 E	—
30 25 N	69 30 W	Evening	do.	00 4 E	—
35 40 N	72 20 W	do.	do.	1 52 W	—
38 34 N	75 5 W	do.	do.	2 41 W	—
00 51 N	25 30 W	do.	do.	7 50 W	—
00 19 N	25 35 W	do.	do.	7 50 W	—
00 46 S	25 30 W	do.	do.	7 49 W	—
5 17 S	27 23 W	do.	Azimuth	5 31 W	—
6 12 S	27 46 W	do.	Amplitude	5 6 W	—
7 30 S	28 19 W	Morning	do.	4 11 W	—
20 28 S	31 5 W	Evening	do.	1 16 W	—
25 30 S	29 8 W	do.	do.	00 57 E	—
26 56 S	28 5 W	do.	do.	00 42 E	—
28 58 S	25 47 W	do.	do.	00 25½ E	—
31 30 S	24 39 W	do.	do.	00 7 W	—
36 00 S	2 50 W	do.	do.	10 49 W	—
35 50 S	3 26 E	do.	do.	15 51 W	—
35 56 S	10 26 E	Morning	do.	17 13 W	—
34 46 S	14 30 E	Evening	do.	21 5 W	—
34 29 S	17 40 E	do.	do.	22 15 W	—
34 6 S	37 40 E	Morning	do.	28 20 W	—
23 49 S	43 00 E	Evening	do.	23 31 W	—
20 00 S	42 40 E	Morning	do.	22 34 W	—
12 45 S	44 30 E	do.	do.	18 10 W	—
3 4 N	50 2 E	Evening	do.	10 00 W	—
4 30 N	51 45 E	do.	do.	8 15 W	—

Variation observed in 1790.

Latitude.	Longitude.	Variation of the Compass.			
1° 30′ S	86° 35′ E	Evening Amplitude		1° 55′ E	in 1790.
8 50 S	87 2 E	Morning	do.	00 33 E	—
9 30 S	87 40 E	do.	do.	00 17 E	—
11 36 S	86 00 E	do.	do.	00 7 W	—
20 32 S	66 00 E	Evening	do.	9 30 W	—
23 20 S	60 49 E	do.	do.	13 21 W	—
24 28 S	59 7 E	Morning	do.	15 28 W	—
24 51 S	58 26 E	do.	do.	17 41 W	—
25 40 S	55 5 E	Evening	do.	19 15 W	—
26 10 S	53 3 E	do.	do.	19 52 W	—
27 5 S	50 50 E	do.	do.	20 17 W	—
29 6 S	43 23 E	Morning	do.	24 45 W	—
30 6 S	40 58 E	Evening	do.	26 36 W	—
30 56 S	38 37 E	do.	do.	26 58 W	—
31 20 S	36 15 E	do.	do.	28 3 W	—
31 43 S	33 12 E	do.	do.	29 00 W	—
32 00 S	32 00 E	do.	do.	28 24 W	—
35 41 S	23 23 E	Morning	do.	25 29 W	—
31 34 S	13 23 E	Evening	do.	21 49 W	—
30 2 S	11 30 E	Morning	do.	21 12 W	—
27 5 S	8 18 E	do.	do.	19 38 W	—
26 23 S	7 00 E	Evening	do.	18 55 W	—
24 50 S	4 24 E	do.	do.	18 21 W	—
11 41 S	12 50 W	do.	do.	12 30 W	—
10 43 S	15 00 W	Morning	do.	12 7 W	—
4 30 S	24 00 W	Evening	do.	7 49 W	—
3 21 S	24 52 W	do.	do.	7 42 W	—
1 43 S	25 40 W	do.	do.	7 5 W	—
3 36 N	33 28 W	do.	do.	4 00 W	—
14 35 N	56 54 W	do.	do.	1 49 E	—
19 38 N	63 37 W	do.	do.	00 4 E	—

Variation observed in 1792.

Latitude.	Longitude.	Variation of the Compass.			
39° 50′ N	14° 57′ W	Evening Amplitude		23° 46′ W	in 1792.
34 14 N	18 7 W	Morning Azimuth		19 45 W	—
14 53 N	23 35 W	Evening	do.	13 28 W	—
5 32 N	25 00 W	do.	do.	11 27 W	—
00 53 N	25 30 W	do.	do.	6 59 W	—
8 15 S	32 52 W	do.	Amplitude	2 15 W	—
10 15 S	33 32 W	do.	do.	00 56 W	—
11 45 S	34 6 W	do.	do.	00 27 W	—
14 56 S	35 22 W	do.	do.	00 6 E	—
25 25 S	29 30 W	do.	do.	1 12 W	—
35 30 S	17 00 W	do.	do.	3 32 W	—
36 42 S	6 47 E	Morning	do.	15 34 W	—

Variation observed in 179[illegible]

Latitude.	Longitude.	Variation of the Compass.			
38° 33′ S	19° 33′ E	Evening Amplitude	23° 19′ W		in 1792.
37 50 S	32 23 E	do.	do.	26 57 W	—
37 46 S	39 45 E	do.	do.	27 54 W	—
35 24 S	65 52 E	do.	do.	22 4 W	—
23 47 S	77 5 E	do.	do.	8 19 W	—
3 14 S	84 20 E	do.	do.	2 34 E	—
00 6 S	83 00 E	do.	do.	2 45 E	—
21 12 S	62 58 E	Morning Azimuth		10 32 W	—
24 27 S	54 31 E	do.	do.	16 48 W	—
26 13 S	51 53 E	Evening Amplitude		19 36 W	—
30 5 S	40 27 E	do.	do.	27 6 W	—
30 18 S	39 57 E	do.	do.	27 8 W	—
33 30 S	29 36 E	do.	do.	26 40 W	—
36 1 S	27 55 E	do.	do.	27 20 W	—
35 15 S	20 50 E	do.	do.	23 50 W	—
23 44 N	32 15 W	do.	do.	7 29 W	—
34 53 N	32 41 W	do.	do.	14 47 W	—

N. B. In or about the parallel of $4°\frac{1}{2}$ South latitude the variation decreases from about the meridian of Cape Verde, on the coast of Africa 32′ to every degree of longitude, as you sail westward, until on a meridian with the NE. Cape of Brazil.

CHAPTER XVIII.

A GENERAL ACCOUNT OF VARIABLE WINDS, PARTICULAR WEATHER, CALMS, &c. &c.

Of Variable Winds, &c.

FROM the latitude of 30° North, towards the North Pole, and from the latitude of 30° South, towards the South Pole, in both hemiſpheres, the winds may be conſidered as variable all the year; though at different ſeaſons they prevail and blow pretty ſteady from particular quarters, according to the ſituation of the coaſts, ſhores, &c. In the northern hemiſpheres, during moſt of the ſummer months, and early in the autumn, within the above limits, or rather northward of the 30° of latitude, the winds blow pretty generally all over the Atlantic ocean from the ſouthward; indeed I may ſay from SSE. to WSW. but towards the middle of September, and until the end of November, they are very variable, though frequently eaſterly, and often blowing up violent ſtorms and hurricanes, accompanied with an abundance of rain. During the winter months the winds are chiefly from the northward, NW. and WNW. blowing very ſtrong; often hard gales, with hail, rain, ſnow, and alternately fine, clear, ſerene, and wholeſome weather. In the ſpring the winds are more changeable than in the winter; indeed they blow in general from the ſame quarters as in the autumn, with ſimilar weather to September: So that upon the whole, the winds and weather all over the Atlantic ocean from the above limits, are very variable and uncertain throughout the year; for even in the middle of ſummer, we have often violent gales of wind from different quarters; and at other times ſevere ſqualls, with much rain, thunder, lightning, &c. though for the moſt part of the ſummer ſeaſon we are favoured with gentle breezes, moderate gales, and pleaſant weather. As for calms, we cannot complain much in theſe limits, at any ſeaſon of the year; and the currents in the open ſea are variable, and in general but ſmall, except the gulph ſtream, which is particularly deſcribed.

In the ſouthern hemiſphere, the winds from 30° South, towards the South Pole, are variable, and pretty much the ſame as in the northern hemiſphere. In their winter blowing from towards the South Pole, the SW. and WSW. as in the northern hemiſphere, they blow in our winter from the North Pole, NW. and WNW. In the ſummer of the ſouthern hemiſphere, the winds are from the northward generally; which is there from towards the Equator; as in the northern hemiſphere they blow from the ſouthward, in the ſummer ſeaſon, as before mentioned; which with us is from the Equator. In the ſpring and autumn of the ſouthern hemiſphere, and particularly about the Equinoxes, the wind and weather are very much like what we have at thoſe ſeaſons of the year; but it muſt be obſerved, that the ſeaſons of the two hemiſpheres are the oppoſite of each other; that is, when it is winter in the one, it is ſummer in the other. As for the gales, calms, currents, particular weather, &c. in the two hemiſpheres, they are ſo nearly alike at the different ſeaſons in the open ſea, that a deſcription of the one in the above limits, anſwers pretty well for the other.

Of the North-east Trade wind.

Between Africa and America, about the 30th degree of North latitude, the NE. trade wind may be looked for near the African coaſt and Canary Iſlands; but farther weſtward than theſe iſlands, you ſeldom meet this trade until you get more to the

the ſouthward, and ſometimes not until you arrive near the Tropic of Cancer, commonly called the Northern Tropic: this trade wind blows from theſe northern limits all the way down to the coaſt of America, through the Weſt India iſlands, and extends itſelf as far South as about the latitude of 3° North, except in a ſmall tract of ſea which forms nearly an oblong. From the longitude of 13° Weſt, to that of 22° Weſt from Greenwich, and between the latitudes of 10° and 3° North, in which ſmall ſpace there is nothing but light airs, variable, with an almoſt conſtant calm, deluges of rain, and the moſt tremendous thunder and lightning known in any part of the globe; ſtrong currents, and often violent tornadoes, in which a ſhip cannot ſhow a rag of canvaſs for an hour or two; after which it falls of a ſudden calm, and often continues ſo, that a veſſel will ſcarcely have ſteerage way for ten or fifteen days together, and ſometimes much longer: here the currents are very variable and ſtrong, ſometimes ſetting to the weſtward, at other times to the eaſtward, and frequently in all other directions. This tract of ſea ſhould be avoided by all ſhips going to, or returning from, the Cape of Good Hope, or beyond it; having paſſed through once, when I experienced the moſt diſagreeable fortnight of my life, I can with the more energy recommend the avoiding it.

Except this particular tract of ſea, the trade wind is within the limits deſcribed very general, blowing pleaſant breezes, with hazy weather, intermixed with ſome ſqualls of wind and rain, and now and then a day or two calm; but calms are not very frequent, but when approaching that ſpace between the trade and variable winds, except during the hurricane ſeaſon.

Hurricanes are ſeldom met with in this tract of ſea, but among or near the Iſlands, where they are generated and bred in their mountains; and they are moſtly confined to the months of July, Auguſt, September, and October; though what is called ſevere norths, ſometimes blow in the winter ſeaſon.

Between the latitudes of 3° North, and 3° South, and every where about the Equator, the weather is ſultry and uncertain, with variable winds moſtly, and much rain, accompanied with thunder, lightning, and frequent calms. Here ſhips bound to or from India, have often an opportunity of filling up their water, and catching an abundance of fiſh, ſuch as Albacores, Dolphins, Skip-Jacks, Bonettas, King-fiſh, and a variety of others; and hereabouts commanders and officers of ſhips ſhould carefully avoid expoſing their men more than is abſolutely neceſſary, as by proper precautions in this tract of ſea, the ſcurvy may be avoided perhaps during the whole voyage, as it is here that frequently the ſeeds of it are generated, by the crew's being unneceſſarily expoſed to the weather, without proper food, and without a proper attention being paid to the drying of their clothes, when opportunities offered, and keeping their appartments ſweet, clean, and dry, by frequently waſhing with hot vinegar, burning powder and fumigating below, making of fires, &c.

In this tract of ſea, to the eaſtward of the 13th degree of Weſt longitude, towards Guinea, the current runs generally very ſtrong to the eaſtward; and to the weſtward of that meridian, it often runs rapidly to the weſtward; and the more ſo as you approach Ferdinando Norono, and the NE. cape of the Brazil: but though this is the general courſe of the current here, it ſometimes changes, and runs northerly and ſoutherly.

Of the South-East Trade wind.

Between the latitudes of 3° North, and 3° South, the SE. trade wind is frequently met, which blows a charming breeze, with ſmooth water in general, all over the Ethiopic ſea, as far as the Tropic of Capricorn, commonly called the Southern Tropic; and often as far as the 30th degree of South latitude, with pleaſant weather, and but few calms. Although this is called the SE. trade wind, it is frequently at S*b*E. and ESE. and as you get to the ſouthward at Eaſt; and ſo it veers about until it gets round to the northward, and becomes quite variable, in the ſame manner as the NE. trade in the northern hemiſphere veers from NE. to SE. and ſo round to the ſouthward, until it becomes variable.

In

In this tract of sea the current runs generally to the eastward, under the African coast (except about the Cape of Good Hope); but to the westward of St Helena it runs most commonly to the westward.

Winds to the Eastward of the Cape of Good Hope.

After lowering the latitude under 30° South, to the eastward of the Cape of Good Hope, the westerly winds grow faint, and you speedily meet the SE. trade wind again, as you had it in the Ethiopic sea: this trade wind is generally confined to between the latitudes of 30° South, and 10° South, between Madagascar and New Holland, where it blows a steady breeze most of the year, except in and about the isles of France and Bourbon; there we find sometimes a little variation during the hurricane season, which is from about a month before and after Christmas: and during the months of May to November, this wind from the SE. extends itself to within one or two degrees of the Equator; but from November to April, between one and two degrees South, as far as 12° South, and from the coast of Africa to Sumatra, the NW. monsoon blows from NW. to SW. with heavy weather and much rain; and this monsoon is continued as far as the Celebes and Spice Islands.

From between one and two degrees of South latitude, and over the whole Bay of Bengal, and from Africa to Sumatra, the NE. monsoon prevails from October to April, and during the other half year, from April to October, the SW. monsoon prevails: both the NE. and SW. monsoons extend themselves over the Chinese sea, and to the eastward of Formosa, but with great variation, according to the bending of the different coasts, straights, &c. On the Malabar coast, the SW. monsoon brings hard gales, much rain, and bad weather; and the NE. monsoon brings quite the reverse, perhaps as fine weather as in any part of the globe. On the Coromandel coast, the SW. monsoon brings the fair weather season, and the NE. the foul. In the Chinese seas, the weather is pretty much the same at the same seasons, as on the Malabar coast; indeed, throughout India (the Coromandel coast excepted) the SW. monsoon produces bad weather, and the NE. monsoon fine weather. The change of these monsoons is frequently attended with long and disagreeable calms, and dreadful tuffoons. As for the currents in every part of these seas, and throughout all those seas of India and China, they set with the monsoons generally, and so strong, that it is very difficult for a ship that once falls to leeward of her consigned port, to get up again. To describe minutely the petty monsoons, and variable winds, in the different gulphs, straights, and passages of India, would fill a large volume of itself: Suffice it to say, that the passage between Madagascar and the main land of Africa, must never be entered, unless in a case of the greatest necessity, by a ship bound to India, but from the months of April to August; during which time the weather is pretty fine, and the winds from SE. to WSW. for in October or the beginning of November, the NE. and northerly winds set in, and often blow up violent storms all the way from the Comero islands, until past the South part of Madagascar: and in every situation like this, not only in India, but throughout the globe, particular winds are generated and formed, and consequently blow often different from neighbouring winds, that are not obstructed or influenced by such gulph or particular situation.

This account of winds being intended merely to accompany my different routes on the chart, I trust they will be found abundantly sufficient for to guide those who have not had an opportunity of becoming acquainted with them by experience.

REMARKS

AND

INSTRUCTIONS

RELATING TO THE

Making of Lunar Obſervations.

Blank page retained for pagination

REMARKS & INSTRUCTIONS

RELATING TO THE MAKING OF

Lunar Obſervations.

AFTER the mariner has ſtudied and perfected himſelf in the uſe of all the neceſſary books and tables (relating to finding the longitude) publiſhed by order of the Commiſſioners of Longitude in Great Britain (for no others are ſufficiently exact, or printed with equal care), viz. The Nautical Almanac, The Requiſite Tables, and Shepherd's Tables, &c. he ſhould endeavour to get a complete ſextant graduated to quarter minutes, or to half minutes, at moſt, with a ſcrew to move the index along the arch; Ramſden's intire braſs ſextants are by far the beſt, but it is not an eaſy matter to procure one of them, as I was near four years after I had wrote for mine before I got it; and moſt people, I have ſince found, have met with the ſame difficulty. Troughton is conſidered a very ingenious artiſt, and his inſtruments are graduated by Ramſden's longitude machine; ſo that if the glaſſes are good, that is, if they are entirely clear and have even ſurfaces, and the whole is carefully made, and well put together, I ſhould conſider them in point of perfection, to ſtand next to Ramſden's, Having one of Ramſden's complete and entire braſs ſextants, when I was in London laſt I got Troughton to make me an octant, which he graduated to half minutes; and I find her to be the beſt inſtrument of the kind I ever uſed, but not equal to Ramſden's ſextant for meaſuring diſtances between

celeſtial

celeſtial objects, which requires the greateſt imaginable nicety. The mariner being thus furniſhed with a perfect inſtrument, ſhould next learn to underſtand well the principles on which ſhe is conſtructed, ſo as to be enabled to adjuſt and keep her in perfect order, for the purpoſe of making the obſervations which I ſhall here deſcribe.

Previous to the making of obſervations of any kind, the inſtrument muſt be adjuſted, and index error found agreeable to Mr Ramſden's directions, which accompany the ſale of all that go out of his ſhop. That very ingenious artiſt has ſaid every thing neceſſary in his pamphlet on the ſubject of adjuſtment; it is therefore needleſs for me to add more than to recommend the ſtricteſt attention to his directions; for if the inſtrument is not well adjuſted, and the index error very nicely aſcertained from time to time, there can be no dependence on the angular diſtance meaſured. The various adjuſtments neceſſary for both ſextants and quadrants, of the more common kind than is here mentioned, I have taken for granted, that every one will underſtand before he attempts to make obſervations for the longitude; and therefore it is unneceſſary for me to dwell on that head, eſpecially as the maker's inſtructions accompany the ſale of them; but I muſt beg leave to obſerve, that there are but few inſtruments ſufficiently exact in their graduation, &c. &c. to meaſure a diſtance for the longitude, that ought to be relied upon, except thoſe made by Ramſden and Troughton: therefore whoever makes uſe of any others, ſhould prove them well, all along the arch, and in every other reſpect, before they place an implicit reliance on them.

Having a good inſtrument well adjuſted, and its index error very nicely found, the firſt thing neceſſary to be done is to take an altitude of the ſun or ſtar, to find the true apparent time at the ſhip, whereby the watch is corrected; after which you proceed to meaſure the diſtance between the objects from which your obſervation is to be made, having a perſon to hold the watch, and note down the hour, minutes, and ſeconds of time when you call out; and two others if you pleaſe to take the altitudes of the ſun and moon, or the ſtar and moon (at the ſame inſtant of time) which ever are the objects whoſe diſtance you are obſerving. Otherwiſe

by

by having the true apparent time at the ſhip found by the firſt obſervation made for that purpoſe, as before mentioned, the altitudes of each object may be minutely found by calculation; which, although more troubleſome, is certainly much more certain, unleſs you have aſſiſtants with good inſtruments, and whoſe candour can be relied upon, which is not always the caſe.

I very often ſet the inſtrument ſo, that when I am meaſuring a diſtance, that the limbs come in contact, exactly at the even minute; and this is eaſily done with a little preparation before-hand; and I conceive it by far the beſt method, as the perſon holding the watch cannot miſtake a ſingle ſecond, when he is directed to call out at the even minute; but in the other caſe it is poſſible he may miſtake two or three ſeconds, unleſs great precaution is given, and ſpecial care taken. It muſt be obſerved, that all ſextants are, or ought to be, furniſhed with an apparatus, ſo as to throw the teleſcope out on a line with the centre of the clear part of the little ſpeculum, or horizon glaſs, which muſt be done when a diſtance is meaſured, but when the inſtrument is to be adjuſted, or the index error found, the teleſcope muſt be ſcrewed nearly in to the plane of the inſtrument.

In meaſuring the diſtance with Ramſden's or any other ſextant, or in ſhort, taking an altitude, &c. by day or night, I would always recommend the uſe of the inverted teleſcope; the field is much larger, the limbs of the objects can be much better defined; in ſhort, the great difference between that teleſcope, and the one that ſhews the objects erect, or in their natural poſition, and the plain tube, is hardly to be conceived by perſons who have not had the experience and knowledge of the uſe of them all; and it only requires a little practice to make its uſe become as eaſy and familiar as either of the others.

The diſtance between the ſun and moon's neareſt limbs, are always meaſured; and the diſtance between the moon's enlightened or defined limb, and the ſtar's, whether that limb be the neareſt to the ſtar or the fartheſt from them. Three diſtances ſhould at leaſt be taken, and indeed as many more as can conveniently be taken within the ſpace of a quarter of an hour. The limbs of the objects meaſured muſt be brought into contact

in the centre of the little ſpeculum, looking up at the moon and letting down the ſun's neareſt limb to her. If the obſervation is making by a ſtar, look at the ſtar, and let the moon's neareſt or fartheſt limb, whichever is the enlightened or defined one, (as before mentioned) down to him. In uſing the inverted teleſcope, there are two wires, in the centre of which the limbs of the objects muſt be brought into contact (ſee Ramſden's inſtructions); the greateſt nicety muſt be attended to in meaſuring a diſtance, as one minute of diſtance is = to half a degree of longitude.

When the ſun is eaſt of the moon, if the diſtance is over meaſure one minute, it will cauſe the longitude given to be half a degree more eaſterly than it really is; but when the ſun is weſt of the moon, if the diſtance is over meaſured one minute, it will cauſe the longitude given to be half a degree more weſterly than it really is: conſequently if the diſtance is under meaſured, the error will in both caſes be vice verſa.

When an obſervation is nicely made, as here directed, proceed to work it according to the accompanying examples, obſerving that the day at Greenwich, as laid down in the Nautical Ephemeris, which is called the aſtronomer's day, begins 12 hours later than the civil day; that it commences at noon on the common day, which is 24 hours later than the ſea-day by log book, and is counted up to 24 hours. The diſtance of the ſun and moon, or ſtar and moon, are calculated for every three hours at Greenwich, and are ſet down accordingly in the Nautical Almanac for 3 hours, 3^h 6^h 9^h 12^h 15^h 18^h 21^h and noon, great care muſt be taken not to confound the common day and aſtronomer's day together, eſpecially in a high longitude, either eaſt or weſt; becauſe a mariner may be in a ſituation that when it is noon with him it may only be midnight at Greenwich, and vice verſa; but the difference of longitude between the ſhip and Greenwich will always be a ſure guide to him if attended to. When the time at Greenwich is found to be greater than at the ſhip, the longitude is weſt; but when the time at Greenwich is leſs than at the ſhip, the longitude is eaſt. When the ſun is eaſt of the moon, and the apparent diſtance of centres is greater at the ſhip than at Greenwich, the proportional time found by the number of ſeconds, that the ſun and moon approach near

each

each other in 3 hours or 180′, and the number of ſeconds that the difference of centres between the ſhip and Greenwich gives, muſt be deduced from the number of hours at the head, under which the Greenwich centres was found to correſpond on that day neareſt to the ſhip's, in the Nautical Almanac, and the reſult will be the true apparent Greenwich time. But if the true apparent centres are leſs at the ſhip than at Greenwich, ſuch proportional time muſt be added to the head under which the Greenwich centres were found in the Nautical Almanac, and the reſult will be the true apparent Greenwich time. When the ſun is weſt of the moon, and the true apparent diſtance of centres is greater at the ſhip than at Greenwich, the proportional time found by the number of ſeconds that the ſun and moon ſeparates from each other in three hours, or 180′, and the number of ſeconds that the difference of centers between the ſhip and Greenwich gives, muſt be added to the head under which the Greenwich centres was found in the Nautical Almanac, and the reſult will be the true apparent Greenwich time. But if the true apparent centres are leſs at the ſhip than at Greenwich, ſuch proportional time muſt be deduced from the number of hours, at the head under which the Greenwich centers were found in the Nautical Almanac, and the reſult is the true apparent Greenwich time. Care muſt be taken in all lunar obſervations to find minutely the moon's horizontal parallax and ſemidiameter exactly for the time of making the obſervation at the ſhip's meridian, as per the examples for that purpoſe, and the augmentation of the moon's ſemidiameter muſt always be added to the ſemidiameter found, and the ſum applied to the moon's altitude according as the upper or lower limb is taken.

The true apparent time at the ſhip muſt be found when the lunar obſervations are made for aſcertaining the true time at Greenwich by the ſun's altitude, as per the different examples ſhewn; and the nearer the ſun, moon, and ſtar are eaſt or weſt, the better in making all and every kind of obſervations (meridional ones excepted) provided they are above ſix degrees high: but in no caſe muſt they be nearer the meridian than two points.

Having

Having annexed a great variety of examples, and endeavoured to ſimplify the work, attending the neceſſary obſervations, &c. for the longitude, by pointing out and explaining every particular that appears to me poſſible, or that can in any wiſe aſſiſt the young navigator, in making himſelf acquainted with the invaluable art of determining the longitude at ſea, which enables the expert and ſkilful mariner to mark the ſhip's place from time to time minutely on the chart :—

I ſhall by way of concluſion, recommend to him the two following methods of clearing the heavenly bodies from refraction and parallax. Firſt by Mayer's, commonly called Shepherd's tables; and ſecondly, by Mr Dunthorn's methods, uſing *ſix places of the log ſines, beſides the index*; of both theſe methods, there are a great variety of my obſervations, inſerted in this book (as well as of ſeveral others) by way of examples (as abovementioned); as theſe are moſt unqueſtionably two of the beſt methods in practice, it is certainly well to underſtand them both, as the one always ſerves to prove the other, when obſervations are worked by them both.

But thoſe who do not underſtand the ſigns and the alteration of caſes in the change of reduction and correcting logarithms, &c. &c. in Mayer's or Shepherd's tables, ſhould adhere to Mr Dunthorn's method altogether; as it has no other diſtinction of caſes, which my obſervations will ſhew, than the following:

When the ſun's or ſtar's altitude is greater than the moon's, the ſum of the correction of the moon's altitude, and the difference of ſun's refraction and parallax muſt be deduced from the difference of their apparent altitudes; but when the ſun's or ſtar's altitude is leſs than that of the moon, this ſum muſt be added to the difference of their apparent altitudes, as I invariably find the index error of my inſtrument to a ſecond or two of a minute, by repeated obſervations made for that purpoſe, as well as the error ariſing from a want of parallaſm; and as I work all my lunar obſervations by at leaſt both the methods which I have here recommended, and ſeldom find the difference in the apparent diſtance amount to more than from one to ten ſeconds of a minute, I am always ſure to aſcertain my

longitude when the mean of a number of ſetts of diſtances are taken as minutely as the latitude; and I think I can with great certainty ſay, that in the tables of day's works throughout thoſe long and tedious Aſiatic voyages which I have for ſome years paſt proſecuted, notwithſtanding the currents are ſo very ſtrong and various, that the longitude does not in any one inſtance err from the truth one quarter of a degree.

N. B. It is abſolutely neceſſary that a ſmall magnifying-glaſs ſhould be procured with the ſextant's other apparatus, to aſſiſt in reading off the diſtance meaſured with greater certainty.

Although the obſervation by the ſun or ſtar for finding the true time at the ſhip, and correcting the watch thereby, is generally made a few minutes before a ſett of diſtances is taken, it amounts to the ſame thing if it is made a few minntes after thoſe diſtances are obſerved, ſo that it is minutely done.

Blank page retained for pagination

TABLE for turning time into degrees of Longitude, *viz.* As one hour of time is = to 15° of longitude, one minute of time = to 15′ of longitude; and one second of time = to 15″ of longitude: So 15° of longitude is = to one hour of time: 15′ of longitude is = to one minute of time, and 15″ of longitude = to one second of time.

Hours of Time.	Degrees of longitude.	Minutes of Time.	Degrees & Minutes of Longitude.		Seconds of Time.	Minutes & Seconds of Longitude.	
H	°	′	°	′	″	′	″
1	15	1		15	1		15
		2		30	2		30
		3		45	3		45
2	30	4	1		4	1	
		5	1	15	5	1	15
3	45	6	1	30	6	1	30
		7	1	45	7	1	45
4	60	8	2		8	2	
		9	2	15	9	2	15
		10	2	30	10	2	30
5	75	11	2	45	11	2	45
		12	3		12	3	
6	90	13	3	15	13	3	15
		14	3	30	14	3	30
		15	3	45	15	3	45
7	105	16	4		16	4	
		17	4	15	17	4	15
8	120	18	4	30	18	4	30
		19	4	45	19	4	45
		20	5		20	5	
9	135	21	5	15	21	5	15
		22	5	30	22	5	30
10	150	23	5	45	23	5	45
		24	6		24	6	
11	165	25	6	15	25	6	15
		26	6	30	26	6	30
		27	6	45	27	6	45
12	180	28	7		28	7	
		29	7	15	29	7	15
13	195	30	7	30	30	7	30
		31	7	45	31	7	45
14	210	32	8		32	8	
		33	8	15	33	8	15
		34	8	30	34	8	30
15	225	35	8	45	35	8	45
		36	9		36	9	
16	240	37	9	15	37	9	15
		38	9	30	38	9	30
17	255	39	9	45	39	9	45
		40	10		40	10	
18	270	41	10	15	41	10	15
		42	10	30	42	10	30
		43	10	45	43	10	45
19	285	44	11		44	11	
		45	11	15	45	11	15
20	300	46	11	30	46	11	30
		47	11	45	47	11	45
		48	12		48	12	
21	315	49	12	15	49	12	15
		50	12	30	50	12	30
22	330	51	12	45	51	12	45
		52	13		52	13	
23	345	53	13	15	53	13	15
		54	13	30	54	13	30
		55	13	45	55	13	45
24	360	56	14		56	14	
		57	14	15	57	14	15
		58	14	30	58	14	30
		59	14	45	59	14	45

Example I.

A Lunar obſervation made January 1ſt, 1791, by ☉ eaſt of the ☽, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 7h 19′ 00″ A.M. by W.	Obs'd ☉ & ☾ near. limb. 47° 2′ 30″	☾ Low. limb. 68° 53′ 00″	Alt. ☉ low. lim. 26° 2′ 00″
At 7 25 00 do.	do. - 47 00 00	do. 70 6 00	do. 27 20 00
At 7 29 00 do.	do. - 46 59 00	do. 70 54 00	do. 28 10 00
At 7 32 00 do.	do. - 46 58 00	do. 71 30 00	do. 28 51 00
29 45 00 Sum.	Sum - 187 59 30	Sum - 281 23 00	Sum - 110 23 00
7 26 15 Mean.	Mean - 46 59 52	Mean - 70 20 45	Mean - 27 35 45
2 13 W. too faſt.	Index error deduce 1 00	Index error deduce 1 00	Index error deduce 1 00
7 24 2 true apparent time at the ſhip when the obſervation was made.	Neareſt limbs - 46 58 52 ☉ Semidiameter - 16 19 ☾ Semidiameter 16′ 23″ } 16 38 Aug. of ſem. in alt. 15 } Apparent centres - 47 31 49	☾ Lower limb 70 19 45 ☾ Semid. & aug. 16 38 70 36 20 Eyes alt. or dip for 30 feet 5 14 ☾ App. alt. 70 31 09	☉ Lower limb 27 34 45 ☉ Semidiameter 16 19 27 51 4 Eyes alt. or dip for 30 feet 5 14 ☉ App. alt. 27 45 50

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. logs
☾ Horiz. parallax 60′ 5″ Exceſs above 53′ is 7 5				
Apparent centres 47 ☾ Apparent alt. 70 ☉ Apparent alt. 27	+ 15′ 6″	+ 589		
Apparent centres 47 ☉ App. alt. incr. 60 28 ☾ Apparent alt. 70	+ 13′ 55″	+ 628	— 71″	+ 39
Apparent centres 47 ☾ Alt. incr. 60 71 ☉ Apparent alt. 27	+ 15′ 24″	+ 580	+ 18″	— 9
App. cent. incr. 60 48 ☾ Apparent alt. 70 ☉ Apparent alt. 27	+ 14′ 01″	+ 625	— 65″	+ 36

If 60′ incr. of ☉ alt. gives — 71″ of a red. & + 39 of a corr. log. odd min. of ☉ alt. gives reduct. — 54 & corr. log. + 30
If 60′ incr. of ☾ alt. gives + 18 of a red. & — 9 of a corr. log. odd min. of ☾ alt. gives reduct. + 9 & corr. log. — 5
If 60′ incr. of ☉ & ☽ cent. g. — 65 of a red. & + 36 of a corr. log. odd min. of ☉ & ☽ cent. g. red. — 35 & corr. log. + 19

This is the reduction and correcting logarithm for the odd min. of ☉ alt. ☾ alt. and diſtance	— 1 20	+ 44
Firſt reduction and correcting logarithm with their reſpective fines as above brought down	+ 15 6	+ 589
This is the correction as far as ☾ parallax 53′ - - - - -	+ 13 46	+ 633
Exceſs of ☾ parallax above 53′ is 7′ 5″ its parallactic log which muſt be added to corr. log. is	- -	+ 104
Sum of correcting log. and parallactic log. is + 737 its correſponding arc is - -	+ 1 39	+ 737
This is the true correction of ☉ & ☾ centers from refraction and parallax - -	+ 15 25	
Apparent centres of ☉ & ☾ brought down - - - - -	47 31 49	
True apparent centres of ☉ & ☾ cleared from refraction and parallax -	47 47 14	
True apparent centres of ☉ & ☾ under head of 15h at Greenwich - -	48 7 36	
Difference of ☉ & ☾ centers between Greenwich and the ſhip -	20 22 = to 1222″	
☾ Diſtance from ☉ in 3h or 180′ is 1° 40′ 43″ which is - - - - - -	= to 6043	

Therefore ſay, as 6043″ is to 180′, ſo 1222″ is to 36′ 24″, which added to 15h gives the Greenwich time from yeſterday noon (the 31ſt.) to be 15h 36′ 24″ or the true apparent time at Greenwich this firſt day of January to be - - - - - - - - 3h 36′ 24″ A. M.

True apparent time at the ſhip as above - - - -	7 24 2 A. M.
Difference of time between Greenwich and the ſhip - -	3 47 38

Difference of time being 3h 47′ 38″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 56° 54′ 30″ eaſt of the Royal Obſervatory of Greenwich in Great Britain.

Example I.

OBSERVATION from the other ſide brought over, and worked by Mr Dunthorn's method improved, uſing ſix places of the log ſines, beſides the index, with the addition of Table X. as the ſun's diſtance was meaſured from the moon; but if a ſtar's diſtance had been meaſured, Table XI. would have been uſed inſtead of Table X. This method, and that by Shepherd's Tables, are the beſt in practice, which I have mentioned in my remarks and inſtructions.

☽ Horizontal parallax 60′ 5″	☉ & ☽ Appar. centres 47° 31′ 49″	☽ True app. alt. 70° 31′ 9″	☉ True app. alt. 27° 45′ 50″

App. alt. of ☉ centre brought down	27° 45′ 50″	With centre of ☾ alt. 70° 31′ 9″ & ☾ horiz. paral. 60′ 5″ enter T. IX.		9,993007
Apparent alt. of ☾ do.	70 31 9			
Difference of apparent altitudes	42 45 19	Deduct always the logarithm found with ☉ centre in Table X.		. 9
Apparent centres brought down	47 31 49			
				9,992998
Sum	90 17 8	Half ſum 45° 8′ 34	Sine	9,850564
Diff. between app. alt. & app. centres	4 46 30	Half ſum 2 23 15	Sine	8,619693
			Sum	18,463255
			Half ſum	9,231627 is=

Difference of apparent altitudes brought down 42° 45′ 19″

☾ Correction from Table VIII. 19′ 43″
Diff. of ☉ refraction and parallax Table I. & III. 1 40 } 21 23 This ſum is added becauſe [the alt. of the ☾ is greateſt

Difference of true altitudes -	43 6 42			
Half difference - - - -	21 33 21			
= is the ſine of this arch - -	9 48 53			
Sum	31 22 14	Coſine	9,931365	
Difference of true altitude and ſum	11 44 28	Coſine	9,990817	
		Sum	19,922182	
		Half ſum	9,961091	is coſine of

Half the true apparent diſtance cleared from refraction and parallax thus - 23° 53′ 38″
2

True apparent centres at the ſhip - - - 47 47 16 which

Only differs from Mayer's or Shepherd's method the other ſide two ſeconds of a minute.

Example II.

A Lunar obſervation made April 25th, 1792, by ☉ weſt of the ☽, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 1h 30′ 00″ P.M. by W.	Obs'd ☉ & ☾ near. limb. 48° 38′ 00″	☾ Upper limb 34° 34′ 00″	☉ Lower limb 45° 4′ 00″
At 1 36 00 do.	do. - 48 40 00	do. 35 20 00	do. 44 23 00
At 1 39 00 do.	do. - 48 41 00	do. 35 45 00	do. 44 3 00
At 1 43 00 do.	do. - 48 42 00	do. 36 13 00	do. 43 39 00
6 28 00 Sum.	Sum - 194 41 00	Sum - 141 52 00	Sum - 177 9 00
1 37 00 Mean.	Mean - 48 40 15	Mean - 35 28 00	Mean - 44 17 15
14 20 W. too faſt.	Index error deduce — 1 15	Index error add + 2 00	Index error ded. — 2 00
1 22 40 true apparent time at the ſhip when the obſervation was made.	Neareſt limbs - 48 39 00 ☉ Semidiameter - 15 55 ☾ Semidiameter 14′ 49″ } 14 58 Aug. of ſemid. in alt. 9 } Apparent centres - 49 9 53	☾ Lower limb 35 30 00 ☾ Semid. & aug. 14 58 35 15 2 Eyes alt. or dip for 24 feet 4 40 ☾ App. alt. 35 10 22	☉ Lower limb 44 15 15 ☉ Semidiameter 15 55 44 31 10 Eyes alt. or dip for 24 feet 4 40 ☉ App. alt. 44 26 30

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. logs
☾ Horiz. parallax 54′ 21″ Exceſs above 53′ is 1 21				
Apparent centres 49 ☾ Apparent alt. 35 ☉ Apparent alt. 44	— 21′ 17″	— 382		
Apparent centres 49 ☉ App. alt. incr. 60′ 45 ☾ Apparent alt. 35	— 22′ 9″	— 365	+ 52″	— 17″
Apparent centres 49 ☾ App. alt. incr. 60′ 36 ☉ Apparent alt. 44	— 20′ 39″	— 394	— 38″	+ 12″
App. cent. incr. 60′ 50 ☾ Apparent alt. 35 ☉ Apparent alt. 44	— 21′ 28″	— 374	+ 11″	— 8″

If 60′ incr. of ☉ alt. gives + 52″ of a red. & — 17 of a corr. log. odd min. of ☉ alt. gives reduct. + 23 & corr. log. — 7
If 60′ incr. of ☾ alt. gives — 38 of a red. & + 12 of a corr. log. odd min. of ☾ alt. gives reduct. — 7 & corr. log. + 2
If 60′ incr. of ☉ & ☽ cent. g. + 11 of a red. & — 8 of a corr. log. odd min. of ☉ & ☽ cent. g. red. + 2 & corr. log. — 1

This is the reduction and correcting logarithm for the odd min. of ☉ alt. ☾ alt. and diſtance	+ 18	— 6
Firſt reduction and correcting logarithms with their reſpective fines as above brought down	— 21 17	— 382
This is the correction as far as ☾ parallax 53′ - - - - - -	— 21 35	— 376
Exceſs of ☾ parallax above 53′ is 1′ 21″ its parallactic log which muſt be added to corr. log. is - -		— 824
Sum of correcting log. and parallactic log. is — 1200 its correſponding arc is - -	— 34	—1200
This is the true correction of ☉ & ☾ centres from refraction and parallax - -	— 22 9	
Apparent centres of ☉ & ☾ brought down - - - - - -	49 9 53	
True apparent centres of ☉ & ☾ cleared from refraction and parallax -	48 47 44	
True apparent centres of ☉ & ☾ under head of 3h at Greenwich - -	48 41 19	
Difference of ☉ & ☾ centres between Greenwich and the ſhip -	6 25 = to 385″	
☾ Diſtance from ☉ in 3h or 180′ is 1° 21′ 36″ which is - - - - - - -	= to 4896	

Therefore ſay, as 4896″ is to 180′, ſo 385″ is to 14′ 9″, which being added to 3h gives the true apparent time at Greenwich to be - - - - - - - 3h 14′ 9″ P.M.
True apparent time at the ſhip as above - - - - 1 22 40 P.M.
Difference of time between Greenwich and the ſhip - - 1 51 29

Difference of time being 1h 51′ 29″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 27° 52′ 15′ weſt of the Royal Obſervatory of Greenwich in Great Britain.

Example

Example II.

OBSERVATION from the other ſide brought over, and worked by Dunthorn's method improved, with ſix places of the log. ſines, beſides the index, *&c. &c.*

☽ Horizontal parallax 54′21″	☉ & ☽ Appar. centres 49° 9′ 53″	☽ True app. alt. 35° 10′ 22″	☉ True app. alt. 44° 26′ 30″

App. alt. of ☉ centre brought down	44° 26′ 30″	With centre of ☾ alt. 35° 10′ 22″ & horiz. parall. 54′ 21″ enter T. IX.		9,996236
Apparent alt. of ☾ centre do.	35 10 22			
Difference of apparent altitudes	9 16 8	Deduct always the logarithm found with ☉ centre in Table X.		13
Apparent centres brought down	49 9 53			
				9,996223
Sum	58 26 1	Half ſum 29° 13′ 0″	Sine	9,688521
Diff. between app. alt. & app. centres	39 53 45	Half ſum 19 56 52	Sine	9,532966
			Sum	19,217710
			Half ſum	9,608855 is=

Difference of apparent altitudes brought down		9° 16′ 8″	
☾ Correction from Table VIII. - -	43′ 4″	43 57	This ſum is deduced becauſe [the alt. of the ☉ is greateſt
Diff. of ☉ refraction and parallax Table I. & III.	53		
Difference of true altitudes -		8 32 11	
Half difference - - - -		4 16 5	
= is the ſine of this arch - -		23 58 25	
Sum		28 14 30	Coſine 9,944956
Difference of true altitudes and ſum		19 42 19	Coſine 9,973792
		Sum	19,918748
		Half ſum	9,959374 is coſine of

Half the true apparent diſtance cleared from refraction and parallax thus 24° 23′ 54″
2

True apparent centres at the ſhip - - - 48 47 48 which

Only differs from Mayer or Shepherd's method the other ſide four ſeconds of a minute.

Example

Example III.

A Lunar obſervation made February 22d, 1790, by ☉ weſt of the ☾, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 4h 30′ 00″ P. M. by W.	Obs'd ☉ & ☾ near. limbs 95° 10′ 30″	☾ Upper limb 30° 3′ 00″	☉ Lower limb 24° 12′ 00″
At 4 33 00 do.	do. - 95 11 30	do. 30 17 00	do. 23 31 00
At 4 36 00 do.	do. - 95 12 30	do. 30 33 00	do. 22 57 00
13 39 00 Sum.	Sum - 285 34 30	Sum - - 90 53 00	Sum - 70 40 00
4 33 00 Mean.	Mean - 95 11 30	Mean - 30 17 40	Mean - 23 33 20
1 18 W. too faſt.	Index error deduce — 1 45	Index err. ded. — 2 00	☉ Semidiam. 16 12
4 31 42 true apparent time at the ſhip when the obſervation was made.	Neareſt limbs - 95 9 45 ☉ Semidiameter 16 12 ☾ Semidiameter 15′ 16″ } 15 24 Aug. of ſem. in alt. 8 } Apparent centres 95 41 21	☾ Upper limb 30 15 40 ☾ Semid. & aug. 15 24 30 00 16 Eye's alt. or dip for 30 feet 5 14 ☾ App. alt. 29 55 2	☉ Lower limb 23 49 32 Eye's alt. or dip for 30 feet 5 14 ☉ Appar. alt. 23 44 18

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. log.
☾ Horiz. parallax 56′ 1″ Exceſs above 53′ 3 1				
Apparent centres 95 ☾ Apparent alt. 29 ☉ Apparent alt. 23	— 20′ 53″	— 363		
Apparent centres 95 ☉ App. alt. inc. 60′ 24 ☾ Apparent alt. 29	— 21′ 45″	— 347	+ 52″	— 16
Apparent centres 95 ☾ App. alt. inc. 60′ 30 ☉ Apparent alt. 23	— 20′ 56″	— 363	+ 3	— 0
App. cent. incr. 60′ 96 ☾ Apparent alt. 29 ☉ Apparent alt. 23	— 21′ 20″	— 357	+ 27	— 6

If 60′ incr. of ☉ alt. gives + 52 of a red. & — 16 of a cor. log. odd min. of ☉ alt. give red. + 38 & cor. log. — 12
If 60 incr. of ☾ alt. gives + 3 of a red. & — 0 of a cor. log. odd min. of ☾ alt. give red. + 3 & cor. log. — 0
If 60 incr. of ☉ & ☾ cent. g. + 27 of a red. & — 6 of a cor. log. odd mid. of ☉ & ☾ cen. g. red. + 19 & cor. log. — 4

This is the reduction and correcting logarithm for the odd minutes of ☉ & ☾ alt. and diſtance + 1 00 — 16
Firſt reduction and correcting logarithms with their reſpective fines as above brought down — 20 53 — 363
This is the correction as far as ☾ parallax 53′ - - - - - — 21 53 — 347
Exceſs of ☾ parallax above 53′ is 3′ 1″ its parallactic log. which muſt be added to corr. log. is - - - — 475
Sum of correcting log. and parallactic log. is — 822 its correſponding arc is - - - — 1 21 — 822
This is the true correction of ☉ and ☾ centres from refraction and parallax - - - — 23 14
Apparent centres of ☉ and ☾ brought down - - - - 95 41 21
True apparent centres of ☉ and ☾ cleared from refraction and parallax - 95 18 7
True app. centres of ☉ and ☾ under head of 6h at Greenwich per Naut. Alm. 95 38 45
Difference of ☉ and ☾ centres between Greenwich and the ſhip - — 20 38 = to 1238″
☾ Diſtance from ☉ in 3h or 180′ is 1° 26′ 21″ which is - - - - - = to 5181
Therefore ſay, As 5181″ is to 180″ ſo is 1238″ to 43′ 1″ which deduced from 6h gives the true apparent Greenwich time to be - - - - - - - 5h 16′ 59″ P. M.
True apparent time at the ſhip as above - - - - - - 4 31 42 P. M.
Difference of time between Greenwich and the ſhip - - 45 17

Difference of time being 45′ 17″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 11° 19′ 15″ weſt, from the royal obſervatory of Greenwich in Great Britain.

Example

Example I.

OBSERVATION from the other ſide brought over, and worked by Mr Lyon's method improved, which is a very good one.

☾ Horizontal parallax 56′ 1″	☉ and ☾ Apparent centres 95° 41′ 21″	☾ True apparent altitude 29° 55′ 2″	☉ True apparent altitude 23° 44′ 18″
Correction of ☉ altitude - 0° 2′ 1″ P. L. - 1,9506 P. L. - 1,9506 ☉ Apparent centre - - - 23 44 18 Coſine - 9,9616 Co. tangent 10,3569 Apparent centres of ☉ and ☾ - 95 41 21 Sine - 9,9979 Tangent 11,0021 ☾ Apparent centre - - - 29 55 2 Co.ſecant 10,3021			☉ Refraction in altitude 2′ 9″ } 2 1 ☉ Parallax in do. 0 8 } ☉ True altitude - 23 42 17
		2,2122 = P. L. for 1ſt arc to 1′ 6″½ 2d arc - 0 5½ Sum of 1ſt and 2d arcs is correction from refraction - - - 1 12	3,3096 = P. L. for 2d arc to 0′ 5″½
Table VIII. correction of ☾ altitude 0° 46′ 53″ P. L. 0,5842 P. L. - 0,5842 ☾ Apparent altitude - - 29 55 2 Coſine 9,9379 Co. tangent 10,2400 App. centres corrected from refrac. 95 42 33 Sine - 9,9978 Tangent 10,9996 ☉ True centre - - - 23 42 17 Co. ſecant 10,3958			Apparent centres brought down 95° 41′ 21″ Sum of 1ſt and 2d arcs - 1 12 Corrected diſtance from refract. 95 42 33 Sum of 3d and 4th arcs - 24 33 Diſt. corrected from principal effects of parallax } 95 18 00 T. XIII. { 1ſt Correction 1″ 2d Correction 2 } Diff. 00 1 True apparent centres of ☉ & ☾ cleared from refr. & parallax } 95 17 59 Which only differs from Mayer or Shepherd's method the other ſide 8 ſeconds of a minute.
		0,9157 = P. L. for 3d arc to 21′ 51″ 4th arc 2 42 Sum of 3d and 4th arcs is principal correctiom from parallax - - 24 33	1,8238 = P. L. for 4th arc to 2′ 42″

N. B. When the diſtance of centres are above 90°, as in this caſe, the ſum of 1ſt and 2d arcs which is the correction from refraction, muſt be always added to the apparent centres. The ſum of 3d and 4th arcs, which is the principal correction from parallax, muſt be always deduced from the apparent centres, after the correction from refraction is firſt properly applied, as above-mentioned; and to the reſult, the difference of firſt and ſecond correction from Table XIII. muſt be always deduced; and you will then have the true apparent centres corrected from refraction and parallax.

Example IV.

A Lunar obſervation made March 9th, 1791, by ☉ weſt of the ☾, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 10h 31′ 00″ A.M. by W	Obs'd ☉ & ☾ near. limbs 53° 20′ 00″	☾ Upper limb 18° 56′ 00″	☉ Lower limb 60° 9′ 00″
At 10 38 00 do.	do. - 53 23 00	do. 20 30 00	do. 61 29 00
At 10 46 00 do.	do. - 53 26 00	do. 22 23 00	do. 62 49 00
31 58 00 Sum.	Sum - 160 9 30	Sum - 61 49 00	Sum - 184 27 00
10 35 20 Mean.	Mean - 53 23 10	Mean - 20 36 20	Mean - 61 29 00
2 47 W. too faſt.	Index error deduce — 53	☾ Semidiameter 14 55	☉ Semidiam. 16 9
10 35 33 true appar. time at the ſhip when the obſervation was made.	Neareſt limbs - 53 22 17	20 21 25	61 45 9
	☉ Semidiameter 16 9	Eye's alt. or dip for 28 feet } 5 3	Eye's alt. or dip for 28 feet } 5 3
	☾ Semidiameter 14′ 49″ } Aug. of ſem. in alt. 6 } 14 55	☾ App. alt. 20 16 22	☉ Appar. alt. 61 40 6
	Apparent centres 53 53 21		

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. log.
☾ Horiz. parallax 54′ 21″ Exceſs above 53′ 1 21				
Apparent centres 53 ☾ Apparent alt. 20 ☉ Apparent alt. 61	— 42′ 18″	— 78		
Apparent centres 53 ☉ App. alt. inc. 60′ 62 ☾ Apparent alt. 20	— 42′ 50″	— 73	+ 32″	— 5
Apparent centres 53 ☾ App. alt. inc. 60′ 21 ☉ Apparent alt. 61	— 41′ 45″	— 84	— 33	+ 6
App. cent. incr. 60′ 54 ☾ Apparent alt. 20 ☉ Apparent alt. 61	— 42′ 3″	— 81	— 15	+ 3

If 60″ incr. of ☉ alt. gives + 32 of a red. & — 5 of a cor. log. odd min. of ☉ alt. gives red. + 21 & cor. log. — 3
If 60″ incr. of ☾ alt. gives — 33 of a red. & + 6 of a cor. log. odd min. of ☾ alt. gives red. — 9 & cor. log. + 1
If 60 incr. of ☉ & ☾ cent. g. — 15 of a red. & + 3 of a cor. log. odd min. of ☉ & ☾ cen. g. red. — 13 & cor. log. + 3

This is the reduction and correcting logarithm for the odd minutes of ☉ & ☾ alt. and diſtance	— 1	+ 1
Firſt reduction and correcting logarithm with their reſpective fines as above brought down	— 42 18	— 78
This is the correction as far as ☾ parallax 53′ - - - - -	— 42 17	— 79
Exceſs of ☾ parallax above 53′ is 1′ 21″ its parallactic log. which muſt be added to corr. log. is - - -		— 824
Sum of correcting log. and parallactic log. is — 903 its correſponding arc is - - -	— 1 8	— 903
This is the true correction of ☉ and ☾ centres from refraction and parallax - - -	— 43 25	
Apparent centres of ☉ and ☾ brought down - - - -	53 53 21	
True apparent centres of ☉ and ☾ cleared from refraction and parallax - .	53 9 56	
True app. centres of ☉ and ☾ under head of 3h at Greenwich per Naut. Alm.	53 21 1	
Difference of ☉ and ☾ centres between Greenwich and the ſhip -	11 5	=to 665″
☾ Diſtance from ☉ in 3h or 180′ is 1° 21′ 17″ which is - - - - -		=to 4877

Therefore ſay, As 4877″ is to 180′ ſo is 665″ to 24′ 33″ which deduced from 3h gives the true apparent Greenwich time to be - - - - - - - 2h 35′ 27″ P. M.
True app. time at the ſhip as above is 10h 35′ 33 A. M. which from noon is 1 24 27
Difference of time between Greenwich and the ſhip - - 3 59 54

Difference of time being 3h 59′ 54″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 59° 58′ 30″ weſt, from the royal obſervatory of Greenwich in Great Britain.

This obſervation was made in ſight of the iſland of Martinico, when the eaſt end bore weſt, diſtance by the run of the ſhip 31′, which places the eaſt end of the iſland in the longitude of 60° 30′ 30″ Weſt from Greenwich in Great Britain.

Example

Example II.

OBSERVATION from the other ſide brought over, and worked by Mr Lyon's method improved, &c.

☾ Horizontal parallax 54′ 21″	☉ and ☾ Apparent centres 53° 53′ 21″	☾ True apparent altitude 20° 16′ 22″	☉ True apparent altitude 61° 40′ 6″
Correction of ☉ altitude - 0° 00′ 27″ P. L. - 2,6021 P. L. - 2,6021 ☉ Apparent altitude - - 61 40 6 Coſine 9,6763 Co. tangent 9,7318 Apparent centres of ☉ and ☾ - 53 53 21 Sine - 9,9073 Tangent 10,1369 ☾ Apparent altitude - - 20 16 22 Co. ſecant 10,4603			☉ Refraction in altitude 0′ 31″ } 27 ☉ Parallax in do. 0 4 } ☉ True altitude - - 61 39 39
	2,6460 = P. L. for 1ſt arc 0′ 24″ for 2d arc 0 37 Difference between 1ſt and 2d arcs is correction from refraction 0 13	2,4708 = P. L.	Apparent centres brought down 53° 53′ 21″ Difference of 1ſt and 2d arcs 13 Corrected diſtance from refract. 53 53 8 Difference of 3d and 4th arcs 43 13
Table VIII. correction of ☾ altitude 0° 48′ 27″ P. L - 0,5700 P. L. - 0,5700 ☾ Apparent altitude - - 20 16 22 Coſine 9,9722 Co. tangent 10,4325 App. centres corrected from refrac. 53 53 8 Sine 9,9073 Tangent 10,1369 ☉ True altitude - - - 61 39 39 Co. ſecant 10,0554			Diſt. corrected from principal effects of parallax } 53 9 55 T. XIII. { 1ſt Correction 0′ 14″ / 2d Correction 0 18 } Diff. 4 True apparent centres of ☉ & ☾ cleared from refr. and parallax } 53 9 59
	0,5049 = P. L. for 3d arc 56′ 17″ for 4th arc 13 4 Difference of 3d and 4th arcs is principal correction from parallax 43 13	1,1394 = P. L.	Which only differs from Mayer or Shepherd's method the other ſide 3 ſeconds of a minute.

N. B. When the diſtance of centres are under 90°, as in this caſe, the difference between the firſt and ſecond arcs, which is the correction from refraction, muſt be always deduced from the apparent centres as above, if the ſecond arc is greater than the firſt; but whenever the firſt arc is greater than the ſecond, this difference muſt be added to the apparent centres.

The difference of third and fourth arcs, which is the principal correction from parallax, muſt be always deduced from the apparent centres, after the correction from refraction is firſt properly applied, as abovementioned, if the third arc is greater than the fourth, but it muſt be added to it if the fourth arc is greater than the third; and to the reſult the difference of firſt and ſecond correction from Table XIII. muſt be always added, and you will then have the true apparent centres corrected from refraction & parallax.

Example V.

A Lunar obſervation made April 29th, 1792, by ☉ weſt of the ☽, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 2h 31′ 00″ P.M. by W.	Obs'd ☉ & ☾ near. limb. 92° 45′ 00″	☾ Upper limb 22° 1′ 00″	☉ Lower limb 27° 45′ 00″
At 2 34 00 do.	do. - 92 46 00	do. 22 45 00	do. 27 16 00
At 2 37 00 do.	do. - 92 47 00	do. 23 16 00	do. 26 47 00
7 42 00 Sum.	Sum - 278 18 00	Sum - 68 2 00	Sum - 81 48 00
2 34 00 Mean.	Mean - 92 46 00	Mean - 22 40 40	Mean - 27 16 00
24 00 W. too ſlow.	Index error - — 1 15	Index error + 2 20	Index error — 1 00
2 58 00 true apparent time at the ſhip when the obſervation was made.	Neareſt limbs - 92 44 45 ☉ Semidiameter - 15 55 ☾ Semidiameter 14′ 59″ Aug. of ſemid. in alt. 6 } 15 5 Apparent centres - 93 15 45	☾ Upper limb 22 43 00 ☾ Semidiameter 15 5 22 27 55 Eyes alt. or dip for 24 feet } 4 40 ☾ App. alt. 22 23 15	☉ Lower limb 27 15 00 ☉ Semidiameter 15 55 27 30 55 Eyes alt. or dip for 24 feet } 4 40 ☉ App. alt. 27 26 15

☾ Horiz. parallax 55′ 2″ Exceſs above 53′ is 2′ 2	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. logs
Apparent centres 93° ☾ Apparent alt. 22 ☉ Apparent alt. 27	— 23′ 6″	— 328		
Apparent centres 93° ☉ App. alt. incr. 60′ 28 ☾ Apparent alt. 22	— 23′ 55″	— 314	+ 49″	— 14″
Apparent centres 93° ☾ App. alt. incr. 60′ 23 ☉ Apparent alt. 27	— 23′ 9″	— 324	+ 3″	— 4″
App. cent. incr. 60′ 94° ☾ Apparent alt. 22 ☉ Apparent alt. 27	— 23′ 25″	— 319	+ 19″	— 9″

If 60′ incr. of ☉ alt. gives + 49″ of a red. & — 14 of a corr. log. odd min. of ☉ alt. gives reduct. + 21 & corr. log. — 6
If 60′ incr. of ☾ alt. gives + 3 of a red. & — 4 of a corr. log. odd min. of ☾ alt. gives reduct. + 1 & corr. log. — 1
If 60′ incr. of ☉ & ☽ cent. g. + 19 of a red. & — 9 of a corr. log. odd min. of ☉ & ☽ cent. g. red. + 5 & corr. log. — 2

This is the reduction and correcting logarithm for the odd min. of ☉ alt. ☾ alt. and diſtance	+ 27	— 9
Firſt reduction and correcting logarithm with their reſpective ſines as above brought down	— 23 6	— 328
This is the correction as far as ☾ parallax 53′ - - - - -	— 23 33	— 319
Exceſs of ☾ parallax above 53′ is 2′ 2″ its parallactic log which muſt be added to corr. log. is	- -	— 646
Sum of correcting log. and parallactic log. is — 965 its correſponding arc is - -	— 59	— 965
This is the true correction of ☉ & ☾ centres from refraction and parallax - -	— 24 32	
Apparent centres of ☉ & ☾ brought down - - - - -	93 15 45	
True apparent centres of ☉ & ☾ cleared from refraction and parallax -	92 51 13	
True apparent centres of ☉ & ☾ under head of 3h at Greenwich per Naut. Alm.	92 17 34	
Difference of ☉ & ☾ centres between Greenwich and the ſhip -	33 39	=to 2019″
☾ Diſtance from ☉ in 3h or 180′ is 1° 23′ 32″ which is - - - - - -		=to 5012

Therefore ſay, as 5012″ is to 180′, ſo 2019′ is to 1h 12′ 33″, which being added to 3h gives the true apparent time at Greenwich to be - - - - - - 4h 12′ 33″ P. M.
True apparent time at the ſhip as above - - - - 2 58 00 P. M.
Difference of time between Greenwich and the ſhip - - 1 14 33

Difference of time being 1h 14′ 33″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 18° 38′ 15″ weſt of the Royal Obſervatory of Greenwich in Great Britain.

Example

Example I.

OBSERVATION from the other ſide brought over, and worked by another method of Mr Dunthorn's improved, uſing only five places of the log ſines, beſides the index. This method is as ſimple as any in practice.

☽ Horizontal parallax 55′ 2″	☉ & ☽ Appar. centres 93° 15′ 45″	☽ True app. alt. 22° 32′ 15″	☉ True app. alt. 27° 26′ 15″

App. alt. of ☉ centre brought down 27° 26′ 15″

Apparent alt. of ☾ do.	22 23 15	With centre of ☾ alt. 22° 23′ 15″ & horiz. paral. 55′ 2″ enter T. IX.		9,99754
Difference of apparent centres	5 3 00			
Apparent centres brought down	93 15 45			
Sum	98 18 45	Half ſum is 49° 9′ 22	Sine	9,87881
Diff. between app. alt. & app. centres	88 12 45	Half ſum is 44 6 22	Sine	9,84260
			Sum	19,71895
			Half ſum	9,85947 is =

Difference of apparent altitudes brought down -		5° 3′ 00″	
☾ Correction from Table VIII. - -	48′ 35″	50 53	This ſum is deduced becauſe [the alt. of the ☉ is greateſt
☉ Refraction Table I. - - - -	2 18		
Difference of true altitudes -		4 12 7	
Half difference - - - -		2 6 3	
= the ſine of this arch - -		46 21 00	
Sum		48 27 3	Coſine 9,82169
Difference of true altitudes and ſum		44 14 56	Coſine 9,85510
			Sum 19,67679
			Half ſum 9,83839 is coſine of

Half the true apparent diſtance cleared from refraction and parallax thus - 46° 25′ 37″
2

True apparent centres at the ſhip - - - 92 51 14 which

Only differs from Mayer's or Shepherd's method the other ſide one ſecond of a minute.

Example VI.

A Lunar observation made May 13th, 1792, by ☉ east of the ☽, and worked by Mayer or Shepherd's Astronomical Tables.

At 7h 36′ 00″ A. M. by W.	Obs'd ☉ & ☾ near. limb. 90° 00′ 30″	☾ Lower limb 56 31′ 30″	☉ Lower limb 6° 37′ 00″
At 7 40 00 do.	do. 89 59 30	do. 56 3 00	do. 7 24 00
At 7 44 00 do.	do. 89 58 30	do. 55 29 00	do. 7 59 00
23 00 00 Sum.	Sum 269 58 30	Sum 168 3 30	Sum 22 00 00
7 40 00 Mean.	Mean 89 59 30	Mean 56 1 10	Mean 7 20 00
1 41 W. too slow.	Index error deduce — 30	☾ Semidiameter 16 12	☉ Semidiameter 15 52
7 41 41 true apparent time at the ship when the observation was made.	Nearest limbs 89 59 00 ☉ Semidiameter 15 52 ☾ Semidiameter 15′ 59″ } 16 12 Aug. of semid. in alt. 13 } Apparent centres 90 31 4	56 17 22 Eyes alt. or dip for 24 feet } 4 40 ☾ App. alt. 56 12 42	7 35 52 Eyes alt. or dip for 24 feet } 4 40 ☉ App. alt. 7 31 12

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. logs
☾ Horiz. parallax 58′43″ Excess above 53′ is 5 43				
Apparent centres 90° ☾ Apparent alt. 56 ☉ Apparent alt. 7	— 0′ 4″	— 920		
Apparent centres 90° ☉ Altitude incr. 60′ 8 ☾ Apparent alt. 56	— 1′ 41″	— 857	+ 1′ 37″	— 03″
Apparent centres 90° ☾ App. alt. incr. 60′ 57 ☉ Apparent alt. 7	+ 0′ 1″	— 920	— 0′ 5″	+ 0″
App. cent. incr. 60′ 91° ☾ Apparent alt. 56 ☉ Apparent alt. 7	— 0′ 45″	— 869	+ 0′ 41″	— 51″

If 60′ incr. of ☉ alt. gives + 1′ 37″ of a red. & — 63 of a corr. log. odd min. of ☉ alt. gives reduct. + 50 & corr. log. — 32
If 60′ incr. of ☾ alt. gives — 0 5 of a red. & + 0 of a corr. log. odd min. of ☾ alt. gives reduct. — 1 & corr. log. — 0
If 60′ inc. of ☉ & ☽ cen. g. + 0 41 of a red. & — 51 of a corr. log. odd min. of ☉ & ☽ cent. g. red. + 21 & corr. log. — 26

This is the reduction and correcting logarithm for the odd min. of ☾ alt. ☉ alt. and distance	+ 1 10	— 58
First reduction and correcting logarithm with their respective fines as above brought down	— 0 4	— 920
This is the correction as far as ☾ parallax 53′ - - - - -	— 1 14	— 862
Excess of ☾ parallax above 53′ is 5′ 43″ its parallactic log which must be added to corr. log. is - -		— 197
Sum of correcting log. and parallactic log. is — 1059 its corresponding arc is - -	— 0 47	—1059
This is the true correction of ☉ & ☾ centres from refraction and parallax - -	— 2 1	
Apparent centres of ☉ & ☾ brought down - - - - -	90 31 4	
True apparent centres of ☉ & ☾ cleared from refraction and parallax -	90 29 3	
True apparent centres of ☉ & ☾ under head of 18h at Greenwich per Naut. Alm.	90 54 58	
Difference of ☉ & ☾ centres between Greenwich and the ship -	25 55	=to 1555″
☾ Distance from ☉ in 3h or 180′ is 1° 36′ 7″ which is - - - - - - -		=to 5767

Therefore say, as 5767″ is to 180′, so 1555″ is to 48′ 32″, which being added to 18h gives the true apparent time at Greenwich from noon yesterday to be 18h 48′ 32″ which is to-day - 6h 48′ 32″ A. M.

True apparent time at the ship as above - - - -	7 41 41	A. M.
Difference of time between Greenwich and the ship - -	53 9	

Difference of time being 0h 53′ 9″ which turned into degrees gives the longitude of the ship when the observation was made as per above time to be 13° 17′ 15″ east of the Royal Observatory of Greenwich in Great Britain.

Example

Example II.

OBSERVATION from the other ſide brought over, and worked by Dunthorn's method improved, with five places of the log. ſines, beſides the index, *&c. &c.*

☽ Horizontal parallax 58′43″ ☉ & ☽ Appar. centres 90° 31′4″	☽ True app. alt. 56° 12′42″	☉ True app. alt. 7° 31′ 12″

App. alt. of ☉ centre brought down	7° 31′ 12″			
Apparent alt. of ☾ centre do.	56 12 42	With ☾ apparent alt. 56° 12′42″ & horiz. parall. 58′ 43″ enter T. IX.		9,99401
Difference of apparent centres	48 41 30			
Apparent centres brought down	90 31 4			
Sum	139 12 34	Half is	69° 36′ 17″	Sine 9,97188
Diff. between app. alt. & app. centres	41 49 34	Half is	20 54 47	Sine 9,55260
				Sum 19,51849
				Half ſum 9,75924 is=

Difference of apparent altitudes brought down	-	48° 41′ 30″	
☾ Correction from Table VIII. - -	32′ 11″	39 4	• This ſum is added becauſe [the alt. of the ☾ is greateſt
☉ Refraction Table I. - - - -	6 53		
Difference of true altitudes	-	49 20 34	
Half difference - - - -		24 40 17	
= the ſine of this arch - -		35 3 37	
	Sum	59 43 54	Coſine 9,70247
Difference of true altitudes and ſum		10 23 20	Coſine 9,99282
		Sum	19,69529
		Half ſum	9,84764 is coſine

Of half the true apparent diſtance cleared from refraction and parallax thus 45° 14′ 32″
2

True apparent centres at the ſhip 90 29 4 which

Only differs from Mayer or Shepherd's method the other ſide one ſecond of a minute.

Example

Example VII.

A Lunar obſervation made May 24th, 1792, by ☉ weſt of the ☾, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 2h 16′ 00″ P. M. by W	Obs'd ☉ & ☾ near. limbs 39° 18′ 00″	☾ Lower limb 32° 7′ 30″	☉ Lower limb 20° 36′ 00″
At 2 19 00 do.	do. - 39 19 00	do. 32 15 00	do. 20 16 00
At 2 22 00 do.	do. - 39 20 00	do. 32 19 00	do. 19 54 00
6 57 00 Sum.	Sum - 117 57 00	Sum - 96 41 30	Sum - 60 46 00
2 19 00 Mean.	Mean - 39 19 00	Mean - 32 13 50	Mean - 20 15 20
12 59 W. too ſlow	Index error - — 2 30	Index error — 2 00	Index error + 40
2 31 59 true appar. time at the ſhip when the obſervation was made.	Neareſt limbs - 39 16 30	☾ Lower limb 32 11 50	☉ Lower limb 20 16 00
	☉ Semidiameter 15 50	☾ Semidiameter 14 53	☉ Semidiameter 15 50
	☾ Semidiameter 14′ 45″ } Aug. of ſem. in alt. 8 } 14 53	32 26 43	20 31 50
		Eye's alt. or dip for 24 feet } 4 40	Eye's alt. or dip for 24 feet } 4 40
	Apparent centres 39 47 13	☾ App. alt. 32 22 3	☉ Appar. alt. 20 27 10

☾ Horiz. parallax 54′ 9″ Exceſs above 53′ 1 9	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. log.
Apparent centres 39 ☾ Apparent alt. 32 ☉ Apparent alt. 20	+ 7′ 12″	+ 906		
Apparent centres 39 ☉ Altitude inc. 60′ 21 ☾ Apparent alt. 32	+ 5′ 45″	+ 1008	— 87″	+ 102″
Apparent centres 39 ☾ App. alt. inc. 60′ 33 ☉ Apparent alt. 20	+ 8′ 12″	+ 846	+ 60	— 60
App. cent. incr. 60′ 40 ☉ Apparent alt. 32 Apparent alt. 20	+ 6′ 35″	+ 940	— 37	+ 34

If 60′ incr. of ☉ alt. gives — 87 of a red. & + 102 of a cor. log. odd min. of ☉ alt. gives red. — 39 & cor. log. + 46
If 60 incr. of ☾ alt. gives + 60 of a red. & — 60 of a cor. log. odd min. of ☾ alt. gives red. + 22 & cor. log. — 22
If 60 incr. of ☉ & ☾ cent. g. — 37 of a red. & + 34 of a cor. log. odd min. of ☉ & ☾ cen. g. red. — 29 & cor. log. + 27

This is the reduction and correcting logarithm for the odd minutes of ☾ alt. ☉ alt. and diſtance	— 46	— 51
Firſt reduction and correcting logarithm with their reſpective fines as above brought down	+ 7 12	+ 906
This is the correction as far as ☾ parallax 53′ - - - - -	+ 6 26	+ 857
Exceſs of ☾ parallax above 53′ is 1′ 9″ its parallactic log. which muſt be added to corr. log. is - - -		+ 894
Sum of correcting log. and parallactic log. is + 1851 its correſponding arc is - - -	+ 0 9	+1751
This is the true correction of ☉ and ☾ centres from refraction and parallax - - -	+ 6 35	
Apparent centres of ☉ and ☾ brought down - - - -	39 47 13	
True apparent centres of ☉ and ☾ cleared from refraction and parallax -	39 53 48	
True app. centres of ☉ and ☾ under head of noon at Greenwich per Naut. Alm.	39 41 29	
Difference of ☉ and ☾ centres between Greenwich and the ſhip -	12 19	=to 739″
☾ Diſtance from ☉ in 3h or 180′ is 1° 20′ 47″ which is - - - - -		=to 4847

Therefore ſay, As 4847″ is to 180′ ſo 738″ is to 27′ 27″ which added to head of noon, gives the true apparent time at Greenwich to be - - - - - - - - 0h 27′ 27″ P. M.
True apparent time at the ſhip as above - - - - 2 31 59 P. M.
Difference of time between Greenwich and the ſhip - - 2 4 32

Difference of time being 2h 4′ 32″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 31° 8′ 00″ eaſt, from the Royal Obſervatory of Greenwich in Great Britain.

Example VIII.

A Lunar obſervation made May 25th, 1792, by ☉ weſt of the ☾, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 1h 33′ 00″ P. M. by W	Obs'd ☉ & ☾ near. limbs 49° 54′ 30″	☾ Lower limb 28° 34′ 00″	☉ Lower limb 26° 36′ 00″
At 1 36 00 do.	do. - 49 55 30	do. 28 51 00	do. 26 21 00
At 1 39 00 do.	do. - 49 56 30	do. 29 10 30	do. 26 5 00
4 48 00 Sum.	Sum - 149 46 30	Sum - 86 35 30	Sum - 79 2 00
1 36 00 Mean.	Mean - 49 55 30	Mean - 28 51 50	Mean - 26 20 40
5 4 W. too ſlow	Index error - — 2 30	Index error — 2 00	Index error 00
1 41 4 true appar. time at the ſhip when the obſervation was made.	Neareſt limbs - 49 53 00 ☉ Semidiameter 15 50 ☾ Semidiameter 14′ 47″ Aug. of ſem. in alt. 8 } 14 55 Apparent centres 50 23 45	☾ Lower limb 28 49 50 ☾ Semidiameter 14 55 29 4 45 Eye's alt. or dip for 25 feet } 4 45 ☾ App. alt. 29 00 00	☉ Lower limb 26 20 40 ☉ Semidiameter 15 50 26 36 30 Eye's alt. or dip for 22 feet } 4 28 ☉ Appar. alt. 26 32 2

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. log.
☾ Horiz. parallax 54°16″ Exceſs above 53′ 1 16				
Apparent centres 50 ☾ Apparent alt. 29 ☉ Apparent alt. 26	— 7′ 38″	— 803		
Apparent centres 50 ☉ Altitude inc. 60′ 27 ☾ Apparent alt. 29	— 8′ 43″	— 750	+ 65″	— 53″
Apparent centres 50 ☾ App. alt. inc. 60′ 30 ☉ Apparent alt. 26	— 6′ 57″	— 840	— 41	+ 37
App. cent. incr. 60′ 51 ☾ Apparent alt. 29 ☉ Apparent alt. 26	— 7′ 57″	— 788	+ 19	— 15

If 60′ incr. of ☉ alt. gives + 65 of a red. & — 53 of a cor. log. odd min. of ☉ alt. gives red. + 35 & cor. log. — 28
If 60 incr. of ☾ alt. gives — 41 of a red. & + 37 of a cor. log. odd min. of ☾ alt. gives red. — 0 & cor. log. + 0
If 60 incr. of ☉ & ☾ cent. g. + 19 of a red. & — 15 of a cor. log. odd min. of ☉ & ☾ cen. g. red. + 8 & cor. log. — 6

This is the reduction and correcting logarithm for the odd minutes of ☾ alt. ☉ alt. and diſtance	+ 43	— 34
Firſt reduction and correcting logarithm with their reſpective fines as above brought down	— 7 38	— 803
This is the correction as far as ☾ parallax 53′ - - - - - -	— 8 21	— 769
Exceſs of ☾ parallax above 53′ is 1′ 16″ its parallactic log. which muſt be added to corr. log. is - - -		— 852
Sum of correcting log. and parallactic log. is — 1621 its correſponding arc is - - -	— 0 13	—1621
This is the true correction of ☉ and ☾ centres from refraction and parallax - - -	— 8 34	
Apparent centres of ☉ and ☾ brought down - - - - -	50 23 45	
True apparent centres of ☉ and ☾ cleared from refraction and parallax -	50 15 11	
True app. centres of ☉ and ☾ under head of noon at Greenwich per Naut. Alm.	50 28 41	
Difference of ☉ and ☾ centres between Greenwich and the ſhip -	13 30	=to 810″
☾ Diſtance from ☉ in 3h or 180′ is 1° 27′ 7″ which is - - - - - -		=to 4867

Therefore ſay, As 4867″ is to 180′ ſo 810″ is to 29′ 57″ which being deduced from the head* of noon, or 12h gives the true apparent time at Greenwich to be - - - 11h 30′ 3″ A. M.

Time before noon at Greenwich - - - - - - - -	29 57	
True apparent time at the ſhip as above - - - - -	1 41 4	P. M.
Difference of time between Greenwich and the ſhip - -	2 11 1	

Difference of time being 2h 11′ 1″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 32° 45′ 15″ eaſt, from the Royal Obſervatory of Greenwich in Great Britain.

* *Or thus : Deduce* 29′ 57″ *from* 24h *and it gives* 23h 30′ 3″ *the time from noon yeſterday, the* 24*th ; from which take* 12h. *and it gives the time this morning at Greenwich as above,* 11h 30° 3′ A. M.

Example IX.

A Lunar obſervation made June 23d, 1792, by ☉ weſt of the ☽, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 4h 35′ 00″ P. M. by W.	Obs'd ☉ & ☾ near. limb. 42° 4′ 30″	☾ Lower limb 59° 36′ 00″	☉ Lower limb 17° 20′ 00″
At 4 39 00 do.	do. - 42 5 30	do. 58 44 00	do. 16 26 00
At 4 43 00 do.	do. - 42 6 30	do. 57 58 00	do. 15 33 00
13 57 00 Sum.	Sum - 126 16 30	Sum - 176 18 00	Sum - 49 19 00
4 39 00 Mean.	Mean - 42 5 30	Mean - 58 46 00	Mean - 16 26 20
3 4 W. too ſlow.	Index error deduce — 2 30	☾ Semidiameter 15 4	☉ Semidiameter 15 47
4 42 4 true apparent time at the ſhip when the obſervation was made.	Neareſt limbs - 42 3 00	59 1 4	16 42 7
	☉ Semidiameter - 15 47	Eyes alt. or dip for 24 feet 4 40	Eyes alt. or dip for 24 feet 4 40
	☾ Semidiameter 14′ 51″ Aug. of ſemid. in alt. 13 15 4	☾ App. alt. 58 56 24	☉ App. alt. 16 37 27
	Apparent centres - 42 33 51		

	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. logs
☾ Horiz. parallax 54′30″ Exceſs above 53′ is 1 30				
Apparent centres 42 ☾ Apparent alt. 58 ☉ Apparent alt. 16	+ 30′ 47″	+ 271		
Apparent centres 42 ☉ Altitude incr. 60′ 17 ☾ Apparent alt. 58	+ 29′ 18″	+ 303	— 89″	+ 32″
Apparent centres 42 ☾ Altitude incr. 60′ 59 ☉ Apparent alt. 16	+ 31′ 17″	+ 262	+ 30″	— 9″
App. cent. incr. 60′ 43 ☾ Apparent alt. 58 ☉ Apparent alt. 16	+ 29′ 30″	+ 297	— 77″	+ 26″

If 60′ incr. of ☉ alt. gives — 89″ of a red. & + 32 of a corr. log. odd min. of ☉ alt. gives reduct — 56 & corr. log. + 20
If 60′ incr. of ☾ alt. gives + 30 of a red. & — 9 of a corr. log. odd min. of ☾ alt. gives reduct + 29 & corr. log. — 9
If 60′ inc. of ☉ & ☽ cen. g. — 77 of a red. & + 26 of a corr. log. odd min. of ☉ & ☽ cent. g. red. — 44 & corr. log. + 15

This is the reduction and correcting logarithm for the odd min. of ☾ alt. ☉ alt. and diſtance	— 1 11	+ 26
Firſt reduction and correcting logarithm with their reſpective fines as above brought down	+ 30 47	+ 271
This is the correction as far as ☾ parallax 53′ - - - - - -	+ 29 36	+ 297
Exceſs of ☾ parallax above 53′ is 1′ 30″ its parallactic log which muſt be added to corr. log. is - -		+ 778
Sum of correcting log. and parallactic log. is + 1075 its correſponding arc is - -	+ 45	+ 1075
This is the true correction of ☉ & ☾ centres from refraction and parallax - -	+ 30 21	
Appar ent centres of ☉ & ☾ brought down - - - - - -	42 33 51	
True apparent centres of ☉ & ☾ cleared from refraction and parallax -	43 4 12	
True apparent centres of ☉ & ☾ under head of noon at Greenwich per Naut. Alm.	43 28 55	
Difference of ☉ & ☾ centres between Greenwich and the ſhip -	24 43	= to 1483″
☾ Diſtance from ☉ in 3h is 1° 21′ 47″ which is - - - - - - - -		= to 4907

Therefore ſay, As 4907″ is to 180′, ſo 1483″ is to 54′ 24″, which being deduced from the head of noon, or 12h.

gives the true apparent time at Greenwich to be - - - - -	1 h [illegible] 36″	A. M.
Time before noon at Greenwich - - - - - - -	5 + 44	
True apparent time at the ſhip as above - - - -	4 2 4	P. M.
Difference of time between Greenwich and the ſhip - -	5 36 28	

Difference of time being 5h 36′ 28″ which turned into degrees gives the longitude of the ſhip when the obſervation was made as per above time to be 84° 7′ 00″ eaſt of the Royal Obſervatory of Greenwich in Great Britain.

Example

Example X.

A Lunar obſervation made November 11th, 1702, by ☉ eaſt of the ☾, and worked by Mayer or Shepherd's Aſtronomical Tables.

At 7h 1′ 00″ A. M. by Watch At 7 4 00 do. At 7 7 00 do.	Obs'd diſt. of ☉ & ☾ near. limbs 41° 36′ 00″ do. - 41 35 00 do. - 41 34 00	Centre of ☾ apparent altitude found by calculation } 49° 31′ 00″
21 12 00 Sum.	Sum - - 124 45 00	
7 4 00 Mean. 2 3 Watch to faſt.	Mean - - 41 35 00 Index error - - - — 2 30	
7 1 57 True appar. time at the ſhip when the obſervation was made.	Neareſt limbs - - 41 32 30 ☉ Semidiameter - - 16 14 ☾ Semidiameter 15′ 33″ } 15 41 Augmen. of ſemid. in alt. 8 }	Centre of ☉ apparent altitude found by calculation } 20 40 23
☾ Horizontal parallax 57′ 1″ Exceſs above 53′ is 4 1	Apparent centres - 42 4 25	

Reductions.		Correcting logarithms.	Diff. of Reduction.	Diff. of Correcting Logar.
Apparont centres 42 ☾ Apparent altitude 49 ☉ Apparent altitude 20	+ 19′ 9″	+ 480	-	
Apparent centres 42 ☉ Alt. increſed 60′ 21 ☾ Altitude - 49	+ 17 45	+ 510	— 84″	+ 30
Apparent centres 42 ☾ Alt. increaſed 60′ 50 ☉ Apparent altitude 20	+ 19 49	+ 465	+ 40	— 15
App. centres incr. 60′ 43 ☾ Apparent altitude 49 ☉ Apparent altitude 20	+ 18 7	+ 503	— 62	+ 23

If 60 incr. of ☉ alt. gives — 84 of a red. & + 30 of a corr. log. odd min. of ☉ alt. gives red. — 56 & corr. log. + 20
If 60 incr. of ☾ alt. gives + 40 of a red. & — 15 of a corr. log. odd min. of ☾ alt. gives red. + 21 & corr. log. — 8
If 60 inc. of ☉ & ☾ cent. g. — 62 of a red. & + 23 of a corr. log. odd min. of centres giv. red. — 4 & corr. log. + 2

This is the reduction and correcting logarithm for the odd minutes of ☾ alt. ☉ alt. and diſtance — 39 + 14
Firſt reduction and correcting logarithm with their reſpectiue fines as above brought down + 19 9 + 480
This is the correction as far as ☾ parallax 53′ - - - - - - + 18 30 + 494
Exceſs of ☾ parallax above 53′ is 4′ 1″ its parallactic log. which muſt be added to corr. log. is - - - + 350
Sum of correcting log. and parallactic log. is + 844 its correſponding arc is - - + 1 17 + 844
This is the true correction of ☉ and ☾ centres from refraction and parallax - - + 19 47
Apparent centres of ☉ and ☾ brought down - - - - - 42 4 25
True apparent centres of ☉ and ☾ cleared from refraction and parallax 42 24 12
True apparent centres of ☉ and ☾ under head of 15h at Greenwich - 42 31 49
Difference of ☉ and ☾ centres between Greenwich and the ſhip - 7 37 to 457″
☾ Diſtance from ☉ in 3h or 180′ is 1h 30′ 8″ which is - - - - - - - =to 5408
Therefore ſay, As 5408″ is to 180′ ſo 457″ is to 15′ 13″ which being added to 15h gives the true apparent time at Greenwich from noon yeſterday to be 15h 15′ 13″ which is to-day 3h 15′ 13″ A. M.
True apparent time at the ſhip as above - - - - - 7 1 57 A. M.
Difference of time between Greenwich and the ſhip - - 3 46 44 which

Turned into degrees gives the longitude of the ſhip to be 56° 41′ 00″ Eaſt from the Royal Obſervatory of Greenwich in Great Britain.

Example

Example XI.

A Lunar obſervation made November 23d, 1792, by ☉ weſt of the ☾, and worked by Mr Lyon's method improved, *&c.*

At 4h 2′ 00″ P. M. by Watch 46 Watch too faſt.	Obs'd diſt of ☉ & ☾ near. limbs 120° 46′ 30″	Centre of ☾ true altitude 22° 47′ 9″
	Index error deduce - 2 30	Correction - — 51 9
4 1 14 True apparent time at the ſhip.	Neareſt limbs - - 120 44 00	☾ Apparent altitude 21 56 00
	☉ Semidiameter - - 16 16	Centre of ☉ true alt. found by calculation } 35 28 00
☾ Horizontal parallax } 57′ 44″	☾ Semidiameter - 15′ 42″ } Augmen. of ſemid. in alt. 7 } 15 49	Correction - 1 13
	Apparent centres - - 121 16 5	☉ Apparent altitude 35 29 13

Correction of ☉ altitude -	0° 1′ 13″	P. L. -	2,1701	P. L. -	2,1701
☉ Apparent centres - -	35 29 13	Coſine	9,9108	Co. tangent	10,1470
Apparent centres - -	121 16 5	Sine -	9,9318	Tangent	10,2167
☾ Apparent centre -	21 56 00	Co. ſecant	10,4277		

	2,4404 = P. L. for 1ſt arc 39″	2,5338 = P. L. for
	2d arc 32	
Correction from refraction is ſum of 1ſt and 2d arcs - - - -	1 11	
Apparent centres brought down - - - - -	121 16 5	
	121 17 16	
Correction from parallax is ſum of 3d and 4th arcs - - -	49 57	
	120 27 19	
Correction from Table XIII. - - - - -	5	
True apparent centres of ☉ and ☾ cleared from refraction and parallax	120 27 14	

Table VIII. correction of ☾ alt.	0° 51′ 9″	P. L -	0,5464	P. L. -	0,5464
☾ Apparent altitude -	21 56 00	Coſine	9,9674	Co. tangent	10,3950
App. centres corr. from refrac.	121 17 16	Sine	9,9318	Tangent	10,2164
☉ True altitude - -	35 28 00	Co. ſecant	10,2364		

	0,6820 P. L. for 3d arc 37′ 26″	1,1576 = P. L. for
	4th arc 12 31	
Sum of 3d and 4th arcs - - - - - -	49 57	

True apparent centres cleared from refraction and parallax brought down - - 120° 27′ 14″
True apparent centres under head of 3h at Greenwich per Nautical Almanac - 121 3 53
Difference - 36 39 is
= to 2199″
☾ Diſtance from ☉ in 3h or 180′ is 1° 32′ 27″ which is - - - - = to 5547
Therefore ſay, As 5547″ is to 180′ ſo 2199″ is to 1h 11′ 21″ which being deduced from 3h leaves the true apparent time at Greenwich to be - - - - - - - - - 1h 48′ 39″ P. M.
True apparent time at the ſhip as above - - - - - - - 4 1 14 P. M.
Difference of time between Greenwich and the ſhip - - 2 12 35
Difference of time 2h 12′ 35″ which turned into degrees gives the longitude of the ſhip to be 33° 8′ 45″ Eaſt from the Royal Obſervatory of Greenwich in Great Britain.

Example XII.

A Lunar observation made February 27th, 1790, by ✻ Pollux west of the ☾, and worked by Mayer or Shepherd's Astronomical Tables.

At 7h 51′ 00″ P. M. by W 13 54 W. too slow	Obs'd ✻ & ☾ near. limbs 31° 17′ 41″	Alt. ☾ L. limb 28° 3′ 00″	✻ Limb - 24° 12′ 00″		
	Index error deduce — 1 45	Indexerrorded.— 2 00	Index err. ded + 2 00		
8 4 54 true appar. time at the ship when the observation was made.	31 15 56	28 1 00	24 14 00		
	✻ Semidiameter 00	☾ Semid. & aug. 16 38	✻ Semidiameter 00		
	☾ Semidiameter 16′ 30″ Aug. of sem. in alt. 8 } 16 38	28 17 38	24 14 00		
		Eye's alt. or dip for 24 feet } 4 40	Eye's alt. or dip for 22 feet } 4 40		
	Apparent centres 31 32 34	☾ App. alt. 28 12 85	✻ Appar. alt. 24 9 20		
☾ Horiz. parallax 60′ 35″ Excess above 53′ is 7 35	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. log.	
Apparent centres 31 ☾ Apparent alt. 28 ✻ Apparent alt. 24	+ 0′ 39″	+ 1887 Correspond. arc + 7			
Apparent distance 31 ✻ Altitude inc. 60′ 25 ☾ Apparent alt. 28	— 1′ 00″	— 1732 Correspond. arc — 10	— 1′ 39″	— 17″	
Apparent distance 31 ☾ Altitude inc. 60′ 29 ✻ Apparent alt. 24	+ 2′ 00″	— 1410 Correspond. arc + 21	+ 1 21	+ 14	
App. dist. incr. 60′ 32 ☾ Apparent alt. 28 ✻ Apparent alt. 24	+ 0′ 14″	+ 2431 Correspond. arc + 2	— 0 25	— 5	

If 60′ incr. of ✻ alt. gives — 1′ 39″ of a red. & — 17 of a cor. arc odd min. of ✻ alt. gives red. — 16 & cor. arc — 3
If 60 incr. of ☾ alt. gives + 1 21 of a red. & + 14 of a cor. arc odd min. of ☾ alt. gives red. + 78 & cor. arc + 14
If 60 incr. of ✻ & ☾ cent. g.— 25 of a red. & — 5 of a cor. arc odd min. of ✻ & ☾ cen. g. red.— 13 & cor. arc — 3

This is the reduction and correcting arc for the odd minutes of ☾ alt. ✻ alt. and dist. + 0 49 + 8
First reduction and correcting arc with their respective fines as above brought down + 0 39 + 7
This is the correction as far as ☾ parallax 53′ - - - - + 1 28 + 15 arc = to log. + 1556

Excess of ☾ paral. above 53′ is 7′ 35″ its paral. log. which must be added to corr. log. is - - - + 74
Sum of correcting log. and parallactic log. is — 2806 its corresponding arc is - + 0 12 - + 2630
This is the true correction of ✻ and ☾ centres from refraction and parallax - + 1 40
Apparent centres of ✻ and ☾ brought down - - - 31 32 34
True centres of ✻ and ☾ cleared from refraction and parallax - 31 34 14
True centres of ✻ and ☾ under head of 9h at Greenwich per Na. Alm. 32 6 18
Difference of ✻ and ☾ centres between Greenwich and the ship — 32 4 = to 1924″
☾ Distance from ✻ in 3h or 180′ is 1° 42′ 27″ which is - - - - = to 6147
Therefore say, As 6147″ is to 180′ so is 1924″ to 56′ 20″ which being deduced from 9h gives the true apparent time at Greenwich to be - - - - - - - 8h 3′ 40″ P. M.
True apparent time at the ship as above - - - - 8 4 54 P. M.
Difference of time between Greenwich and the ship - - 1 14

Difference of time being 0h 1′ 14″ which turned into degrees gives the longitude of the ship when the observation was made as per above time to be 28′ 30″ east, from the Royal Observatory of Greenwich in Great Britain.

Example XIII.

A Lunar observation made April 13th, 1704, by ✱ Regulus west of the ☾, and worked by Mayer or Shepherd's Astronomical Tables.

At 8h 15′ 00″ P. M. by Watch 3 5 Watch to fast. 8 11 55 True appar. time at the ship when the observation was made.	Obs'd dist. of ✱ & ☾ near. limbs 42° 27′ 30″ Index error - - - — 3 00 Nearest limbs - - 42 24 30 ✱ Semidiameter - - 00 ☾ Semidiameter 14′ 48″ Augmen. of semid. in alt. 9 } 14 57 Apparent centres - 42 39 27	Centre of ☾ apparent altitude found by calculation } 34° 22′ 00″ Centre of ✱ apparent altitude found by calculation } 66 10 00
☾ Horizontal parallax 54′ 17″ Excess above 53′ is 4 17		

	Reductions.	Correcting logarithms.	Diff. of Red.	Diff. of Cor. Log.
Apparent centres 42 ☾ Apparent altitude 34 ✱ Apparent altitude 66	— 38′ 19″	— 131		
Apparent centres 42 ✱ App. alt. increased 60′ 67 ☾ Apparent ultitude 34	— 38 52	— 125	+ 33″	— 6
Apparent centres 42 ☾ App. alt. increased 60′ 35 ✱ Apparent altitude 66	— 37 31	— 139	— 48	+ 8
App. centres incr. 60′ 43 ☾ Apparent altitude 34 ✱ Apparent altitude 66	— 38 2	— 132	— 17	+ 1

If 60′ incr. of ✱ alt. gives + 33 of a red. & — 6 of a corr. log. odd min. of ✱ alt. gives red. + 5 & corr. log. — 1
If 60 incr. of ☾ alt. gives — 48 of a red. & + 8 of a corr. log. odd min. of ☾ alt. gives red. — 17 & corr. log. + 3
If 60 inc. of ✱ & ☾ cent. g. — 17 of a red. & + 1 of a corr. log. odd min. of centres giv. red. — 12 & corr. log. + 1

This is the reduction and correcting logarithm for the odd minutes of ☾ alt. ✱ alt. and distance — 24 + 1′
First reduction and correcting logarithm with their respective fines as above brought down — 38 19 — 131
This is the correction as far as ☾ parallax 53′ - - - - - — 37 55 — 132
Excess of ☾ parallax above 53′ is 4′ 17″ its parallactic log. which must be added to corr. log. is - - - — 846
Sum of correcting log. and parallactic log. is — 978 its corresponding arc is . - — 57 — 978
This is the true correction of ✱ and ☾ centres from refraction and parallax - - — 38 52
Apparent centres of ✱ and ☾ brought down - - - - - 42 39 27
True apparent centres of ✱ and ☾ cleared from refraction and parallax 42 00 35
True apparent centres of ✱ and ☾ under head of 12h at Greenwich per Na. Al. 41 40 26
Difference of ✱ and ☾ centres between Greenwich and the ship - 20 9 = to 1209″
☾ Distance from ✱ in 3h or 180′ is 1° 29′ 26″ which is - - - - - - - = to 5366
Therefore say, As 5366″ is to 180′ so 1209″ is to 40′ 33″ which being added to 12h the head under which the Greenwich time was found makes the apparent time at Greenwich 12h 40′ 33″ or 0h 40′ 33″ A. M.
Apparent time at the ship 8h 11′ 55″ P. M. which from midnight is 3 48 5
Difference of time between Greenwich and the ship - - 4 28 38

Difference of time being 4h 28′ 38′ which turned into degrees gives the longitude of the ship when the observation was made as per above time to be 67° 9′ 30″ West from the Royal Observatory of Greenwich in Great Britain.

Example

Example XIV.

A Lunar observation made April 16th, 1794, by ✱ Antares east of the ☾, and worked by Mayer or Shepherd's Astronomical Tables.

At 4h 31′ 00″, A. M. by Watch 8 34 Watch too slow. 4 39 34 True apparent time at the ship when the observation was made.	Obs'd dist. of ✱ & ☾ near. limb. 30° 49′ 30″ Index error - - - — 3 00 Nearest limbs - - 30 46 30 ✱ Semidiameter - - 00 ☾ Semidiameter - 14′ 59″ Augmen. of semid. in alt. 6 } 15 5 Apparent centres - - 31 1 35	Centre of ☾ apparent altitude found by calculation	17° 27′ 00″
		Centre of ✱ apparent altitude found by calculation	20 16 00

☾ Horiz. parallax 54′56″ Excess above 53′ is 1 56	Reductions.	Correcting Logarithms.	Diff. of red.	D. of cor. logs
Apparent centres 31° ☾ Apparent alt. 17 ✱ Apparent alt. 20	— 8′ 16″	— 824		
Apparent centres 31 ✱ App. alt. incr. 60′ 21 ☾ Apparent alt. 17	— 9′ 56″	— 735	+ 100″	— 89″
Apparent centres 31 ☾ App. alt. incr. 60′ 18 ✱ Apparent alt. 20	— 6′ 49″	— 913	— 87″	+ 89″
App. cent. incr. 60′ 32 ☾ Apparent alt. 17 ✱ Apparent alt. 20	— 8′ 16″	— 819	+ 00″	— 5″

If 60′ incr. of ✱ alt. gives + 100″ of a red. & — 89 of a corr. log. odd min. of ✱ alt. gives reduct. + 27 & corr. log. — 24
If 60′ incr. of ☾ alt. gives — 87 of a red. & + 89 of a corr. log. odd min. of ☾ alt. gives reduct. — 39 & corr. log. + 40
If 60′ inc. of ✱ & ☽ cen. g. + 00 of a red. & — 5 of a corr. log. odd min. of ✱ & ☽ cent. g. red. + 00 & corr. log. — 00

This is the reduction and correcting logarithm for the odd min. of ☾ alt. ✱ alt. and distance	— 12	+ 16
First reduction and correcting logarithm with their respective fines as above brought down	— 8 16	— 824
This is the correction as far as ☾ parallax 53′ - - - - - -	— 8 4	— 840
Excess of ☾ parallax above 53′ is 1′ 56″ its parallactic log which must be added to corr. log. is - - -		— 668
Sum of correcting log. and parallactic log. is — 1508 its corresponding arc is - -	— 17	— 1508
This is the true correction of ✱ & ☾ centres from refraction and parallax - -	— 8 21	
Apparent centres of ✱ & ☾ brought down - - - - - -	31 1 35	
True apparent centres of ✱ & ☾ cleared from refraction and parallax -	30 53 14	
True apparent centres of ✱ & ☾ under head of 21h at Greenwich per Naut. Alm.	31 4 21	
Difference of ✱ & ☾ centres between Greenwich and the ship -	11 7	= to 667″
☾ Distance from ✱ in 3h or 180′ is 1° 26′ 37″ which is - - - - - - -		= to 5197

Therefore say, As 5197″ is to 180′, so 667″ is to 23′ 6″, which added to 21h. the head under which the Greenwich time was found, makes the apparent time at Greenwich 21h 23′ 6″ or - 9h 23′ 6″ A. M.

True apparent time at the ship as above - - - - -	4 39 34 A. M.
Difference of time between Greenwich and the ship - -	4 43 32

Difference of time being 4h 43′ 32″ which turned into degrees gives the longitude of the ship when the observation was made as per above time to be 70° 53′ 00″ west of the Royal Observatory of Greenwich in Great Britain.

APPENDIX.

APPENDIX.

PHILADELPHIA, *June* 23d, 1794.

SIR,

AS I consider the masting of our frigates as of the utmost importance to their sailing, working, and general ease and management at sea, I have herewith annexed proportions calculated from a system I formed some years ago; and although I believe these proportions would be approved of by competent judges of the subject in Europe, yet I wish the most experienced sea-officers of skill here, or other ingenious persons, who have been at sea, to be consulted before they are adopted: I mention sea-officers, &c. because it is almost impossible that any other description of men, who have not had an opportunity of being often at sea, can form a proper judgment on this important subject; as the complete masting of a ship must be guided by nice observation, experience, and judgment, accompanied with some degree of philosophy.

I have the honour to be,

SIR,

Your most obedient

And very humble servant,

THOMAS TRUXTUN.

(Copy.)

Hon. GENERAL KNOX,
Secretary of War, &c. &c.

REMARKS.

As the extreme breadth of beam of a ſhip is proportioned to the length of her keel, ſo are the length of her maſts and yards calculated to that breadth; but as the formation of all veſſels' bodies differ according to the purpoſe for which they are intended, it is abſolutely neceſſary to vary in the mode of calculating the dimenſions of the ſpars, according to the conſtruction of the body.

The diameter of all ſpars here, under the denomination of maſts, are intended to be one inch in the partners to every three feet in length; and that of the yards one inch in the ſlings to four and three quarters feet of the whole length, the mizen-maſt excepted, which from its being made the ſame length of the fore-maſt, on account of carrying a large boom, mizen, or ſpanker, the ſize is reduced to one inch in the partners, to every four feet of the whole length; and the bow-ſprit in the bed is fixed of the ſame ſize as the foremaſt in the partners.

In calculating the diameter of pole-maſts, ſuch as a pole mizen-top-maſt, or pole top-gallant-maſt, the length of the pole is deducted, and the remainder being the length of the maſt from the heel to the hound, is divided by three, to give its diameter in inches in the cap.

As the breadth of beam, length of main-maſt and main-yard, is here given as the baſis of all proportions for the other ſpars, to find the length of the main-maſt I take twice the breadth of the beam, and one-ſixth of the ſum, and add them together; and to find the length of the main yard, I take twice the breadth of the beam. The ſtudding-ſail booms and yards, &c. not mentioned here, are calculated and regulated by the uſual mode. The ſame principle of maſting will anſwer for ſhips of the line, only with them a reſpect muſt be had to their additional depth.

Here

Here follows the calculation of the maſts, yards, and ſpars of a Frigate of 44 guns, of the following dimenſions, viz.

145 feet keel, ſtraight rabbet; extreme breadth of beam 43 feet 6 inches; depth of hold 14 feet 3 inches; depth between decks 6 feet 3 inches; and the waiſt 7 feet; otherwiſe in proportion.

Extreme breadth of beam -	Feet	43	6
Multiply by - - -		2	
This the length of the main-yard -		87	
Add one-ſixth of this ſum - -		14	6
The length of main-maſt - -		101	6

General proportions of *Masts, Spars, &c.* for a Frigate built for War of 44 guns.

	Feet.	Inch		Feet.		Inch.
Main-mast the whole length (as calculated page 3)	101	6	Head out of same	$13\frac{1}{3}$	Diameter	34
One-thirteenth deduct from the main-mast, and the remainder is the whole length of the fore-mast	93	8	- -	$13\frac{1}{3}$		$31\frac{1}{7}$
Mizen-mast the same length of the fore-mast	93	8	- -	10		$23\frac{1}{3}$
Main-yard the whole length (as calculated page 3)	87		Arms out of same	$4\frac{1}{3}$		$18\frac{1}{3}$
One-twentieth deduct from main-yard, and the remainder is the whole length of the fore-yard	82	8	- -	$4\frac{1}{3}$		$17\frac{1}{7}$
Cross-jack-yard one-quarter shorter than the fore-yard	62		- -	$3\frac{1}{3}$		13
Bow-sprit one-third shorter than the fore-mast	62	6	- -	-		$31\frac{1}{4}$
Jibb-boom one-quarter shorter than the bow-sprit	47		- -	-		$15\frac{3}{4}$
Three-fifths the length of the main-mast is the main-top-mast	60	9	Head out of same	8		$20\frac{1}{3}$
One-twentieth deduct from main-top-mast, and the remainder is the fore-top-mast	57	8	- -	8		19
Two-thirds of the mizen-mast is the pole mizen-top-mast	62	4	- -	21		14
Four-fifths of the main-top-mast is the main-top-gallant-mast	48	8	- -	16		11
Four-fifths of the fore-top-mast is the fore-top-gallant-mast	46		- -	16		10
Difference between one-third and one-fourth taken from the main-yard, gives the main-top-sail-yard	61	7	Arms out of same	5		$13\frac{1}{7}$
Difference between one-third and one-fourth taken from the main-top-sail-yard, gives the main-top-gallant-yard	43	8	- -	2		9
One-fourth taken from the main-top-gallant-yard, gives the main-royal-yard	32	10	- -	$1\frac{1}{2}$		7
Difference between one-third and one-fourth taken from the fore-yard, gives the fore-top-sail-yard	58	7	- -	5		$12\frac{1}{7}$
Difference between one-third and one-fourth taken from the fore-top-sail-yard, gives the fore-top-gallant-yard	41	7	- -	2		$8\frac{3}{7}$
One fourth taken from the fore-top-gallant-yard, gives the fore-royal yard	31	3	- -	$1\frac{1}{4}$		$6\frac{3}{7}$
Difference between one-third and one-fourth taken from cross-jack-yard, gives the mizen-top-sail-yard	43	11	- -	$3\frac{1}{3}$		$9\frac{1}{7}$
Difference between one-third and one-fourth taken from mizen-top-sail-yard, gives the mizen-top gallant-yard	31	2	- -	$1\frac{1}{3}$		$6\frac{3}{7}$
Mizen-gaff, the length of the mizen top-sail-yard	43	11	- -	-		$9\frac{1}{7}$
Mizen or spanker-boom, once and one-third the length of the mizen-gaff	58	7	- -	-		$12\frac{1}{3}$
Ensign-staff one-fourth shorter than mizen-top-sail-yard	33					
Jack-staff one half the length of the ensign-staff	16	6				
One half and one-twentieth of the beam is the width of main-top	24					
One half the beam is the width of the fore-top	21	9				
Two-thirds the width of the main-top is the mizen top	16					

The sprit-sail-yard the same as the fore-top-sail-yard, and the sprit-sail-top-sail-yard the same as the fore-top-gallant-yard.

Of Maſt-heads and Yard-arms in Men of War.

TAKE the depth of waiſt, and the depth between decks, of a frigate, for the length of the main and fore-maſt heads; and three-fourths of the main-maſt-head, for the head of the mizen-maſt: or you may take the fourth of the length of each top-maſt (leaving out the pole of the mizen-top-maſt) for their reſpective lower-maſt-heads; (the former method will only anſwer for frigates, but the latter for all ſorts of ſhips*.)

Four-fifths of the mizen-maſt head, for main and fore-top-maſt heads (or one-ſeventh of the length of ſaid top-maſts.)

One-third of the length of the pole-mizen-top-maſt and pole-top-gallant-maſts, for their reſpective heads.

One-third of the main-maſt head for the main and fore-yard arms (or one-twentieth of the length of ſaid yards for each arm.)

One-third of mizen-maſt head for croſs-jack yard arms (or one-eighteenth of the ſaid yard for each arm.)

One half of mizen-maſt head for main and fore-top-ſail yard arms (or one-twelfth of the ſaid yards for each arm).

Mizen-top-ſail yard arms the ſame as croſs-jack yard arms.

Main and fore-top-gallant-yard arms are two-thirds of the mizen-top-ſail yard arms.

Mizen-top-gallant yard arms, and main and fore-royal yard arms one-fourth ſhorter than main and fore-top-gallant yard arms.)

In a line-of-battle ſhip take the depth of waiſt; and half the depth of waiſt, with the depth between the next decks, for the length of main and fore-maſt heads; or you may take one-fourth of the length of each top-maſt, as above-mentioned, for their reſpective lower-maſt heads, and then calculate the reſt per the above rule.

Of placing of Maſts in Men of War.

TAKE one-ſeventh of the gun deck from the rabbet of the apron, and let that be the centre of the fore-maſt, in all ſhips properly built for war, of a ſharp conſtruction; but ſhips built with a full harpin, or of a great length, take one-eighth of the gun-deck inſtead of one-ſeventh.

Take one-ſixth of the gun-deck from the rabbet of the poſt, and let that be the centre of the mizen-maſt for a ſhip built for war, of ſixty feet keel, ſtraight rabbet; and as the main-maſt is carried proportionably farther aft in larger ſhips, the mizen-maſt ſhould be carried aft in the ſame

 ratio.

* The Europeans take generally a proportion of the lower-maſt for their reſpective heads; but that is by no means a good mode, as ſome ſhips bury much more of their lower maſts than others.

The depth of waiſt, and depth between decks, however, being nearly proportionate in frigates and men of war, purpoſely built for that ſort of ſervice, the method here mentioned, from thoſe depths, may be taken with much more propriety than any proportion of the lower maſts; but as the top-maſts of ſhips are in a great meaſure ſupported by the lower-maſt heads, the proportion of the top-maſt is a rule that will always anſwer: but here is a choice of two methods, which may be taken according to circumſtances, or the judgment of thoſe who undertake the maſting of ſhips.

ratio. In ſhips of ſixty feet keel, ſtraight rabbet, place the centre of the main-maſt abaft the centre of the keel for ſtraight rabbet, ſquared up to the gun deck thirty inches, and in all other ſhips properly built for war in the ſame proportion; as per example.

Suppoſe I want to know the proper place for the centre of the main-maſt of one of our 44 gun frigates—I proceed thus: If 60 feet by the keel give 30 inches, what will 145 feet, the length of keel, ſtraight rabbet, of our 44's give? *Anſ.* 6 feet and one-half inch.

Again: Suppoſe I want to know on the ſame principles the place for the main-maſt of one of our 36 gun frigates; I ſay, As 60 feet is to 30 inches, ſo I find 136 feet, the length of keel, ſtraight rabbit, of our 36 gun frigates, is to five feet eight inches, the proper place for the centre of the main-maſt, abaft the centre of the keel.

Suppoſe I want to know the proper place for the centre of the main-maſt of a 74 gun ſhip of 147 feet keel, ſtraight rabbet; I find that as 60 feet keel is to 30 inches, ſo 147 feet is to 6 feet, one inch and an half.

Here I muſt remark, that it is not many years ſince it was a cuſtom among the maritime nations of Europe to place the main-maſt of a ſhip on or about the centre of the keel; but that method is now univerſally exploded, for reaſons well known to every good ſea officer.

The place of the mizen-maſt for the 44 gun frigates is found by the before-mentioned method, in the following manner, *viz.*

Length of the gun-deck (which is underſtood here to be the upper deck, with the line of guns fore and aft) is 175 feet; one-ſixth of which from the rabbet to the ſtern poſt, is 29 feet 2 inches.

Centre of the main-maſt of the 44 gun frigates, found as above, is 6 feet and one half inch; deduct therefrom 2 feet 6 inches, the place of the centre of the main-maſt of a ſhip of 60 feet keel, and the remainder is 3 feet, 6 inches and a half, the ratio farther aft in a ſhip of 145 feet keel, ſuch as our 44 gun frigates, than it is in one of 60 feet keel, as aforeſaid. Now deduct this 3 feet, 6 inches and a half from 29 feet 2 inches, the one-ſixth of the gun-deck as above, and the remainder is 25 feet, 7 inches and a half, the true place for the center of the mizen-maſt, from before the rabbet of the ſtern poſt of our 44 gun frigates; and in the ſame manner calculate the place for the centre of the mizen-maſt for all other ſhips of war.

The length of the gun-deck of the 36 gun frigates being 163 feet 7 inches by the draught, by the above rule the centre of the mizen-maſt ſhould be placed before the rabbet of the ſtern-poſt, 24 feet 1 inch on the gun-deck; and the centre of the fore-maſt of thoſe frigates 20 feet, 5 inches and a half abaft the rabbet of the apron, on ſaid deck; and in the 44 gun frigates, the gun-deck being 175 feet by the draught, the centre of the fore-maſt will be, by the above rule, 21 feet, 10 inches and a half abaft the rabbet of the apron.

Of the Rake of Maſts, &c.

THE bowſprit to ſteeve one foot two inches to every three feet in length.

The fore-maſt to rake aft one-eighth of an inch to every three feet in length.

The main-maſt to rake aft one-half inch to every three feet in length.

The mizen-maſt to rake aft one inch to every three feet in length.

DIMENSIONS of the *Masts*, *Yards*, and *Spars* of a Frigate of 36 guns; whose length of keel is 136 feet—extreme breadth of beam 40 feet—depth of hold 13 feet—depth between decks 6 feet—and waist 6 feet 9 inches, and otherwise in proportion: calculated from the principles laid down in the foregoing sheets.

	Feet.	Inch		Feet.		Inch.
Main-mast the whole length - - - - -	93	4	Head	$12\frac{1}{4}$	Diameter	$31\frac{1}{4}$
Fore-mast do. - - - - -	86	2	-	$12\frac{3}{4}$		$28\frac{1}{4}$
Mizen-mast do. - - - - - -	86	2	-	$9\frac{1}{4}$		$21\frac{1}{4}$
Main yard do. - - - - - -	80	-	Arms	$4\frac{1}{4}$		17
Fore yard do. - - - - - -	76	-	-	$4\frac{1}{4}$		16
Cross-jack yard do. - - - - - -	57	-	-	$3\frac{1}{4}$		12
Bow-sprit do. - - - - - -	57	6	-	-		$28\frac{1}{4}$
Jibb boom do. - - - - -	43	2	-	-		$14\frac{1}{4}$
Main top-mast do. - - - -	56	-	Head	$7\frac{1}{4}$		$18\frac{1}{4}$
Fore top-mast do. - - - - - -	53	-	-	$7\frac{1}{4}$		$17\frac{1}{4}$
Mizen top-mast do. - - -	57	4	-	19		13
Main-top-gallant-mast do. - - - - - -	44	8	-	15		10
Fore-top-gallant-mast do. - - - -	42	7	-	15		$9\frac{1}{4}$
Main-top-sail yard do. - - -	56	8	-	$4\frac{3}{4}$		12
Main-top-gallant yard do. - - - -	40	2	-	2		$8\frac{1}{4}$
Main-royal yard do. - - - - - -	30	2	-	$1\frac{1}{4}$		$6\frac{1}{4}$
Fore-top-sail yard do. - - - - - -	53	10	-	$4\frac{3}{4}$		$11\frac{1}{4}$
Fore-top-gallant yard do. - - - - - -	38	2	-	2		7
Fore-royal yard do. - - - - -	28	8	-	$1\frac{1}{4}$		6
Mizen-top-sail yard do. - - -	40	4	-	3		$8\frac{1}{4}$
Mizen top-gallant yard do. - - -	28	7	-	$1\frac{1}{4}$		6
Mizen-gaff - do. - - - - -	40	4	-	-		$8\frac{1}{4}$
Spanker-boom do. - - - - - -	53	9	-	-		$11\frac{1}{4}$
Ensign-staff - do. - - - - -	30	3				
Jack-staff - do. - - - - -	15	1				
Width of main-top do. - - - - -	22	-				
Do. fore-top. do. - - - - -	20	-				
Do. mizen-top. do. - - - - -	14	8				

N. B. I have observed before, that it is necessary to vary the size and dimensions of masts, according to the formation of the body, or the purpose the ship is intended for. And I may add also, that in merchant-ships, according to the number of hands to be employed on board them, in any particular service. The foregoing calculation being intended only for ships constructed and built for war, the master may easily make the necessary variations for other vessels.

In forming this system of masting, I have made the extreme breadth of beam the great basis of calculation, as it is by the breadth of beam that we are to measure or to judge what quantity of weight and pressure a ship will bear, from her masts, sails, and rigging aloft, without reclining, so as to drag a part of her upper works through the water; for if a ship from this, or any other cause, does not sail on that fine bottom which the artist has taken so much pains to construct, his labour is lost, and his intention destroyed.

One

One proportion (the breadth of beam) of the hull being taken to find the length of the main-maſt and main-yard, as I have ſhown, another part may as properly be taken to proportion the maſt-heads, &c. I have therefore brought forward the depth of waiſt, and the depth between decks for this purpoſe; which I think will anſwer as a better proportion than one-fourth of the length of the top-maſt: for it muſt be obſerved, that there are inconveniences attending maſt-heads, being too long as well as their being too ſhort. However, if one-fourth of the whole length of the top-maſt, as I have before mentioned, is taken for the lower maſts heads, it will make but little difference from the firſt method; as per example. By the firſt method, the 44 gun ſhips' main and fore-maſt heads are 13 feet 4 inches, (as the agitation of the fore-maſt is greater than the main-maſt, I have fixed the fore-maſt head to be of the ſame length as the main-maſt head), and by the ſecond method, the main-maſt head would be 15 feet 2 inches and a quarter; difference 22 inches and a quarter; and the fore-maſt head 14 feet 5 inches; difference from the firſt method 13 inches.

The pole-mizen-top-maſt the whole length is 62 feet 4 inches. I deduct the pole 21 feet therefrom, and the remainder being 41 feet 4 inches, is the length of the mizen-top maſt, from heel to hound; one-fourth of which is 10 feet 4 inches, for the head of the mizen-maſt; and by the firſt method, the head of the mizen-maſt is 10 feet; difference 4 inches.

The pole main-top-gallant-maſt the whole length is 48 feet 8 inches. I deduct the pole 16 feet, and the remainder being 32 feet 8 inches, is the length of the main-top-gallant-maſt, from heel to hound; one-fourth of which is 8 feet 2 inches, for the head of the main-top-maſt; and by the firſt method, the head of the main-top-maſt is 8 feet; difference 2 inches only.

The fore-top-maſt head calculated in the ſame way, would give but little difference alſo from the firſt method. In fact, either of theſe methods of finding the lengths of maſt-heads will anſwer very well, as their difference is too trifling to be of any conſequence.

The only true way of maſting a ſhip, is by her own dimenſions, and not at random, as merchantmen moſtly are: and with reſpect to yards, I am clearly of opinion, that the ſhips of war of all nations carry too ſquare yards, for the following reaſons, 1ſt, Where a ſhip of this ſort is going by the wind, and her yards braced up, you will find in general that the after part of her ſails becomes a back ſail; conſequently

inſtead

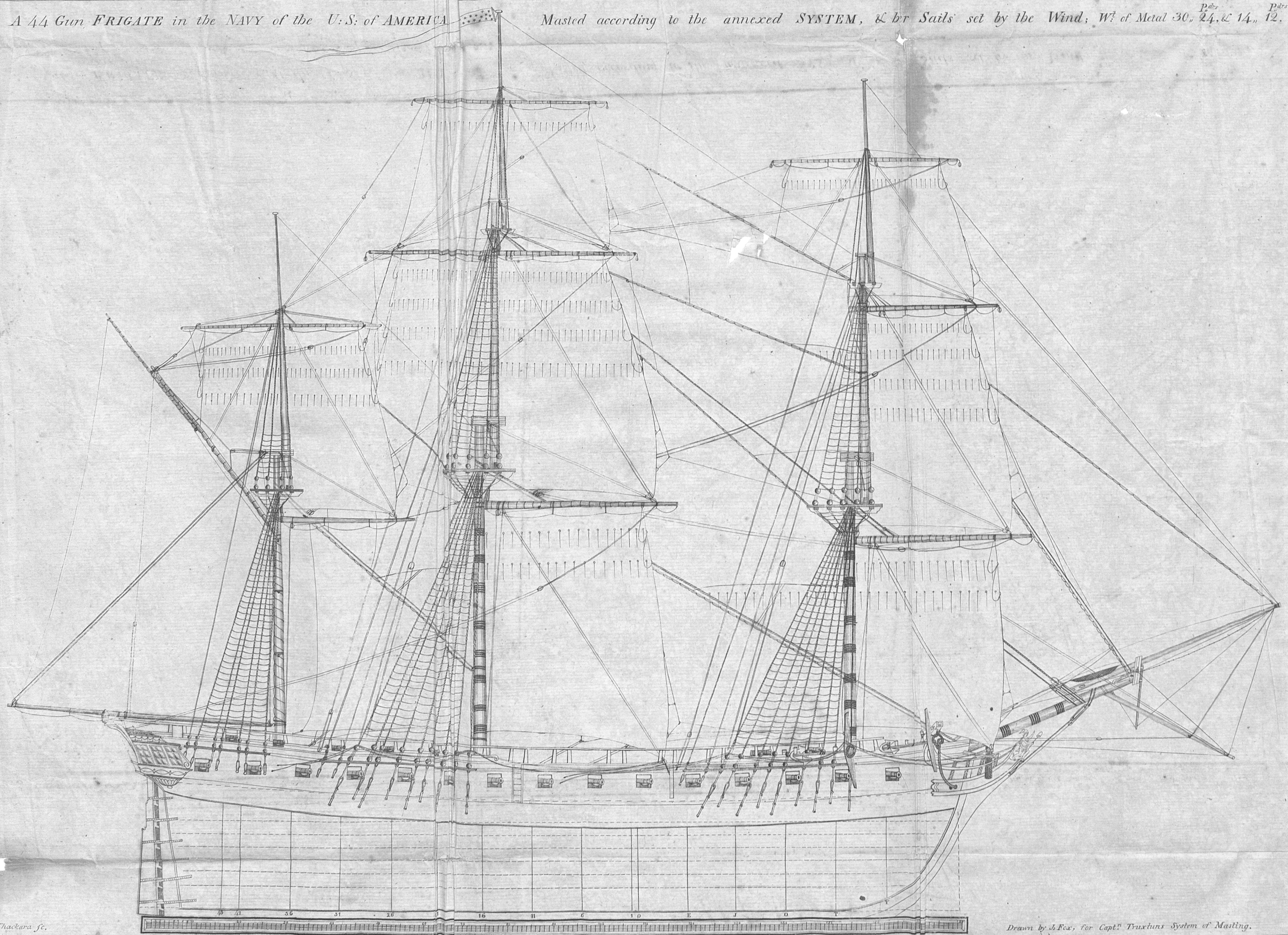
inſtead of increaſing the velocity, as is intended, they cauſe a counter action. 2dly, By a ſhip having too ſquare yards, the unneceſſary and additional weight tends to make them crank, or lay down more than they otherwiſe would. 3dly, With yards too ſquare, the ſtay-ſails between the maſts are rendered uſeleſs. Whereas ſhips with moderate yards, having their maſts properly extended, in the manner I have ſtated, may not only carry their ſtay-ſails to advantage, when cloſe hauled, but they will hold up their ſides to the breeze; by which means their velocity muſt naturally be increaſed. I have often noticed the diſproportion of our former frigates' maſts and yards, and lamented the want of ſome good general ſyſtem of maſting in this country, and of our never having got the proper rules by which the French and Engliſh maſt their ſhips of war: but thoſe nations are very tenacious of communicating any ſort of improvements that they make in naval architecture, particularly ſuch are approved of by the heads of their naval departments.

By many drawings which I have made at my leiſure when at ſea, I at laſt fixed on the principles now laid down, as the beſt I could deviſe; and if they ſhould accord with the judgment of others, who are competent to an opinion on the ſubject, I ſhall be extremely happy.

T. T.

THE END.

A 44 Gun FRIGATE in the NAVY of the U: S: of AMERICA Masted according to the annexed SYSTEM, & her Sails set by the Wind; Wt. of Metal 30 Pdrs 24, & 14 Pdrs 12.



Thackara sc.

Drawn by J. Fox, for Capt.n Truxtuns System of Masting.

A

SHORT ACCOUNT

OF THE

Several General Duties of Officers,

OF SHIPS OF WAR;

FROM AN ADMIRAL, *DOWN TO THE MOST INFERIOR OFFICER.*

Placed on the Books of the Navy, according to the Britiſh Regulations.

ARRANGED WITH ADDITIONS, &c.

By Thomas Truxtun.

INTRODUCTION.

BY the act of Congreſs for providing a Naval Armament, there are neither quarter-maſters, a boatſwain's yeoman, nor ſeveral other petty officers (abſolutely neceſſary) mentioned; which, if not provided by an amendment of the ſaid act, ſhould be made out of the different ſhips' crews, to act nominally.

In the eſtabliſhment of our young navy, the moſt ſkilful and experienced among us muſt acknowledge, that recourſe for precedents and examples, to ſome maritime European nation, in very many points, will be found highly neceſſary, to ſecure a good organization of it; and as our cuſtoms and manners in the ſea ſervice are very ſimilar to thoſe of the Engliſh, under whom many of us received our nautical education, I have ſelected from their ſyſtem the general outlines of duty for all deſcriptions of officers, in a ſhip of war, with ſuch additions and alterations as I found neceſſary to make: And notwithſtanding the prejudice that exiſts in our nation againſt the Britiſh government, for their ſpoliations and many unprovoked cruelties exhibited on our citizens, yet I think none can be ſo much ſo, as not to acknowledge them, at this time, the firſt maritime power on the globe, with reſpect to naval tactics, diſcipline, and the general management of ſhips of war; they are therefore a proper example for us to imitate in our infancy, in all thoſe points of duty and regulation, in which precedents are wanting: and by a ſteady attention to their general naval ſyſtem, we ſhall very early have our ſhips of war and marine affairs in good order, and our internal government on board the different ſhips in the navy (of the United States of America) ſimilar to each other, which muſt be very deſirable to every officer; but what from the diſtance we are from each other in conferring, building, and equipping, cannot without ſome pains be reaſonably expected.

OF GENERAL DUTIES OF ADMIRALS.

ADMIRAL, (*amiral*, Fr.) an officer of the first rank and command in the fleet, and who is distinguished by a flag displayed at his main-top-mast-head. Also an officer who superintends the naval forces of a nation, and who is authorised to determine in all maritime causes.

The origin and denomination of this important office, which seems to have been established in most countries that border on the sea, have given rise to a great variety of opinions. Some have borrowed them from the Greek, others from the Arabic, while a third sort, with greater probability, derive both the title and dignity from the Saracens. But since no certain conclusions have been deduced from these elaborate researches, and as it rather appears the province of this work to give the reader an idea of the office and duty of an admiral at sea, than to furnish an historical or chronological detail of the rank and power with which admirals have been invested in different nations, we shall contentedly resign this task to the ingenious lexicographers, who have so repeatedly entertained us with such critical investigations.

The ADMIRAL, or commander in chief of a squadron, being frequently invested with a great charge, on which the fate of a nation may depend, ought certainly to be possessed of abilities equal to so important a station, and so extensive a command. His squadron is unavoidably exposed to a variety of perplexing situations in a precarious element. A train of dangerous incidents necessarily arise from those situations. The health, order, and discipline of his people are not less the objects of his consideration, than the condition and qualities of his ships. A sudden change of climate, a rank and infectious air, a scarcity or unwholesomeness of provisions may be as pernicious to the former, as tempestuous weather or dangerous navigation to the latter. A lee-shore, an injudicious engagement with an enemy greatly superior, may be equally fatal to both. He ought to have sufficient experience to anticipate all the probable events that may happen to his squadron during an expedition or cruise, and, by consequence, to provide against them. His skill should be able to counteract the various disasters which his squadron may suffer from different causes. His vigilance and presence of mind are necessary to seize every favourable opportunity that his situation may offer to prosecute his principal design; to extricate himself from any difficulty or distress; to check unfortunate events in the beginning, and retard the progress of any great calamity. He should be endued with resolution and fortitude to animate his officers by force of example, and promote a sense of emulation in those who are under his command, as well to improve any advantage, as to frustrate or defeat the efforts of his ill fortune.

The most essential part of his duty, however, appears to be military conduct. As soon as the squadron under his command shall put to sea, he is to form it into the proper order of battle, called the LINE. In this arrangement he is to make a judicious distribution of strength from the van to the rear, throwing the principal force into the centre, to resist the impression of the enemy's fleet; which might otherwise, at some favourable opportunity, break through his line, and throw the van and rear into confusion.

A competent knowledge of the seas, weather, and reigning winds, of the coast or region where he is stationed, is also requisite, as it will greatly facilitate his plans on the enemy. It will enable him to avoid being improperly embayed, where he might be surprised in a disadvantageous situation; and to judge whether it will be most expedient to attack his adversary, or lie prepared to receive his assault. When his squadron is forced by stress of weather, or otherwise, to take shelter in a road or bay, it will likewise suggest the necessary conduct of keeping a sufficient number of cruisers at sea, to bring him early intelligence, that they may be ready to cut or slip the cables when they shall be too much hurried to weigh their anchors.

As

As the forming a complete, ſtrong, and uniform line is a very material article in naval war, the admiral ought frequently to arrange the ſquadron under his command into this order, that the inferior officers may obſerve to bring their ſhips, with great dexterity and alertneſs, into their ſeveral ſtations, and maintain the regularity of the line when they tack, veer, or ſail abreaſt.

When the admiral intends a deſcent on an enemy's coaſt, or other attack which may be attended with complicated and unforeſeen incidents, his orders ſhould be delivered or drawn up with the greateſt accuracy and preciſion: they ſhould be ſimple, perſpicuous, direct, and comprehenſive; they ſhould collect a number of objects into one point of view, and foreſeeing the effects of ſucceſs or defeat, appoint the proper meaſures to be adopted in either event. Hiſtory and experience confirm the neceſſity of this obſervation, and preſent us with a variety of diſaſters that have happened on ſuch occaſions, merely by a deficiency in this material article. In the commanding officer, inattention, barrenneſs of expedient or a circumſcribed view of the neceſſary effects of his enterprize, may be equally pernicious. And general orders ought to be utterly free from pedantry and perplexity, which always betray a falſe taſte and confuſed imagination, beſides the probability of producing many fatal conſequences.

When an admiral ſhall conquer in battle, he ſhould endeavour to improve his victory, by puſhing the acquired advantages as far as prudence directs; a conduct that merits his attention as much as any in the action! When he ſhall be defeated, he ought to embrace every opportunity of ſaving as many of his ſhips as poſſible, and endeavour principally to aſſiſt thoſe which have been diſabled. In ſhort, it is his duty to avail himſelf of every practicable expedient rather than ſink under his misfortune, and ſuffer himſelf to become an eaſy prey to an enemy.

He ſhould be ſufficiently acquainted with civil law, to judge with propriety of the proceedings of courts-martial, and to correct the errors, and reſtrain the abuſes which may happen therein by miſtake, ignorance, or inattention.

As ſecret treaties, propoſitions, or ſchemes of the enemy, may occaſionally be ſubmitted to his inſpection, or fall into his poſſeſſion by capture; and which it might be improper to diſcover to any perſon near him, he ought to have a competent knowledge of the modern languages, or at leaſt thoſe of the countries againſt whom his military operations are directed, to be able to comprehend with facility the full ſcope and purport of ſuch papers.

He ought to be well verſed in geometry, ſo as to be capable of ordering proper and correct ſurveys of unknown coaſts, roads, or harbours to be made, and to judge of their accuracy, and detect their errors. To aſcertain the ſituation and longitude of different places, he ſhould be alſo ſufficiently ſkilled in aſtronomy and the method of taking obſervations, which indeed is eſſentially neceſſary to the profeſſion of a ſea-officer, although too much neglected.

By his inſtructions the admiral is likewiſe to aſſiſt at all councils of war that relate to naval affairs: to viſit, as often as convenient, the other ſhips of his ſquadron: to enquire particularly into their condition, and obſerve the men muſtered, taking care that no ſupernumeraries are born on the books. He is directed to acquaint the ſecretary of the marine with all his proceedings relative to the ſervice; and to attend him, on his return home, with an account of his voyage or expedition, and to deliver a copy of his journal.

Much more might be obſerved on this occaſion. It appears however by the general outline which we have ſketched, that the office and duty of an admiral requires greater ſkill and more comprehenſive abilities than is generally ſuppoſed neceſſary to the command of a naval armament. And that he ought to be duly qualified to aſſiſt the councils of government, and enter

into the enlarged ſyſtem of protecting his country from an invaſion by ſea, or of meditating a deſcent on an enemy's coaſt; as well as to improve navigation, and open new channels of commerce.

Vice-ADMIRAL, (*vice amiral*, Fr.) the officer next in rank and command to the admiral; his flag is diſplayed at the fore-top-maſt-head.

Rear-ADMIRAL, (*contre-amiral, lieutenant general des armées navales*, Fr.) the officer next in rank and command to the vice-admiral, and who carries his flag at the mizen-top-maſt-head.

OF COMMODORES.

COMMODORE, (*chef d'eſcadre*, Fr.) a general officer in the marine, inveſted with the command of a detachment of ſhip's of war deſtined on any particular enterpriſe; during which time he bears the rank of brigadier-general in the army, and is diſtinguiſhed from the inferior ſhips of his ſquadron by a broad pendant tapering towards the outer end, and ſometimes forked. The word is corrupted from the Spaniſh *comendador*.

COMMODORE is alſo a name given to ſome ſelect ſhip in a fleet of merchantmen, who leads the van in time of war, and carries a light in his top, to conduct the reſt and keep them together.

OF CAPTAINS.

CAPTAIN *of a ſhip of war*, (*capitaine du haut bord*, Fr.) the officer who commands a ſhip of the line of battle, or a frigate carrying twenty or more cannon. The charge of a captain is very comprehenſive, inaſmuch as he is not only anſwerable for any bad conduct in the military government, navigation, and equipment of the ſhip he commands; but alſo for any neglect of duty, or ill management in his inferior officers, whoſe ſeveral charges he is appointed to ſuperintend and regulate.

On his firſt receiving information of the condition and quality of the ſhip he is appointed to command, he muſt attend her conſtantly, and haſten the neceſſary preparations to fit her for ſea. So ſtrict indeed are the injunctions laid on him, that he is forbid to lie out of his ſhip, from his arrival on board, till the day of his diſcharge, unleſs by particular leave from the head of the marine department, or his commander in chief.

He is enjoined to ſhow a laudable example of honour and virtue to the officers and men, and to diſcountenance all diſſolute, immoral, and diſorderly practices, and ſuch as are contrary to the rules of diſcipline and ſubordination, as well as to correct thoſe who are guilty of ſuch offenſes, as are puniſhable according to the uſage of the ſea.

He is ordered particularly to ſurvey all the military ſtores which are ſent on board, and to return whatſoever is deemed unfit for ſervice. His diligence and application are required to procure his complement of men; obſerving carefully to enter only ſuch as are fit for the neceſſary duty, that the government may not be put to improper expence. When his ſhip is fully manned, he is expected to keep the eſtabliſhed number of men complete, and ſuperintend the muſter himſelf, if there is no clerk of the check at the port.

When his ſhip is employed on a cruiſing ſtation, he is expected to keep the ſea the whole length of time previouſly appointed; but if he is compelled by ſome unexpected accident to return to port ſooner than the limited time, he ought to be very cautious in the choice of a good

ſituation for anchoring, ordering the maſter, or other careful officers, to ſound, and diſcover the depth of water, and dangers of the coaſt.

Previous to any poſſibility of an engagement with an enemy, he is to quarter the officers and men to the neceſſary ſtations according to their office or abilities, and to exerciſe them in the management of the artillery, &c. that they may be more expert in the time of battle.

His ſtation in an engagement is on the quarter-deck; at which time he is expected to take all opportunities of annoying his enemy, and improving every advantage over him; to exhibit an example of courage and fortitude to his officers and crew, and to place his ſhip oppoſite to his adverſary, or in ſuch a poſition, according to circumſtances, as that every cannon ſhall do effectual execution.

At the time of his arrival in port after his return from abroad, he is to aſſemble his officers, and draw up a detail of the obſervations that have been made during the voyage; of the qualities of the ſhip, as to her trim, ballaſt, ſtowage, and manner of ſailing, for the information and direction of thoſe who may ſucceed in command: and this account is to be ſigned by himſelf and officers, and to be returned to the ſecretary of the marine, or principal officer under the ſecretary, at the port where the ſhip is diſcharged.

OF LIEUTENANTS.

LIEUTENANT *of a ſhip of war*, the officer next in rank and power to the captain, in whoſe abſence he is accordingly charged with the command of the ſhip; as alſo the execution of whatever orders he may have received from the commander relating to the ſervice.

The lieutenant, who commands the watch at ſea, keeps a liſt of all the officers and men thereto belonging, in order to muſter them, when he judges it expedient, and report to the captain the names of thoſe who are abſent from their duty. During the night-watch, he occaſionally viſits the lower decks, or ſends thither a careful officer, to ſee that the proper centinels are at their duty, and that there is no diſorder amongſt the men; no tobacco ſmoaked between decks, nor any fire or candles burning there, except the lights which are in lanthorns, under the care of a proper watch, for particular purpoſes. He is expected to be always upon deck in his watch, as well to give the neceſſary orders, with regard to *trimming* the ſails and ſuperintending the navigation, as to prevent any noiſe or confuſion; but he is never to change the ſhip's courſe without the captain's directions, unleſs to avoid an immediate danger.

The lieutenant, in time of battle, is particularly to ſee that all the men are preſent at their quarters, where they have been previouſly ſtationed according to the regulations made by the captain. He orders and exhorts them every where to perform their duty, and acquaints the captain at all other times of the miſbehaviour of any perſons in the ſhip, and of whatever elſe concerns the ſervice or diſcipline.

OF MASTERS.

MASTER *of a ſhip of war*, (*maître*, Fr.) is an officer to aſſiſt in ſitting, and to take charge of the navigating and conducting a ſhip from port to port, under the direction of the captain, or other his ſuperior officer. The management and diſpoſition of the ſails, the working of the ſhip into her ſtation in the order of battle, and the direction of her movements in the time of action, and in the other circumſtances of danger, are alſo more particularly under his inſpection. He is to be careful that the rigging, ſails, and ſtores, alſo be duly preſerved: to ſee that

the log and log-book be regularly and correctly kept: accurately to obſerve the appearances of coaſts, rocks, and ſhoals, with their depths of water and bearings, noting them in his journal and log book. He is to keep the hauſe clear when the ſhip is at anchor, and to attend her conſtantly. He is to provide himſelf with proper inſtruments, maps, and books of navigation. It is likewiſe his duty to examine the proviſions, and accordingly to admit none into the ſhip but ſuch as are ſound, ſweet, and wholeſome. He is moreover charged with the *ſtowage*, or diſpoſition of theſe materials in the ſhip's hold. And when ſhe ſhall be laid-up, he is to depoſite a copy of the log-book and journal with the commiſſioners of the navy. And to enable him the better to perform theſe ſervices, he is allowed ſeveral aſſiſtants, who are properly termed mates and quarter-maſters.

MASTER *of a merchant-ſhip*, the commanding officer, who is appointed by the merchants to manage the navigation and every thing relating to her cargo, voyage, ſailors, &c.

OF CAPTAINS OR LIEUTENANTS OF MARINES.

THE principal marine officer on board a ſhip of war is to train the marines to the uſe of fire-arms, to diſcipline and frequently exerciſe them: his office in time of battle is chiefly to direct and attend them, and at all other times to have a due regard to the preſervation of the ſmall-arms, accoutrements, &c. thereto belonging, that they be not loſt, embezzled, or injured; but kept ſafe, clean, and in good condition for ſervice. It is alſo his duty to have the centinels placed, agreeable to the regulations of the ſhip: and as his duty oftentimes calls him with the marines on ſhore, he ſhould make himſelf well acquainted with military ſervice. This officer has under his direction, beſides the marines, the ſergeants, corporals, drum and fife, and occaſionally the armourer, &c.

OF MIDSHIPMEN.

MIDSHIPMAN, a ſort of naval cadet, appointed to ſecond the orders of the ſuperior officers, and aſſiſt in the neceſſary buſineſs of the veſſel, either aboard or on ſhore.

The number of midſhipmen, like that of ſeveral other officers, is always in proportion to the ſize of the ſhip to which they belong. Thus a firſt-rate man of war has twenty-four, and the inferior rates a ſuitable number in proportion. No perſon can be appointed lieutenant, without having previouſly ſerved two years in the navy in this capacity, or in that of *mate*, beſides having been at leaſt four years in actual ſervice at ſea, either in merchant-ſhips, or in the navy.

Midſhipman is accordingly the ſtation in which a young volunteer is trained in the ſeveral exerciſes, neceſſary to attain a ſufficient knowledge of the machinery, diſcipline, movements, and military operations of a ſhip, to qualify him for a ſea-officer.

As the chief object of our attention has been to facilitate the acquiſition of this intelligence, we have endeavoured to treat thoſe ſubjects at large, in the different parts of this work, according to their importance. We have alſo ſketched the general outlines of the reſpective charges of all the ſuperior officers, which, in conformity to the plan of this work, become previous to this article. Thus the duties of the admiral, the captain, the lieutenant, and the maſter, are already explained in their proper places; and whatever intelligence appears neceſſary to diſcharge thoſe offices, is alſo, in a high degree, eſſential to the midſhipman. Thoſe officers indeed, as well as many others, are furniſhed with ſuitable inſtructions to regulate their conduct; but the midſhipman, being inveſted with no particular charge from the government, is by conſequence

ſequence omitted in thoſe official regulations. In a work of this kind, however, the importance of the ſubject is not always determined by the ſuperiority of rank or ſtation. If our province is to communicate inſtruction, thoſe who are the leaſt informed are certainly the principal objects thereof, and to them our attention is more peculiarly directed. Hence the extent of our deſign comprehends many circumſtances which would be immaterial in general orders and regulations; and hence abundance of particular directions to reſpective officers, inſerted in thoſe general regulations, are rejected here as foreign to our purpoſe. Averſe as we are, on other occaſions, to offend the rigid nicety of a critic, by introducing moral reflections in a performance dedicated to ſcientifical deſcription, we muſt for once be indulged with a ſhort deviation from the plan hitherto invariably followed. Happy! if our efforts may in any degree operate to produce the effects for which they were calculated.

On his firſt entrance in a ſhip of war, every midſhipman has ſeveral diſadvantageous circumſtances to encounter. Theſe are partly occaſioned by the nature of the ſea-ſervice, and partly by the miſtaken prejudices of people in general, reſpecting naval diſcipline, and the genius of ſailors and their officers. No character, in their opinion, is more excellent than that of the common ſailor, whom they generally ſuppoſe to be treated with great ſeverity by his officers, drawing a compariſon between them not very advantageous to the latter. The midſhipman uſually comes aboard tinctured with theſe prejudices, eſpecially if his education has been amongſt the higher rank of people; and if the officers happen to anſwer his opinion, he conceives an early diſguſt to the ſervice, from a very partial and incompetent view of its operations. Blinded by theſe prepoſſeſſions, he is thrown off his guard, and very ſoon ſurpriſed to find, amongſt theſe honeſt ſailors, a crew of abandoned miſcreants, ripe for any miſchief or villainy. Perhaps, after a little obſervation, many of them will appear to him equally deſtitute of gratitude, ſhame, or juſtice, and only deterred from the commiſſion of any crimes by the terror of ſevere puniſhment. He will diſcover, that the pernicious example of a few of the vileſt in a ſhip of war is too often apt to poiſon the principles of the greateſt number, eſpecially if the reins of diſcipline are too much relaxed, ſo as to foſter that idleneſs and diſſipation, which engender ſloth, diſeaſes, and an utter profligacy of manners. If the midſhipman, on many occaſions, is obliged to mix with theſe, particularly in the exerciſe of extending or reducing the ſails in the tops, he ought reſolutely to guard againſt this contagion, with which the morals of his inferiors may be infected. He ſhould however avail himſelf of their knowledge, and acquire their expertneſs in managing and fixing the ſails and rigging, and never ſuffer himſelf to be excelled by an inferior. He will probably find a virtue in almoſt every private ſailor, which is entirely unknown to many of his officers: that virtue is emulation, which is not indeed mentioned amongſt their qualities by the gentlemen of *terra firma*, by whom their characters are often copiouſly deſcribed with very little judgment. There is hardly a common tar who is not envious of ſuperior ſkill in his fellows, and jealous on all occaſions to be outdone in what he conſiders as a branch of his duty! Nor is he more afraid of the dreadful conſequences of whiſtling in a ſtorm, than of being ſtigmatized with the opprobrious epithet of *lubber*. Fortified againſt this ſcandal by a thorough knowledge of his buſineſs, the ſailor will ſometimes ſneer in private, at the execution of orders, which to him appear aukward, improper, or unlike a ſeaman. Nay, he will perhaps be malicious enough to ſuppreſs his own judgment, and by a punctual obedience to command, execute whatever is to be performed, in a manner which he knows to be improper, in order to expoſe the perſon commanding to diſgrace and ridicule. Little ſkilled in the method of the ſchools, he conſiders the officer who conſs his leſſon by rote as very ill qualified for his ſtation, becauſe particular ſituations might render it neceſſary for the ſaid officer to aſſiſt at putting his own orders in practice. An ignorance in this practical knowledge will therefore neceſſarily be thought an unpardonable deficiency by thoſe who are to follow his directions. Hence the midſhipman, who aſſociates with theſe ſailors in the tops, till he has acquired a competent ſkill in the ſervice of extending or reducing the ſails, &c. will be often entertained with a number of ſcurrilous

 jeſts,

jeſts, at the expence of his ſuperiors. Hence alſo he will learn, that a timely application to thoſe exerciſes can only prevent him from appearing in the ſame deſpicable point of view, which m uſt certainly be a cruel mortification to a man of the ſmalleſt ſenſibility.

If the midſhipman is not employed in theſe ſervices, which are undoubtedly neceſſary to give him a clearer idea of the different parts of his occupation, a variety of other objects preſent themſelves to his attention. Without preſuming to dictate the ſtudies which are moſt eſſential to his improvement, we could wiſh to recommend ſuch as are moſt ſuitable to the bent of his inclination. Aſtronomy, geometry, and mechanics, which are in the firſt rank of ſcience, are the materials which form the ſkilful pilot, and the ſuperior mariner. The theory of navigation is entirely derived from the two former, and all the machinery and movements of a ſhip are founded upon the latter. The action of the wind upon the ſails, and the reſiſtence of the water at the ſtem, naturally dictate an enquiry into the property of ſolids and fluids: and the ſtate of the ſhip, floating on the water, ſeems to direct his application to the ſtudy of hydroſtatics and the effects of gravity. A proficiency in theſe branches of ſcience will equally enlarge his views, with regard to the operations of naval war, as directed by the efforts of powder, and the knowledge of projectiles. The moſt effectual method to excite his application to thoſe ſtudies is, perhaps, by looking round the navy, to obſerve the characters of individuals. By this enquiry he will probably diſcover, that the officer, who is eminently ſkilled in the ſciences, will command univerſal reſpect and approbation; and that whoever is ſatisfied with the deſpicable ambition of ſhining the hero of an aſſembly, will be the object of univerſal contempt. The attention of the former will be engaged in thoſe ſtudies, which are highly uſeful to himſelf in particular, and to the ſervice in general. The employment of the latter is to acquire thoſe ſuperficial accompliſhments, that unbend the mind from every uſeful ſcience, emaſculate the judgment, and render the hero infinitely more dextrous at falling into his ſtation in the dance, than in the line of battle.

Unleſs the midſhipman has an unconquerable averſion to the acquiſition of thoſe qualifications, which are ſo eſſential to his improvement, he will very rarely want opportunities of making a progreſs therein. Every ſtep he advances in thoſe meritorious employments will facilitate his acceſſion to the next in order. If the dunces, who are his officers or meſſ-mates, are rattling the dice, roaring bad verſes, hiſſing on the flute, or ſcraping diſcord from the fiddle, his attention to more noble ſtudies will ſweeten the hours of relaxation. He ſhould recollect that no example from fools ought to influence his conduct, or ſeduce him from that laudable ambition which his honour and advantage are equally concerned to purſue.

OF MASTER's MATES.

MATE *of a ſhip of war*, an officer under the direction of the maſter, by whoſe choice he is generally appointed, to aſſiſt him in the ſeveral branches of his duty. Accordingly he is to be particularly attentive to the navigation in his watch, &c. to keep the *log* regularly, and examine the line and glaſſes by which the ſhip's courſe is meaſured, and to adjuſt the ſails to the wind in the fore-paſt of the ſhip. He is alſo to have a diligent attention to the cables, ſeeing that they are well *coiled* and kept clean when laid in the *tier*, and ſufficiently *ſerved* when employed to ride the ſhip. Finally, he is to ſuperintend and aſſiſt at the ſtowage of the hold, taking eſpecial care that all the ballaſt and proviſions are properly ſtowed therein.

MATE *of a merchant-ſhip*, the officer who commands in the abſence of the maſter thereof, and ſhares the duty with him at ſea; being charged with every thing that regards the internal management of the ſhip, the government of her crew, the directing her courſe, &c. under the maſter's orders.

OF

OF CHAPLAINS.

CHAPLAIN *of a ſhip of war*; his particular duty is to ſhow a good example of religion, morality, and virtue, at all times and places: to diſcountenance vice and immorality; to preach, and read prayers, agreeable to ſuch regulations as may be made for the navy; to viſit and adminiſter comfort to the ſick; and to attend the burial of the dead, with the uſual chriſtian ceremonies, &c.

OF SURGEONS AND SURGEONS' MATES.

SURGEON *of a ſhip of war*, is the officer whoſe particular buſineſs it is to receive on board, and account for, all drugs, medicines, and inſtruments; carefully and conſtantly to ſuperintend the health of the crew; to viſit and ſerve out medicine to the ſick, keep a regiſter of their different ailments and diſorders; perform amputations where it is neceſſary; dreſs and attend the wounded; obſerve whether the proviſions given to the crew be ſound and wholeſome; examine the veſſels provided for cooking, and cauſe them to be kept clean, ſweet, and free from verdigreaſe, &c. It is his buſineſs alſo to make returns to the captain of the health of the ſhip, a ſtate of the ſick and wounded, and of all other matters within the line of his duty, as often as may be deſired; and in performing this duty, he is aſſiſted by one or more mates, which are under his direction; and ſuch other aid as circumſtances may require.

OF PURSERS.

PURSER *of a ſhip of war*, is an officer to receive, examine, and account for all proviſions, &c. and to ſee that they are carefully diſtributed to the officers and crew, according to ſuch inſtructions as he may receive for that purpoſe.

OF SECRETARIES AND CLERKS.

SECRETARY AND CLERK *of an admiral or commodore, and the clerk of a ſingle ſhip of war*, is to keep a particular account of all tranſactions and things that may be ordered by their chief commanding officer to be written or recorded, &c.

OF BOATSWAINS, BOATSWAINS' MATES, AND BOATSWAINS' YEOMAN.

BOATSWAIN, (*contre-maître*, Fr.) the officer who has the boats, ſails, rigging, colours, anchors, and cables committed to his charge.

It is the duty of the boatſwain particularly to direct whatever relates to the rigging of a ſhip, after ſhe is equipped from a dock-yard. Thus he is to obſerve that the maſts are properly ſupported by their ſhrouds, ſtays, and back-ſtays, ſo that each of thoſe ropes may ſuſtain a proportional effort when the maſt is ſtrained by the violence of the wind, or the agitation of the ſhip. He ought alſo to take care that the blocks and running-ropes are regularly placed, ſo as to anſwer the purpoſes for which they are intended; and that the ſails are properly fitted to their yards and ſtays, and well furled or reefed when occaſion requires.

It is likewiſe his office to ſummon the crew to their duty; to aſſiſt with his mates in the neceſſary buſineſs of the ſhip; and to relieve the watch when it expires. He ought frequently to examine the condition of the maſts, ſails, and rigging, and remove whatever may be judged unfit for ſervice, or ſupply what is deficient: and he is ordered by his inſtructions to perform this duty *with as little noiſe as poſſible*.

The BOATSWAIN'S *Mate* is to assist the boatswain in all and every part of his duty; and he is an officer whose business it is to be vigilant in turning up the watch, or the crew generally, when all hands are called or ordered out: he is, as well as the boatswain, to carry and wind a call on proper occasions, agreeable to the usage and custom of the naval service. It is the boatswain's mate whose duty it is to flog such as may be seized up for that purpose, by the quarter-masters, under the captain's orders; and he is, as well as the boatswain, to carry a rattan, which is only to be used when absolutely necessary, in keeping good order, and carrying on the duty of the ship, &c.

The BOATSWAIN'S *Yeoman's* particular duty is the stowage, account, and distribution of the stores of that department, under the boatswain's orders.

OF GUNNERS, GUNNERS' MATES, GUNNERS' YEOMEN, AND QUARTER GUNNERS.

GUNNER *of a ship of war* (*cannonier de vaisseau*, Fr.) an officer appointed to take charge of the artillery and ammunition aboard; to observe that the former are always kept in order, and properly fitted with tackles and other furniture, and to teach the sailors the exercise of the cannon.

The GUNNER'S *Mate* is to assist the gunner in every part of his business; he is an officer who should be as well acquainted with gunnery, and every thing respecting the ordnance and military stores, as the gunner himself: his particular business under the gunner is to have every thing ready for action in a moment's warning; he should never be at a loss to know where to lay his hand upon any article belonging to the gunner's department; he should be expert in preparing port and false fires, match stuff, grenadoes, and every sort of combustible used in war; and in a word, in doing every part of a gunner's duty on board a ship of war.

The GUNNER'S *Yeoman's* particular business is the stowage of the magazine, filling the store-rooms, &c. account, care, and distribution of all the stores of that department, under the gunner's orders.

Quarter-GUNNER, an inferior officer under the direction of the gunner of a ship of war, whom he is to assist in every branch of his duty; as keeping the guns and their carriages in proper order, and duly furnished with whatever is necessary; filling the powder into cartridges; scaling the guns, and keeping them always in a condition for service. The number of quarter-gunners in any ship is always in proportion to the number of her artillery, one quarter-gunner being allowed to every four cannon.

OF CARPENTERS, CARPENTERS' MATES, AND CAULKERS.

CARPENTER *of a ship* (*charpentier*, Fr.) an officer appointed to examine and keep in order the frame of the ship, together with her masts, yards, boats, and all other wooden machinery, and stores committed to him by indenture from the surveyor of the dock-yard.

It is his duty in particular to keep the ship *tight*; for which purpose he ought frequently to review the decks and sides, and to caulk them when it is found necessary. In the time of battle he is to examine up and down, with all possible attention, in the lower apartments of the ship, to stop any holes that may have been made in the sides by shot, with wooden plugs provided, of several sizes, for that purpose.

The

The CARPENTER'S *Mate* is to assist the carpenter in every part of his business; to attend particularly to the stowage and distribution of the stores of that department; to sound and keep the pumps and pump geer in good order; and to have the ship pumped dry as often as it may be found necessary; to prepare lead to nail over, and plugs to stop shot holes; to examine frequently the spars of every sort; to fish and repair those that require it; make new ones; and to have every thing, for which the carpenter is accountable, or that comes within the line of that department, ready when called for, or done when ordered, without the smallest delay whatever.

The CAULKERS belong to the carpenter's department, and are under his particular orders: their business is to have at all times a quantity of oakum spun, and the caulking apparatus, pitch, rosin, &c. ready at the shortest notice, to do the things needful in their line.

OF MASTERS AT ARMS AND CORPORALS.

MASTER *at arms*, an officer appointed by warrant from the board of admiralty, to teach the officers and crew of a ship of war the exercise of small arms; to confine and plant centinels over the prisoners, and superintend whatever relates to them during their confinement. He is also, as soon as the evening gun shall be fired, to see all the fires and lights extinguished, except such as shall be permitted by proper authority, or under the inspection of centinels. It is likewise his duty to attend the *gangway*, when any boats arrive aboard, and search them carefully, together with their rowers, that no spirituous liquors may be conveyed into the ship, unless by permission of the commanding officer. He is to see that the small arms be kept in proper order. He is to visit all vessels coming to or going from the ship, and prevent the crew from going from the ship without leave. He is also to acquaint the officer of the watch with all irregularities in the ship which shall come to his knowledge. In these several duties he is assisted with proper attendants, called his corporals, who also relieve the centinels, and one another, at proper periods.

CORPORAL *of a ship of war*, an officer under the master at arms, employed to teach the sailors the exercise of small arms, or musketry; to attend at the gang-way, or entering-ports, and observe that no spirituous liquors are brought into the ship, unless by particular leave from the officers. He is also to extinguish the fire and candles at eight o'clock in winter, and nine in summer, when the evening gun is fired; and to walk frequently down into the lower decks in his watch, to see that there are no lights but such as are under the charge of proper centinels, which he is to see placed, &c.

OF SERJEANTS.

SERJEANT *on board a ship of war*, is an officer whose particular business it is to execute the commands of the principal marine officer, in the line of that duty, and to have every thing in the marine department ready for service at a moment's notice, &c. &c.

OF ARMOURERS.

The ARMOURER *of a ship of war*, is an officer whose business it is to keep in repair all guns and other implements of war, muskets, pistols, cutlasses, hand-cuffs, locks, &c. and to make such things in his department as may be found wanting, from time to time, for the use of the navy, and to receive, account for, and take particular care of, all the tools in his department. The armourer's business is chiefly in this way, and under the marine officer, gunner, master at arms, &c.

OF

OF SAIL-MAKERS AND SAIL-MAKERS' MATES.

SAIL-MAKER *of a ſhip of war*, is to keep an account, and carefully ſtow away in the ſail room, and deliver out when ordered by the commanding officer or maſter, all ſails, twine, canvaſs, needles, bolt-rope, cringle thimbles, &c. which he may have received, belonging to his department: he is to cut out, make, and repair the ſails, as may be found neceſſary; tarpawlings, maſt-coats and other cloths, &c. for painting or other purpoſes: his mate is to aſſiſt him in all this ſort of buſineſs; and is, as well as the ſail-maker himſelf, to be particularly careful that nothing belonging to their department is waſted, or left lying about, or out of its proper place.

OF COOPERS.

COOPER *of a ſhip of war*, is an officer employed in making and repairing water and other caſks, buckets, kids, &c; his buſineſs alſo is to attend the purſer and ſteward in broaching, heading up, ſecuring, and overhauling the different ſorts of proviſions, water, and other ſtores, &c. for which purpoſe he has the tools neceſſary for that department put under his charge and care, for which he muſt account.

OF STEWARDS AND STEWARDS' MATES.

STEWARD (*maitre-valet*, Fr.) an officer in a ſhip of war, appointed by the purſer, to diſtribute the different ſpecies of proviſions to the officers and crew; for which purpoſe he is furniſhed with a mate and proper aſſiſtants.

OF COOKS AND COOKS' MATES.

The COOK *of a ſhip of war* (with his mate) is to receive, properly ſoak, and ſee finally delivered, ſuch proviſions as are ſerved out, and put in his charge to be cooked for the officers and ſhip's company. He is to be at all times careful of the fire, and attend particularly to the orders reſpecting fire; he is alſo to be very careful in putting by the ſluſh, ſo that no greaſe is thrown about the decks, and that there is no want of that article for the uſe of the ſervice: and in the line of his buſineſs, he ſhould be as accommodating and obliging to every one who has his kettle to boil, &c. as is conſiſtent with his general duty.

OF COCKSWAINS.

COCKSWAIN, or COXEN, the officer who manages and ſteers a boat, and has the command of the boat's crew. It is evidently compounded of the words *cock* and *ſwain*, the former of which was anciently uſed for a yawl or ſmall boat, as appears by ſeveral authors; but it has now become obſolete, and is never uſed by our mariners.

OF QUARTER-MASTERS.

QUARTER-MASTER, an inferior officer appointed by the maſter of a ſhip of war to aſſiſt the *mates* in their ſeveral duties; as ſtowing the ballaſt and proviſions in the hold, *coiling* the cables on their platforms, overlooking the ſteerage of the ſhip, keeping the time by the watch-glaſſes, &c.

OF THE DRUM AND FIFE.

The DRUM and FIFE, though they generally act together, are notwithſtanding uſed ſeparately in performing various duties: their general buſineſs, however, is connected with the marine officer's department, and are conſequently under his principal direction.

N. B. The outlines of ſervice here laid down are ſufficient to inſtruct and put each officer in the way of doing his duty generally; after which his particular duty, with a little practice and attention, will become familiar and eaſy: but it muſt be remembered, that little more than the introduction to ſervice is here laid down, that being thought ſufficient for the intended purpoſe. The firſt thing to be done, when a ſhip in our infant navy is receiving on board her ſtores and crew is, for the captain to inform every officer where his ſtore-rooms, lodgings, meſs, &c. are to be; what duty is expected of him, the manner in which they are to receive and account for the ſtores of their reſpective departments, &c. &c. and ſo ſoon as the complement of men is complete, a quarter-bill muſt be made out and entered in the log book, and another paſted on a board, and hung up at the bulk head, under the quarter-deck, or in ſome other more conſpicuous part of the ſhip: this quarter-bill muſt have the ſtation of every one on board marked againſt his name, whither he is to repair in an inſtant on the drum beating (or the call given) to quarters; and annexed to this quarter-bill ſhould be the regulations of the navy generally, and of the ſhip particularly; all of which muſt be attended to, under pain of the puniſhments inflicted according to the common uſage of the ſea ſervice, or courts-martial.

T. T.

FINIS.