SEAMANSHIP,

BOTH IN

THEORY AND PRACTICE.

RARE BOOK
VK
541
.S8
1795

ILLUSTRATED WITH ENGRAVINGS.

LONDON:

PRINTED FOR DAVID STEEL, AT HIS NAVIGATION-WAREHOUSE,

NO. 1, UNION-ROW, LITTLE TOWER-HILL.

M.DCC.XCV.

1795

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

SCIENTIA NAVALIS
VENTORUM
MARISQUE DOMINATRIX

[This Work is entered at Stationers Hall.]

PREFACE.

"THE ELEMENTS AND PRACTICE OF RIGGING, SEAMANSHIP, AND NAVAL TACTICS," a work in two volumes quarto, was laſt year preſented to the public.

The re-publication of it, in a ſmaller form and in ſingle volumes, each containing one ſubject, has been called for from the proprietor, by a large portion of the naval world, as an object of peculiar convenience and advantage to them. In compliance, therefore, with that wiſh, the preſent treatiſe on SEAMANSHIP is now announced.

The working of ſhips depends on principles of mathematical form and origin: but the early authors who developed it ſcientifically have been found too abſtruſe for general uſe; and of this deſcription were the Pere Hoſte and M. Bouguer. They afforded materials, however, that form the baſis of that theory which was afterwards produced by M. Bourdé de Villehuet, the truth and utility of which have been confirmed by experience. This latter gentleman

has treated the laws of motion in fluids, with regard to ſhips, and the effects of the different ſails and rudder, in a manner equally correct and more acceſſible to general comprehenſion. But he has, in the humble opinion of the editor, performed a more eſſential ſervice to maritime nations, by ſhewing the exact correſpondence of practice with theory, the one accompanying the other, as the rule and its example: by which not only is the truth of this ſcience eſtabliſhed, but nautical ſtudents are led on to argue from effect to cauſe, and to make themſelves maſters of that upon principle, which elſe they could know only from practice.

In the preſent volume, therefore, will be found a more correct tranſlation of M. Bourdé's work, named Le Manœuvrier, and a large collection of practical directions for the management of ſhips, in calm or ſtorm, in harbour or on the ocean.

CON-

CONTENTS.

Page.

EXPLANATION of the terms used in seamanship - - 2

THE THEORY OF WORKING SHIPS - - - - - 33

Of the motion which a body communicates, when it strikes a surface - 33

Of the action which water or wind have, by their pressure, on surfaces - 34

Of the centre of gravity - - - - - - - 41

Of the centre of rotation - - - - - - - - 44

Of the action of a sail on a ship, when it is not perpendicular to her length 49

Of the most advantageous angle of the sails, with the keel and the wind - 52

Remarks on sailing by the wind - - - - - - 56

Of the joint forces which act upon a ship when sailing - - - 59

A table of the situation of the sails, to run with the greatest velocity - 63

Of the sails which are before the centre of gravity - - - 65

Of the effect of the fore-and-aft sails which are before the centre of gravity 66

Of the effect of the fore-sail, fore-topsail, fore-topgallant sail, and spritsail, in their different situations - - - - - - - 67

Of the sails which are abaft the centre of gravity - - - - 70

Of the effect of the fore-and-aft sails abaft the centre of gravity - - 70

Of the effect of the square-sails of the main-mast, and of the mizen-topsail, in their different obliquities - - - - - - - 71

Of the equilibrium necessary to be kept in practice between the sails before and abaft the centre of gravity - - - - - - 74

Remarks on the effect of the main-sail - - - - - - 79

Of the rudder - - - - - - - - - 81

Of the time employed by different vessels to perform the same evolution - 90

Of the height of masts - - - - - - - - 92

Observations on the different inclinations given to the masting of ships, with respect to the water-line - - - - - - - 97

Of the tension of sails, and their tendency to fix themselves perpendicularly to the direction of the wind - - - - - - - 98

General observations on the effect of more or less surface of sails exposed, in various weathers, to the wind - - - - - - 101

THE PRACTICE OF WORKING SHIPS - - - - - - 107

RIVER-MOORINGS.—Description of head-and-stern moorings - - 107

Description of swinging moorings - - - - - - 108

Of mooring to head-and-stern and swinging moorings - - - 108

OF THE BALLAST AND LADING - - - - - - 109

The practice of stowing ballast - - - - - - - 114

Manner of getting on board and stowing the anchors and cables - - 116

Of getting under way from river-moorings - - - - 120

Of

Of anchoring - - - - - - - - 120
Preparations necessary to be made for anchoring - - - 120
Of coming to anchor - - - - - - - 123
To anchor in fine weather in a place where you will ride head to wind being close-hauled - - - - - - - 125
To anchor in fine weather in a place where you will ride head to wind, the wind being large - - - - - - - 127
To anchor in fine weather in a place where you are to ride head to the stream and wind, the wind being large - - - - 128
To anchor in fine weather in a place where you will ride head to the stream, which comes from leeward, the wind being large - - - 128
To come to an anchor with the wind aft - - - - 129
To come to an anchor, scudding under a foresail - - - - 131
To anchor with a spring, in order to present the vessel's side to a place or ship you wish to cannonade - - - - - - 132
To come to an anchor in roads that are often crowded with ships, and to leave clear births for others - - - - - - - 132
To come to an anchor with the wind across the tide - - - 133
To come to an anchor when the wind is right against the tide, the ship driving with the strength of the tide against the wind - - - 134
To come to an anchor without tending - - - - - 134
Description of a floating anchor to ride a vessel by in a gale of wind - - 135
Instructions for the management of ships at single anchor - - 137
Of sheering a ship - - - - - - - 137
Of riding at anchor in moderate weather - - - - 138
To back a ship - - - - - - - - 138
Of bracing the yards when riding at anchor - - - - 138
Of riding when in danger of breaking her sheer - - - - 139
How to manage a ship when her sheer is broken - - - 139
Of tending to leeward when the ship must be set a-head - - - 140
When the ship is likely to go to windward with a long service out - 140
To manage in a storm when riding at anchor - - - - 141
To tend a ship for a weather-tide - - - - - 141
To tend a ship with the wind a few points across the tide - - - 142
To tend a ship with the wind across the tide - - - - 143
General observations on riding at single anchor - - - - 143
On mooring - - - - - - - - 145
To moor with two, three, or more, anchors a-head - - - 146
To back an anchor - - - - - - - 146
To moor in a tide's way - - - - - - - 147
To moor with an open hawse to any particular quarter - - - 148
How the weakest moorings may be best applied to help a ship to ride out a storm - - - - - - - - 148
Of keeping a clear hawse - - - - - - - 149
Explanation of a foul hawse - - - - - - 150
Of clearing the hawse - - - - - - - 152

Of

OF GETTING UP OR WEIGHING ANCHOR - - - - 154
To get up an anchor in ships which have a main and jeer capstern - - 154
To get up an anchor in ships which have not a jeer-capstern - - 156
To get up a second anchor - - - - - - 157
To get up an anchor in merchant-ships - - - - - 157
To weigh an anchor with the long-boat - - - - - 158
To weigh an anchor by under-running - - - - - 158
Of cutting or slipping the cable to make sail - - - - 158
To sweep an anchor - - - - - - - 159
To unmoor - - - - - - - - 160
OF GETTING UNDER SAIL - - - - - - - 161
To get under sail when the ship is swinging head to wind, and to cast either to starboard or larboard, where there is no current - - - 162
To get under sail when the ship is riding head to wind and tide - - 164
To get under sail when the ship is swinging with her head to the current, and with the wind a point abaft the beam - - - - - - 165
To get under sail with a spring - - - - - - 166
To get under sail with a leading wind in a tide-way - - - 167
To cast a ship upon the larboard-tack, and back her a-stern of danger - 168
To cast a ship on the larboard-tack, in a tide-way, with the wind two points on the starboard-bow - - - - - - - 169
To cast a ship on the larboard-tack, and shoot her by the wind a-head of danger - - - - - - - - - 170
To cast a ship on the larboard-tack, with the wind right a-head, and to veer her short round before the wind in little room - - - 171
ON TACKING - - - - - - - - - 172
To tack a ship in getting to windward as much as possible - - 172
To tack a ship without endeavouring to get to windward - - - 177
To tack a ship in a dangerous rough sea when her staying is doubtful - 178
On turning to windward in very narrow channels - - - 179
ON VEERING - - - - - - - - - 181
To veer a ship without losing the wind out of the sails - - - 181
To veer a ship that has lost her fore-mast - - - - - 183
To veer a ship when lying-to under a main-sail - - - - 183
To veer a ship under bare poles - - - - - - 185
To boxhaul a ship - - - - - - - 185
To clubhaul a ship - - - - - - - 188
OF LYING-TO - - - - - - - - 189
Of lying-to in fair weather - - - - - - - 189
To lie-to to windward of a ship, so as not to drift near her - - 189
To lie-to under the lee of another ship - - - - - 190
To bring-to with the fore or main topsails a-back to the mast or filled - 190
To bring-to with the three topsails a-back - - - - 191
To fill, when lying-to with the fore-topsail to the mast - - - 192
To fill, when lying-to with the main-topsail to the mast - - - 193
To fill, when lying-to with all the sails to the mast - - - - 194

Of

Of lying-to in a gale of wind - - - - - - 195
Of lying-to under a fore-ſail - - - - - - 195
Of lying-to under a main-ſail - - - - - - 196
Of lying-to under the mizen - - - - - - 196
Of lying-to under the main-ſtayſail - - - - - 196
Of lying-to under the fore, main, and mizen, ſtayſails - - - 197
OF SOUNDING - - - - - - - - 199
Of ſounding in fair weather, whether cloſe-hauled or going large - - 199
Another method - - - - - - - - 200
ON SHIPS DRIVING - - - - - - - 202
To drive to windward when the wind is againſt the tide - - - 202
To drive when the wind is acroſs the tide - - - - - 203
ON BENDING SAILS - - - - - - - 204
To bend a courſe in fair weather - - - - - - 204
To bend a topſail in fair weather - - - - - - 204
ON SETTING AND TAKING-IN SAILS IN BLOWING WEATHER - - 206
To ſet a main-ſail in blowing weather - - - - - 206
To ſet a fore-ſail in blowing weather - - - - - 206
To ſet a topſail in blowing weather - - - - - 206
To take in a courſe - - - - - - - 207
To take in the foreſail in the time of veering - - - - 207
To take in a topſail - - - - - - - 208
To take in a jib - - - - - - - - 208
To haul in a lower ſtudding-ſail - - - - - - 209
To haul down a topmaſt ſtudding-ſail - - - - - 209
To brail up and haul down a main-topmaſt ſtayſail - - - - 209
To haul up a mizen - - - - - - - 210
To take in a topgallant-ſail - - - - - - 210
To unbend a courſe - - - - - - - 210
To unbend a topſail - - - - - - - 211
Of SCUDDING or bearing away in a ſtorm - - - - 211
Of a SHIP OVERSET on her ſide - - - - - - 212
ON CHASING - - - - - - - - 213
To chaſe a ſhip which is to windward, and to join her in the ſhorteſt method 213
Obſervations for the ſhip to windward, which is chaſed - - - 215
To chaſe a ſhip which is to leeward - - - - - 216
Obſervations for the ſhip to leeward which is chaſed - - - 217
OF BOARDING - - - - - - - - 218
To board to windward, or to avoid being boarded - - - - 218
To board to leeward, when cloſe to the wind, or to avoid being boarded - 220
To board with the wind large - - - - - - 221
Boarding at an anchor - - - - - - - 225
Capt. PAKENHAM's INVENTIONS - - - - - 227
Subſtitute for a rudder, when loſt.
To prevent the loſs of a rudder.
Method of reſtoring wounded maſts.

THE

THE THEORY AND PRACTICE OF WORKING SHIPS.

THE working of ſhips, like other ſciences, conſiſts of theory and practice. The knowledge of a theory, which is founded upon unerring principles, is ſurely indiſpenſible for the correct attainment of the practice which it guides; and it cannot therefore be unuſeful to ſhew that the theory of working ſhips is ſupported by mathematical principles, and capable of convincing demonſtration.

To the theoretic part are ſuperadded directions for the performance of many evolutions, accompanied with DEMONSTRATIONS of the agreement of each with the mathematical principles before laid down. The whole, we truſt, will form the moſt extenſive collection ever yet brought together; and all founded, we equally hope, upon the ſureſt principles.

But we do not affect to give ſpecific directions for every poſſible ſituation of a ſhip at ſea; becauſe, if ſuch directions could be given, they would moſt likely be unſerviceable from their bulk: but, in explaining the theory upon which all nautical operations ought to be founded, we impart an unfailing ſource of knowledge to the ſeaman. Thoſe principles will be his ſureſt ſafeguard in the hour of danger, and his beſt aſſiſtant in the time of untried difficulty.

EXPLANATION OF THE TERMS USED IN SEAMANSHIP.

ABACK. The ſituation of the ſails, when their ſurfaces are preſſed aft againſt the maſt by the force of the wind.

ABAFT. The hinder part of a ſhip, or towards the ſtern. It alſo ſignifies *farther aft* or *nearer to the ſtern*; as, the barricade ſtands ABAFT the main maſt; that is, nearer to the ſtern.

ABAFT THE BEAM denotes the relative ſituation of any object with the ſhip, when the object is placed in any part of that arch of the horizon, which is contained between a line at right angles with the keel and that point of the compaſs which is directly oppoſite to the ſhip's courſe. See BEARING.

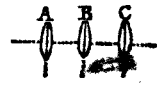
ABOARD. The inſide of a ſhip.

ABOARD MAIN TACK! The order to draw the lower corner of the mainſail down to the cheſtree.

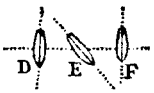
ABOUT. The ſituation of a ſhip as ſoon as ſhe has tacked or changed her courſe.

ABOUT SHIP! The order to the ſhip's crew to prepare for tacking.

ABREAST. The ſituation of two or more ſhips lying with their ſides parallel, and their heads equally advanced; in which caſe, they are abreaſt of each other, as are the ſhips A B C. But, if their ſides be not parallel, then that ſhip, which is in a line with the beam of the other, is



ſaid



ſaid to be abreaſt of her, as the ſhip E is abreaſt of D and F. With regard to objects within the ſhip, it implies on a line parallel with the beam, or at right angles with the ſhip's length. ABREAST OF ANY PLACE, means off or directly oppoſite to it.

ADRIFT. The ſtate of a ſhip broken from her moorings, and driving about without controul.

AFLOAT. Buoyed up by the water from the ground.

AFORE. All that part of a ſhip which lies forward, or near the ſtem. It alſo ſignifies *farther forward*; as, the manger ſtands AFORE the fore-maſt; that is, nearer to the ſtem.

AFT. Behind, or near the ſtern of the ſhip.

AFTER. A phraſe applied to any object in the hinder part of the ſhip, as the after-hatchway, the after-ſails, &c.

A-GROUND. The ſituation of a ſhip when her bottom or any part of it reſts on the ground.

A-HEAD. Any thing, which is ſituated on that point of the compaſs to which a ſhip's ſtem is directed, is ſaid to be a-head of her. See BEARING.

A-HULL. The ſituation of a ſhip, when all her ſails are furled and her helm is laſhed to the lee ſide; by which ſhe lies nearly with her ſide to the wind and ſea, her head being ſomewhat inclined to the direction of the wind.

A-LEE. The poſition of the helm when it is puſhed down to the lee ſide.

ALL IN THE WIND. The ſtate of a ſhip's ſails, when they are parallel to the direction of the wind, ſo as to ſhake or ſhiver.

ALL HANDS HOAY! The call by which all the ſhip's company are ſummoned upon deck.

ALOFT. Up in the tops, at the maſt-heads, or any where about the higher rigging.

ALONG-SIDE. Side-by-ſide, or joined to a ſhip, wharf, &c.

ALONG-SHORE. Along the coaſt; a courſe which is in ſight of the ſhore, and nearly parallel to it.

AMAIN. At once, ſuddenly: as, LET GO AMAIN!

AMIDSHIPS. The middle of a ſhip, either with regard to her length or breadth.

To ANCHOR. To let the anchor fall into the ground, for the ſhip to ride thereby.

ANCHORAGE. Ground, fit to hold a ſhip by her anchor.

THE ANCHOR IS A COCK-BILL. The ſituation of the anchor, when it drops down perpendicularly from the cat-head, ready to be ſunk at a moment's warning.

AN-END. The poſition of any maſt, &c. when erected perpendicularly on the deck. The top-maſts are ſaid to be AN-END when they are hoiſted up to their uſual ſtations.

APEEK. Perpendicular to the anchor; the cable having been drawn ſo tight as to bring the ſhip directly over it. The anchor is then ſaid to be APEEK.

ASHORE. On the ſhore, as oppoſed to ABOARD. It alſo means A-GROUND.

ASTERN. Any diſtance behind a ſhip, as oppoſed to A-HEAD. See BEARING.

AT ANCHOR. The ſituation of a ſhip riding by her anchor.

ATHWART. Acroſs the line of a ſhip's courſe.

ATHWART-HAWSE. The ſituation of a ſhip when driven by acccident acroſs the fore-part of another, whether they touch or are at a ſmall diſtance from each other, the tranſverſe poſition of the former being principally underſtood.

ATHWART THE FORE FOOT. When any object croſſes the line of a ſhip's courſe, but a-head of her, it is ſaid to be ATHWART HER FORE FOOT.

ATHWART-SHIPS. Reaching, or in a direction, acroſs the ſhip from one ſide to the other.

ATRIP. When applied to the anchor, it means that the anchor is drawn out of the ground, and hangs, in a perpendicular direction, by the cable or buoy-rope. The topſails are ſaid to be ATRIP, when they are hoiſted up to the maſt-head, or to their utmoſt extent.

AVAST! The command to ſtop, or ceaſe, in any operation.

AWEIGH.

AWEIGH. The ſame as ATRIP, when applied to the anchor.

To BACK THE ANCHOR. To carry out a ſmall anchor a-head of the large one, in order to ſupport it in bad ground, and to prevent it from looſening or coming home.

To BACK ASTERN, *in rowing, is to impel the boat with her* ſtern foremoſt, by means of the oars.

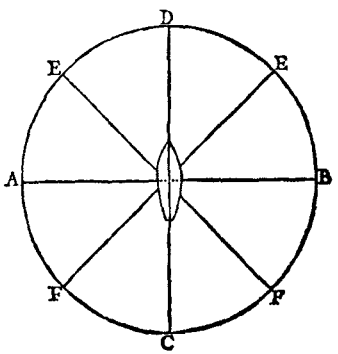
To BACK THE SAILS. To arrange them in a ſituation that will occaſion the ſhip to move a-ſtern.

To BAGPIPE THE MIZEN. To lay it a-back, by bringing the ſheet to the mizen-ſhrouds.

To BALANCE. To contract a ſail into a narrower compaſs, by folding up a part of it at one corner. BALANCING is peculiar only to the mizen of a ſhip, and the mainſail of thoſe veſſels wherein it is extended by a boom.

BARE POLES. When a ſhip has no ſail ſet, ſhe is UNDER BARE POLES.

BEARING. The ſituation of one place from another, with regard to the points of the compaſs. The ſituation alſo of any diſtant object, eſtimated from ſome part of the ſhip, according to her ſituation: theſe latter bearings are either ON THE BEAM, as A and B; BEFORE THE BEAM, as the arcs A D and D B; ABAFT THE BEAM, as the arcs A C and C B; ON THE LEE OR WEATHER BOW, as the lines E E; ON THE LEE OR WEATHER QUARTER, as the lines F F; A-HEAD, as the line D; OR A-STERN, as the line C.



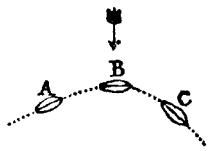
BEAR A-HAND. Make haſte, diſpatch.

To BEAR IN WITH THE LAND is when a ſhip ſails towards the ſhore.

To BEAR OF. To thruſt or keep off from the ſhip's ſide, &c. any weight, when hoſting.

To

To BEAR UP, OR AWAY. The act of changing a ſhip's courſe, to make her ſail more before the wind. Thus the ſhip A bears away from a cloſe-hauled courſe, when ſhe gets into either of the courſes B and C.



BEATING TO WINDWARD. The making a progreſs againſt the direction of the wind, by ſteering alternately cloſe-hauled on the ſtarboard and larboard tacks.

To BECALM. To intercept the current of the wind, in its paſſage to a ſhip, by any contiguous object, as a ſhore above her ſails, a high ſea behind, &c. and thus one ſail is ſaid to becalm another.

BEFORE THE BEAM denotes an arch of the horizon comprehended between the line of the beam and that point of the compaſs on which the ſhip ſtems. See BEARING.

To BELAY. To faſten a rope, by winding it ſeveral times round a cleat or pin.

To BEND A SAIL is to affix it to its proper yard or ſtay.

BENEAPED. See NEAPED.

BETWEEN-DECKS. The ſpace contained between any two decks of a ſhip.

BILGE-WATER is that which, by reaſon of the flatneſs of a ſhip's bottom, lies on her floor, and cannot go to the well of the pump.

BIRTH. The ſtation in which a ſhip rides at anchor, either alone or in a fleet; the due diſtance between two ſhips; and alſo a room or apartment on board for the officers of a meſs.

To BITT THE CABLE is to confine the cable to the bitts, by one turn under the croſs-piece and another turn round the bitt-head. In this poſition it may be either kept fixed or it may be veered away.

BITTER. The turn of the cable round the bitts.

BITTER-END. That part of the cable which ſtays within-board round about the bitts when the ſhip is at anchor.

A BOARD is the diſtance run by a ſhip on one tack; thus they ſay, *a good board*, when a ſhip does not go to leeward of her courſe; a *ſhort board* and a *long board*, according to the diſtance run.

BOARD-

BOARD-AND-BOARD. When two ſhips come ſo near as to touch each other, or when they lie ſide-by-ſide.

To BOARD A SHIP. To enter an enemy's ſhip in an engagement.

BOLD SHORE. A ſteep coaſt, permitting the cloſe approach of ſhipping.

BOOT-TOPPING. Cleaning the upper part of a ſhip's bottom, or that part which lies immediately under the ſurface of the water; and daubing it over with tallow, or with a mixture of tallow, ſulphur, roſin, &c.

BOTH SHEETS AFT. The ſituation of a ſhip ſailing right before the wind.

BOW-GRACE. A frame of old rope or junk, laid out at the bows, ſtems, and ſides, of ſhips, to prevent them from being injured by flakes of ice.

To BOWSE. To pull upon any body with a tackle, in order to remove it.

BOXHAULING. A particular method of veering a ſhip, when the ſwell of the ſea renders tacking impracticable.

BOXING. An operation ſomewhat ſimilar to BOXHAULING. It is performed by laying the head-ſails aback, to receive the greateſt force of the wind in a line perpendicular to their ſurfaces, in order to return the ſhip's head into the line of her courſe, after ſhe had inclined to windward of it.

To BRACE THE YARDS. To move the yards, by means of the braces, to any direction required.

To BRACE ABOUT. To brace the yards round for the contrary tack.

To BRACE SHARP. To brace the yards to a poſition, in which they will make the ſmalleſt poſſible angle with the keel, for the ſhip to have head-way.

To BRACE-TO. To eaſe off the lee-braces, and round in the weather-braces, to aſſiſt the motion of the ſhip's head in tacking.

To BRAIL UP. To haul up a ſail by means of the brails, for the more readily furling it when neceſſary.

BRAILS.

BRAILS. A name peculiar only to certain ropes belonging to the mizen, uſed to truſs it up to the maſt. But it is likewiſe applied to all the ropes which are employed in hauling up the bottoms, lower corners, and ſkirts, of the other great ſails.

To BREAK BULK. The act of beginning to unload a ſhip.

To BREAK SHEER. When a ſhip at anchor is forced, by the wind or current, from that poſition in which ſhe keeps her anchor moſt free of herſelf and moſt firm in the ground, ſo as to endanger the tripping of her anchor, ſhe is ſaid to break her ſheer.

BREAMING. Burning off the filth from a ſhip's bottom.

BREAST-FAST. A rope employed to confine a ſhip ſideways to a wharf or to ſome other ſhip.

To BRING BY THE LEE. See TO BROACH TO.

To BRING TO. To check the courſe of a ſhip when ſhe is advancing, by arranging the ſails in ſuch a manner as that they ſhall counteract each other, and prevent her from either retreating or advancing. See TO LIE TO.

To BROACH TO. To incline ſuddenly to windward of the ſhip's courſe, ſo as to preſent her ſide to the wind, and endanger her overſetting. The difference between BROACHING TO and BRINGING BY THE LEE may be thus defined. Suppoſe a ſhip under great ſail is ſteering ſouth, having the wind at N.N.W. then weſt is the weather-ſide, and eaſt the lee-ſide. If, by any accident, her head turns round to the weſtward, ſo as that her ſails are all taken a-back on the weather ſide, ſhe is ſaid to BROACH TO. If, on the contrary, her head declines ſo far eaſtward as to lay her ſails aback on that ſide which was the lee-ſide, it is called BRINGING BY THE LEE.

BROADSIDE. A diſcharge of all the guns on one ſide of a ſhip both above and below.

BROKEN BACKED. The ſtate of a ſhip which is ſo looſened in her frame as to drop at each end.

BY THE BOARD. Over the ſhip's ſide.

BY

BY THE HEAD. The ſtate of a ſhip when ſhe is ſo unequally loaded as to draw more water forward than aft.

BY THE WIND. The courſe of a ſhip as near as poſſible to the direction of the wind, which is generally within ſix points of it.

To CAREEN. To incline a ſhip on one ſide ſo low down, by the application of a ſtrong purchaſe to her maſts, as that her bottom on the other ſide may be cleanſed by breaming.

CASTING. The motion of falling off, ſo as to bring the direction of the wind on either ſide of the ſhip after it had blown ſome time right a-head. It is particularly applied to a ſhip about to weigh anchor.

To CAT THE ANCHOR is to hook the cat-block to the ring of the anchor and haul it up cloſe to the cat-head.

CAT's PAW. A light air of wind perceived at a diſtance in a calm, ſweeping the ſurface of the ſea very lightly, and dying away before it reaches the ſhip.

CENTRE. This word is applied to that ſquadron of a fleet, in line of battle, which occupies the middle of the line; and to that column (in the order of ſailing) which is between the weather and lee columns.

CHANGE THE MIZEN. Bring the mizen-yard over to the other ſide of the maſt.

CHAPELLING. The act of turning a ſhip round in a light breeze of wind when ſhe is cloſed-hauled, ſo as that ſhe will lie the ſame way ſhe did before. This is uſually occaſioned by negligence in ſteering or by a ſudden change of wind.

CHASE. A veſſel purſued by ſome other.

CHASER. The veſſel purſuing.

CHEERLY. A phraſe implying heartily, quickly, cheerfully.

To CLAW OFF. The act of turning to windward from a lee-ſhore to eſcape ſhipwreck, &c.

CLEAR is variouſly applied. The weather is ſaid to be CLEAR, when it is fair and open; the ſea-coaſt is CLEAR, when the navigation is not interrupted by rocks, &c. It is applied to cordage,

cables, &c. when they are diſentangled, ſo as to be ready for immediate ſervice. In all theſe ſenſes it is oppoſed to FOUL.

To CLEAR THE ANCHOR is to get the cable off the flukes, and to diſencumber it of ropes ready for dropping.

CLEAR HAWSE. When the cables are directed to their anchors without lying athwart the ſtem.

To CLEAR THE HAWSE is to untwiſt the cables when they are entangled by having either a croſs, an elbow, or a round turn.

CLENCHED. Made faſt, as the cable is to the ring of the anchor.

CLOSE-HAULED. That trim of the ſhip's ſails, when ſhe endeavours to make a progreſs in the neareſt direction poſſible towards that point of the compaſs from which the wind blows.

To CLUB-HAUL. A method of tacking a ſhip when it is expected ſhe will miſs ſtays on a lee-ſhore.

To CLUE UP. To haul up the clues of a ſail to its yard by means of the clue-lines.

COASTING. The act of making a progreſs along the ſea-coaſt of any country.

To COIL THE CABLE. To lay it round in a ring, one turn over another.

To COME HOME. The anchor is ſaid to come home when it looſens from the ground by the effort of the cable, and approaches the place where the ſhip floated, at the length of her moorings.

COMING TO denotes the approach of a ſhip's head to the direction of the wind.

COURSE. The point of the compaſs on which a ſhip ſteers.

CRANK. The quality of a ſhip, which, for want of ſufficient ballaſt, is rendered incapable of carrying ſail without being expoſed to the danger of overſetting.

To CROWD SAIL. To carry more ſail than ordinary.

CUNNING. The art of directing the ſteerſman to guide the ſhip in her proper courſe.

To

To CUT AND RUN. To cut the cable and make ſail inſtantly, without waiting to weigh anchor.

To DEADEN A SHIP'S WAY. To impede her progreſs through the water.

DEAD WATER. The eddy of water, which appears like whirl-pools, cloſing in with the ſhip's ſtern as ſhe ſails on.

DISMASTED. The ſtate of a ſhip that has loſt her maſts.

DOUBLING. The act of ſailing round or paſſing beyond a cape or point of land.

DOUBLING UPON. The act of incloſing any part of a hoſtile fleet between two fires, or of cannonading it on both ſides.

To DOWSE. To lower ſuddenly, or ſlacken.

To DRAG THE ANCHOR. To trail it along the bottom, after it is looſened from the ground.

To DRAW. When a ſail is inflated by the wind, ſo as to advance the veſſel in her courſe, the ſail is ſaid TO DRAW; and ſo TO KEEP ALL DRAWING is to inflate all the ſails.

DRIFT. The angle which the line of a ſhip's motion makes with the neareſt meridian, when ſhe drives with her ſide to the wind and waves, and not governed by the power of the helm. It alſo implies the diſtance which the ſhip drives on that line.

DRIVING. The ſtate of being carried at random, as impelled by a ſtorm or current. It is generally expreſſed of a ſhip when accidentally broke looſe from her anchors or moorings.

DROP. Uſed ſometimes to denote the depth of a ſail; as the fore-top-ſail DROPS twelve yards.

To DROP ANCHOR. Uſed ſynonymouſly with TO ANCHOR.

To DROP A-STERN. The retrograde motion of a ſhip.

To EASE, TO EASE AWAY, OR TO EASE OFF. To ſlacken gradually; thus they ſay, EASE the bowline, EASE the ſheet.

EASE THE SHIP! The command given by the pilot, to the ſteerſman, to put the helm hard a-lee, when the ſhip is expected to plunge her fore part deep in the water when cloſe-hauled.

To EDGE AWAY. To decline gradually from the ſhore or from the line of the courſe which the ſhip formerly held, in order to go more large.

To EDGE IN WITH. To advance gradually towards the ſhore or any other object.

ELBOW IN THE HAWSE. A particular twiſt in the cables by which a ſhip is moored; explained at length hereafter in the PRACTICE OF WORKING SHIPS.

END-FOR-END. A reverſal of the poſition of any thing is turning it END-FOR-END. It is applied alſo to a rope that has run quite out of the block in which it was reeved, or to a cable which has all run out of the ſhip.

END ON. When a ſhip advances to a ſhore, rock, &c. without an apparent poſſibility of preventing her, ſhe is ſaid to go END ON for the ſhore, &c.

EVEN KEEL. When the keel is parallel with the horizon, a ſhip is ſaid to be upon an EVEN KEEL.

FAIR. A general term for the diſpoſition of the wind when favourable to a ſhip's courſe.

FAIR-WAY. The channel of a narrow bay, river, or haven, in which ſhips uſually advance in their paſſage up and down.

To FALL A-BOARD OF. To ſtrike or encounter another ſhip when one or both are in motion.

To FALL A-STERN. The motion of a ſhip with her ſtern foremoſt.

To FALL CALM. To become in a ſtate of reſt by a total ceſſation of the wind.

To FALL DOWN. To ſail or be towed down a river nearer towards its mouth.

FALLING OFF denotes the motion of the ſhip's head from the direction of the wind. It is uſed in oppoſition to COMING TO.

FALL NOT OFF! The command to the ſteerſman to keep the ſhip near the wind.

To FETCH WAY. To be ſhaken or agitated from one ſide to another ſo as to looſen any thing which was before fixed.

To FILL. To brace the ſails ſo as to receive the wind in them, and advance the ſhip in her courſe, after they had been either ſhivering or braced a-back.

To

To FISH THE ANCHOR. To draw up the flukes of the anchor towards the top of the bow, in order to ſtow it, after having been catted.

FLAT-AFT. The ſituation of the ſails when their ſurfaces are preſſed aft againſt the maſt by the force of the wind.

To FLAT IN. To draw in the aftermoſt lower corner or clue of a ſail towards the middle of the ſhip, to give the ſail a greater power to turn the veſſel.

To FLAT IN FORWARD. To draw in the fore-ſheet, jib-ſheet, and fore-ſtayſail-ſheet, towards the middle of the ſhip.

FLAW. A ſudden breeze or guſt of wind.

FLOATING. The ſtate of being buoyed up by the water from the ground.

FLOOD-TIDE. The ſtate of a tide when it flows or riſes.

FLOWING SHEETS. The poſition of the ſheets of the principal ſails when they are looſened to the wind, ſo as to receive it into their cavities more nearly perpendicular than when cloſe-hauled, but more obliquely than when the ſhip ſails before the wind. A ſhip going two or three points large has FLOWING SHEETS.

FORE. That part of a ſhip's frame and machinery that lies near the ſtem.

FORE-AND-AFT. Throughout the whole ſhip's length. Lengthways of the ſhip.

To FORE-REACH UPON. To gain ground of ſome other ſhip.

To FORGE OVER. To force a ſhip violently over a ſhoal by a great quantity of ſail.

FORWARD. Towards the fore part of a ſhip.

FOUL. Is uſed in oppoſition both to CLEAR and FAIR. As oppoſed to CLEAR, we ſay FOUL WEATHER, FOUL BOTTOM, FOUL GROUND, FOUL ANCHOR, FOUL HAWSE. As oppoſed to FAIR, we ſay FOUL WIND.

To FOUNDER. To ſink at ſea by filling with water.

To FREE. Pumping is ſaid to FREE the ſhip when it diſcharges more water than leaks into her.

To

To FRESHEN. When a gale increaſes it is ſaid to FRESHEN.

To FRESHEN THE HAWSE. Veering out or heaving in a little cable to let another part of it endure the ſtreſs at the hawſe-holes. It is alſo applied to the act of renewing the ſervice round the cable at the hawſe-holes.

FRESH WAY. When a ſhip increaſes her velocity ſhe is ſaid to get FRESH WAY.

FULL. The ſituation of the ſails, when they are kept diſtended by the wind.

FULL-AND-BY. The ſituation of a ſhip, with regard to the wind, when cloſe-hauled; and ſailing, ſo as to ſteer neither too nigh the direction nor to deviate to leeward.

To FURL. To wrap or roll a ſail cloſe up to the yard or ſtay to which it belongs, and winding a cord round it, to keep it faſt.

To GAIN THE WIND. To arrive on the weather-ſide, or to windward of, ſome ſhip or fleet in ſight, when both are ſailing as near the wind as poſſible.

To GATHER. A ſhip is ſaid to gather on another as ſhe comes nearer to her.

GIMBLETING. The action of turning the anchor round by the ſtock, ſo that the motion of the ſtock appears ſimilar to that of the handle of a gimblet, when employed to turn the wire.

To GIVE CHASE TO. To purſue a ſhip or fleet.

GOOSE-WINGS OF A SAIL. The clues or lower corners of a ſhip's mainſail or foreſail, when the middle part is furled or tied up to the yard.

GRIPING. The inclination of a ſhip to run to windward of her proper courſe.

GROUNDING. The laying a ſhip a-ſhore, in order to repair her. It is alſo applied to running a-ground accidentally.

GROUND-TACKLE. Every thing belonging to a ſhip's anchors, and which are neceſſary for anchoring or mooring; ſuch as cables, hawſers, tow-lines, warps, buoy-ropes, &c.

GROWING. Stretching out; applied to the direction of the cable from the ſhip towards the anchors; as, the cable GROWS on the ſtarboard bow.

GYBING.

GYBING. The act of ſhifting any boom-ſail from one ſide of the maſt to the other.

To HAIL. To ſalute or ſpeak to a ſhip at a diſtance.

To HAND THE SAILS. The ſame as to FURL them.

HAND-OVER-HAND. The pulling of any rope, by the men's paſſing their hands alternately one before the other or one above another. A ſailor is ſaid to go aloft HAND-OVER-HAND when he climbs into the tops by a ſingle rope, dexterouſly throwing one hand over the other.

HANDSOMELY. Gradually, as LOWER HANDSOMELY.

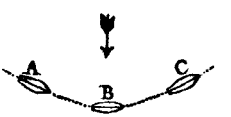
HANK-FOR-HANK. When two ſhips tack and make a progreſs to windward together.

HARD A-LEE. The ſituation of the helm, when puſhed cloſe to the lee ſide of the ſhip.

HARD A-WEATHER. The ſituation of the helm, when puſhed cloſe to the weather ſide of the ſhip.

To HAUL. To pull a ſingle rope without the aſſiſtance of blocks.

To HAUL THE WIND. To direct the ſhip's courſe nearer to the point from which the wind blows. Thus the ſhip A hauls the wind, when, by the trim of her ſails and the action of her rudder, ſhe gets on either of the courſes B and C.



HAWSE. The ſituation of the cables before the ſhip's ſtem, when ſhe is moored with two anchors out from forward. It alſo denotes any ſmall diſtance a-head of a ſhip, or the ſpace between her head and the anchors employed to ride her.

HEAD-FAST. A rope employed to confine the head of a ſhip to a wharf or to ſome other ſhip.

HEADMOST. The ſituation of any ſhip or ſhips which are the moſt advanced in a fleet.

HEAD-SAILS. All the ſails which belong to the fore-maſt and bowſprit.

HEAD-SEA. When the waves meet the head of a ſhip in her courſe, they are called a HEAD-SEA. It is likewiſe applied to a large ſingle wave coming in that direction.

HEAD-

HEAD-TO-WIND. The ſituation of a ſhip when her head is turned to the point from which the wind blows, as it muſt when tacking.

HEAD-WAY. The motion of advancing, uſed in oppoſition to STERN-WAY.

To HEAVE. To turn about a capſtern, or other machine of the like kind, by means of bars, handſpecs, &c.

To HEAVE A-HEAD. To advance the ſhip by heaving-in the cable or other rope faſtened to an anchor at ſome diſtance before her.

To HEAVE A-PEEK. To heave-in the cable, till the anchor is a-peek.

To HEAVE A-STERN. To move a ſhip backwards by an operation ſimilar to that of HEAVING A-HEAD.

To HEAVE DOWN. To CAREEN.

To HEAVE-IN THE CABLE. To draw the cable into the ſhip, by turning the capſtern.

To HEAVE IN STAYS. To bring a ſhip's head to the wind, by a management of the ſails and rudder, in order to get on the other tack.

To HEAVE OUT. To unfurl or looſe a ſail; more particularly applied to the ſtayſails: thus we ſay, looſe the topſails and HEAVE OUT the ſtayſails.

To HEAVE SHORT. To draw ſo much of the cable into the ſhip, as that ſhe will be almoſt perpendicularly over her anchor.

To HEAVE TIGHT or TAUGHT. To turn the capſtern round, till the rope or cable becomes ſtraitened.

To HEAVE THE CAPSTERN. To turn it round.

To HEAVE THE LEAD. To throw the lead overboard, in order to find the depth of water.

To HEAVE THE LOG. To throw the log overboard, in order to calculate the velocity of the ſhip's way.

To HEEL. To ſtoop or incline to one ſide; thus they ſay TO HEEL TO PORT, that is to heel to the larboard ſide.

HELM A-LEE! A direction to put the helm over to the lee ſide.

HELM A-WEATHER! An order to put the helm over to the windward ſide.

HIGH-

HIGH-AND-DRY. The ſituation of a ſhip when ſo far run a-ground as to be ſeen dry upon the ſtrand.

To HOIST. To draw up any body by the aſſiſtance of one or more tackles. Pulling by means of a ſingle block is never termed HOISTING, except only the drawing of the ſails upwards along the maſts or ſtays.

To HOLD ITS OWN is applied to the relative ſituation of two ſhips when neither advances upon the other; each is then ſaid to HOLD ITS OWN. It is likewiſe ſaid of a ſhip which, by means of contrary winds, cannot make a progreſs towards her deſtined port, but which however keeps nearly the diſtance ſhe had already run.

To HOLD ON. To pull back or retain any quantity of rope acquired by the effort of a capſtern, windlaſs, tackle, block, &c.

HOME implies the proper ſituation of any object; as, to haul HOME the topſail-ſheets is to extend the bottom of the topſail to the lower yard, by means of the ſheets. In ſtowing a hold, a caſk, &c. is ſaid to be HOME, when it lies cloſe to ſome other object.

To HULL A SHIP. To fire cannon-balls into her hull within the point-blank range.

HULL-TO. The ſituation of a ſhip when ſhe lies with all her ſails furled; as in TRYING.

IN STAYS. See to HEAVE in ſtays.

KECKLED. Any part of a cable, covered over with old ropes, to prevent its ſurface from rubbing againſt the ſhip's bow or fore foot.

To KEEP AWAY. To alter the ſhip's courſe to one rather more large, for a little time, to avoid ſome ſhip, danger, &c. KEEP AWAY is likewiſe ſaid to the ſteerſman, who is apt to go to windward of the ſhip's courſe.

To KEEP FULL. To keep the ſails diſtended by the wind.

To KEEP HOLD OF THE LAND. To ſteer near to or in ſight of the land.

To KEEP OFF. To ſail off or keep at a diſtance from the ſhore.

To KEEP THE LAND ABOARD. The ſame as TO KEEP HOLD OF THE LAND.

To KEEP THE LUFF. To continue cloſe to the wind.

To KEEP THE WIND. The ſame as TO KEEP THE LUFF.

KNOT. A diviſion of the log-line, anſwering, in the calculation of the ſhip's velocity, to one mile.

To LABOUR. To roll or pitch heavily in a turbulent ſea.

LADEN IN BULK. Freighted with a cargo not packed, but lying looſe, as corn, ſalt, &c.

LAID-UP. The ſituation of a ſhip when moored in a harbour, for want of employ.

LAND-FALL. The firſt land diſcovered after a ſea-voyage. Thus a GOOD LAND-FALL implies the land expected or deſired; a BAD LAND-FALL the reverſe.

LAND-LOCKED. The ſituation of a ſhip ſurrounded with land, ſo as to exclude the proſpect of the ſea, unleſs over ſome intervening land.

LARBOARD. The left ſide of a ſhip, looking towards the head.

LARBOARD-TACK. The ſituation of a ſhip when ſailing with the wind blowing upon her larboard ſide.

LAYING THE LAND. A ſhip which increaſes her diſtance from the coaſt, ſo as to make it appear lower and ſmaller, is ſaid to LAY THE LAND.

LEADING-WIND. A fair wind for a ſhip's courſe.

LEAK. A chink or breach in the ſides or bottom of a ſhip, through which the water enters into the hull.

To LEAK. To admit water into the hull through chinks or breaches in the ſides or bottom.

LEE. That part of the hemiſphere to which the wind is directed, to diſtinguiſh it from the other part which is called to windward.

LEE-GAGE. A ſhip or fleet to leeward of another is ſaid to have the lee-gage.

LEE-LURCHES. The ſudden and violent rolls which a ſhip often takes to leeward, in a high ſea; particularly when a large wave ſtrikes her on the weather ſide.

LEE OF THE SHORE. See UNDER THE LEE OF THE SHORE.

LEE-

LEE-QUARTER. That quarter of a ſhip which is on the lee-ſide.

LEE-SHORE. That ſhore upon which the wind blows.

LEE-SIDE. That half of a ſhip lengthwiſe, which lies between a line drawn through the middle of her length and the ſide which is fartheſt from the point of wind.

To LEEWARD. Towards that part of the horizon to which the wind blows.

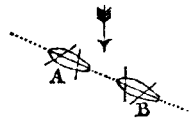
LEEWARD SHIP. A ſhip that falls much to leeward of her courſe, when ſailing cloſe-hauled.

LEEWARD TIDE. A tide that ſets to leeward.

LEE-WAY. The lateral movement of a ſhip to leeward of her courſe; or the angle which the line of her way makes with a line in the direction of her keel.

To LIE ALONG. To be preſſed down ſideways by a weight of ſail in a freſh wind.

To LIE-TO. To retard a ſhip in her courſe, by arranging the ſails in ſuch a manner as to counteract each other with nearly an equal effort, and render the ſhip almoſt immovable, with reſpect to her progreſſive motion or headway. Thus the poſition of the yards, in the figures A and B, cauſes the ſails to counteract each other, the wind blowing upon the after-ſurface of one and the fore-ſurface of the other.



A LONG SEA. An uniform motion of long waves.

LOOK-OUT. A watchful attention to ſome important object or event that is expected to ariſe. Thus perſons on board of a ſhip are occaſionally ſtationed to LOOK OUT for ſignals, other ſhips, for land, &c.

To LOOSE. To unfurl or caſt looſe any ſail.

To LOWER. To eaſe down gradually.

LUFF! The order to the ſteerſman to put the helm towards the lee-ſide of the ſhip, in order to ſail nearer to the wind.

To MAKE A BOARD. To run a certain diſtance upon one tack, in beating to windward.

To MAKE FOUL WATER. To muddy the water, by running in ſhallow places, ſo that the ſhip's keel diſturbs the mud at bottom.

To MAKE SAIL. To increaſe the quantity of ſail already ſet, either by unreefing or by ſetting others.

To MAKE STERNWAY. To retreat or move with the ſtern foremoſt.

To MAKE THE LAND. To diſcover it from afar.

To MAKE WATER. To leak.

To MAN THE YARD, &c. To place men on the yard, in the tops, down the ladder, &c. to execute any neceſſary duties.

MASTED. Having all her maſts complete.

To MIDDLE A ROPE. To double it into two equal parts.

MIDSHIPS. See AMIDSHIPS.

To MISS STAYS. A ſhip is ſaid to MISS STAYS, when her head will not fly up into the direction of the wind, in order to get her on the other tack.

MOORING. Securing a ſhip in a particular ſtation by chains or cables, which are either faſtened to an adjacent ſhore or to anchors at the bottom.

MOORING SERVICE. When a ſhip is moored, and rides at one cable's length, the mooring ſervice is that which is at the firſt ſplice.

NEAPED. The ſituation of a ſhip left a-ground on the height of a ſpring tide, ſo that ſhe cannot be floated till the return of the next ſpring tide.

NEAR or NO NEAR. An order to the ſteerſman not to keep the ſhip ſo cloſe to the wind.

OFF-AND-ON. When a ſhip is beating to windward, ſo that by one board ſhe approaches towards the ſhore, and by the other ſtands out to ſea, ſhe is ſaid to ſtand OFF-AND-ON ſhore.

OFFING. Out at ſea, or at a competent diſtance from the ſhore, and generally out of anchor-ground.

OFFWARD. From the ſhore; as when a ſhip lies a-ground and leans towards the ſea, ſhe is ſaid to heel OFFWARD.

ON THE BEAM. Any diſtance from the ſhip on a line with the beams, or at right angles with the keel. See BEARING.

ON THE BOW. An arch of the horizon, comprehending about four points of the compaſs on each ſide of that point to which the ſhip's head is directed. Thus, they ſay, the ſhip in ſight bears three

three points ON THE STARBOARD-BOW; that is three points, towards the right-hand, from that part of the horizon which is right a-head. See BEARING.

ON THE QUARTER. An arch of the horizon, comprehending about four points of the compaſs on each ſide of that point to which the ſhip's ſtern is directed. See ON THE BOW and BEARING.

OPEN. The ſituation of a place expoſed to the wind and ſea. It is alſo expreſſed of any diſtant object to which the ſight or paſſage is not intercepted.

OPEN HAWSE. When the cables of a ſhip at her moorings lead ſtrait to their reſpective anchors, without croſſing, ſhe is ſaid to ride with an OPEN HAWSE.

OVER-BOARD. Out of the ſhip.

OVER-GROWN SEA is expreſſed of the ocean when the ſurges and billows riſe extremely high.

To OVER-HAUL. To open and extend the ſeveral parts of a tackle, or other aſſemblage of ropes, thereby fitting them the better for running eaſily.

OVER-RAKE. When a ſhip at anchor is expoſed to a head-ſea, the waves of which break in upon her, the waves are ſaid to OVER-RAKE her.

OVER-SET. A ſhip is OVER-SET, when her keel turns upwards.

OUT-OF-TRIM. The ſtate of a ſhip, when ſhe is not properly balanced for the purpoſes of navigation.

PARLIAMENT-HEEL. The ſituation of a ſhip when ſhe is made to ſtoop a little to one ſide, ſo as to clean the upper part of her bottom on the other ſide. See BOOT-TOPPING.

PARTING. Being driven from the anchors, by the breaking of the cable.

To PAWL THE CAPSTERN. To fix the pawls, ſo as to prevent the capſtern from recoiling, during any pauſe of heaving.

To PAY. To daub or cover the ſurface of any body with pitch, tar, &c. in order to prevent it from the injuries of the weather.

To PAY AWAY or PAY OUT. To ſlacken a cable or other rope, ſo as to let it run out for ſome particular purpoſe.

To

To PAY OFF. To move a ſhip's head to leeward.

To PEEK THE MIZEN. To put the mizen-yard perpendicular by the maſt.

PITCHING. The movement of a ſhip, by which ſhe plunges her head and after-part alternately into the hollow of the ſea.

To PLY TO WINDWARD. To endeavour to make a progreſs againſt the direction of the wind. See BEATING TO WINDWARD.

POINT-BLANK. The direction of a gun when levelled horizontally.

POOPING. The ſhock of a high and heavy ſea upon the ſtern or quarter of a ſhip, when ſhe ſcuds before the wind in a tempeſt.

PORT. A name given on ſome occaſions to the larboard ſide of the ſhip; as, the ſhip heels to port, top the yards to port, &c.

PORT THE HELM! The order to put the helm over to the larboard ſide.

PORT-LAST. The gunwale.

PORTOISE. The ſame as PORT-LAST; TO RIDE A PORTOISE is to ride with a yard ſtruck down to the deck.

PRESS OF SAIL. All the ſail a ſhip can ſet or carry.

PRIZING. The application of a lever to move any weighty body.

PURCHASE. Any ſort of mechanical power employed in raiſing or removing heavy bodies.

QUARTERS. The ſeveral ſtations of a ſhip's crew in time of action.

QUARTERING. When a ſhip under ſail has the wind blowing on her quarter.

To RAISE. To elevate any diſtant object at ſea by approaching it; thus, TO RAISE THE LAND is uſed in oppoſition to LAY THE LAND.

To RAKE. To cannonade a ſhip at the ſtern or head, ſo that the balls ſcour the whole length of the decks.

RANGE

RANGE OF CABLE. A ſufficient length of cable drawn upon deck before the anchor is caſt looſe, to admit of its ſinking to the bottom without any check.

REACH. The diſtance between any two points on the banks of a river, wherein the current flows in an uninterrupted courſe.

READY ABOUT! A command of the boatſwain to the crew, and implies that all the hands are to be attentive and at their ſtations for tacking.

REAR. The laſt diviſion of a ſquadron, or the laſt ſquadron of a fleet. It is applied likewiſe to the laſt ſhip of a line, ſquadron, or diviſion.

REEF. Part of a ſail from one row of eyelet-holes to another. It is applied likewiſe to a chain of rocks lying near the ſurface of the water.

REEFING. The operation of reducing a ſail by taking in one or more of the reefs.

To REEVE. To paſs the end of a rope through any hole, as the channel of a block, the cavity of a thimble, &c.

RENDERING. The giving way or yielding to the efforts of ſome mechanical power. It is uſed in oppoſition to jambing or ſticking.

RIDING, when expreſſed of a ſhip, is the ſtate of being retained in a particular ſtation by an anchor and cable. Thus ſhe is ſaid to RIDE EASY or to RIDE HARD, in proportion to the ſtrain upon her cable. She is likewiſe ſaid to RIDE LEEWARD TIDE if anchored in a place at a time when the tide ſets to leeward, and to RIDE WINDWARD TIDE if the tide ſets to windward: to RIDE BETWEEN WIND AND TIDE, when the wind and tide are in direct oppoſition, cauſing her to ride without any ſtrain upon her cables.

RIGHTING. Reſtoring a ſhip to an upright poſition, either after ſhe has been laid on a careen, or after ſhe has been preſſed down on her ſide by the wind.

To RIGHT THE HELM is to bring it into midſhips, after it has been puſhed either to ſtarboard or larboard.

RIGGING

RIGGING OUT A BOOM. The running out a pole at the end of a yard to extend the foot of a ſail.

To RIG THE CAPSTERN. To fix the bars in their reſpective holes.

ROLLING. The motion by which a ſhip rocks from ſide to ſide like a cradle.

ROUGH-TREE. A name applied to any maſt, yard, or boom, placed in merchant-ſhips, as a rail or fence above the veſſel's ſide, from the quarter-deck to the fore-caſtle.

ROUNDING-IN. The pulling upon any rope which paſſes through one or more blocks in a direction nearly horizontal; as, ROUND-IN the weather-braces.

ROUND-TURN. The ſituation of the two cables of a ſhip when moored, after they have been ſeveral times croſſed by the ſwinging of the ſhip.

ROUNDING-UP. Similar to ROUNDING-IN, except that it is applied to ropes and blocks which act in a perpendicular direction.

To ROW. To move a boat with oars.

ROWSING. Pulling upon a cable or rope without the aſſiſtance of tackles.

To RUN OUT A WARP. To carry the end of a rope out from a ſhip in a boat, and faſtening it to ſome diſtant object, ſo tha by it the ſhip may be removed by pulling on it.

To SAG TO LEEWARD. To make conſiderable lee-way

SAILING-TRIM is expreſſed of a ſhip when in the beſt ſtate for ſailing.

SCANTING. The variation of the wind, by which it becomes unfavourable to a ſhip's making great progreſs, as it deviates from being large, and obliges the veſſel to ſteer cloſe-hauled or nearly ſo.

SCUDDING. The movement by which a ſhip is carried precipitately before the wind in a tempeſt.

SCUTTLING. Cutting large holes through the bottom or ſides of a ſhip, either to ſink her or to unlade her expeditiouſly when ſtranded.

SEA.

SEA. A large wave is ſo called. Thus they ſay, a HEAVY SEA. It implies likewiſe the agitation of the ocean, as, a GREAT SEA. It expreſſes the direction of the waves, as, A HEAD SEA. A LONG SEA means an uniform and ſteady motion of long and extenſive waves; a SHORT SEA, on the contrary, is when they run irregularly, broken, and interrupted.

SEA-BOAT. A veſſel that bears the ſea firmly, without ſtraining her maſts, &c.

SEA-CLOTHES. Jackets, trowſers, &c.

SEA-MARK. A point or object on ſhore conſpicuouſly ſeen at ſea.

SEA-ROOM. A ſufficient diſtance from the coaſt or any dangerous rocks, &c. ſo that a ſhip may perform all nautical operations without danger of ſhipwreck.

SENDING. The act of pitching precipitately into the hollow between two waves.

SETTING. The act of obſerving the ſituation of any diſtant object by the compaſs.

To SET SAIL. To unfurl and expand the ſails to the wind, in order to give motion to the ſhip.

To SET UP. To increaſe the tenſion of the ſhrouds, backſtays, &c. by tackles, laniards, &c.

To SETTLE THE LAND. To lower in appearance. It is ſynonymous with TO LAY THE LAND.

To SHAPE A COURSE. To direct or appoint the track of a ſhip in order to proſecute a voyage.

SHEERING. The act of deviating from the line of the courſe, either to the right or left.

To SHEER OFF. To remove to a greater diſtance.

To SHEET-HOME. To haul the ſheets of a ſail home to the block on the yard-arm.

To SHIFT THE HELM. To alter its poſition from right to left, or from left to right.

To SHIP. To take any perſon, goods, or thing, on board. It alſo implies to fix any thing in its proper place; as, to SHIP THE OARS, to fix them in their rowlocks.

SHIVERING. The ſtate of a ſail when fluttering in the wind.

SHOAL. Shallow.

To SHOE THE ANCHOR. To cover the flukes with a piece of plank to give it firmer hold in ſoft ground.

To SHOOT A-HEAD. To advance forward.

SHORE. A general name for the ſea-coaſt of any country.

To SHORTEN SAIL. Uſed in oppoſition to MAKE SAIL.

SLACK-WATER. The interval between the flux and reflux of the tide, when no motion is perceptible in the water.

SLATCH is applied to the period of a tranſitory breeze.

To SLIP THE CABLE. To let it run quite out when there is not time to weigh the anchor.

To SLUE. To turn any cylindrical piece of timber about its axis without removing it. Thus, to SLUE A MAST or BOOM is to turn it in its cap or boom-iron.

SOUNDING. Trying the depth of the water with a plummet, ſunk from a ſhip to the bottom.

To SPELL THE MIZEN. To let go the ſheet and peek it up.

To SPILL. To diſcharge the wind out of the cavity or belly of a ſail, when it is drawn up in the brails, in order to furl or reef it.

SPLIT. The ſtate of a ſail rent by the violence of the wind.

SPOON-DRIFT. A ſort of ſhowery ſprinkling of the ſea-water, ſwept from the ſurface of the waves in a tempeſt, and flying like a vapour before the wind.

SPRAY. The ſprinkling of a ſea, driven occaſionally from the top of a wave, and not continual as SPOON-DRIFT.

To SPRING A MAST, YARD, &c. To crack a maſt, yard, &c. by means of ſtraining in blowing weather, ſo that it is rendered unſafe for uſe.

To SPRING A LEAK. When a leak firſt commences, a ſhip is ſaid to SPRING A LEAK.

To SPRING THE LUFF. A ſhip is ſaid to SPRING HER LUFF when ſhe yields to the effort of the helm, by ſailing nearer to the wind than before.

SQUALL.

SQUALL. A ſudden violent blaſt of wind.

SQUARE. This term is applied to yards that are very long, as TAUNT is to high maſts.

To SQUARE THE YARDS. To brace the yards, ſo as to hang at right angles with the keel.

To STAND ON. To continue advancing.

To STAND IN. To advance towards the ſhore.

To STAND OFF. To recede from the ſhore.

STARBOARD. The right-hand ſide of the ſhip, when looking forward.

STARBOARD-TACK. A ſhip is ſaid to be on the STARBOARD-TACK, when ſailing with the wind blowing upon her ſtarboard-ſide.

STARBOARD THE HELM! An order to puſh the helm to the ſtarboard-ſide.

To STAY A SHIP. To arrange the ſails and move the rudder, ſo as to bring the ſhip's head to the direction of the wind, in order to get her on the other tack.

STEADY! The order to the helmſman to keep the ſhip in the direction ſhe is going at that inſtant.

STEERING. The art of directing the ſhip's way by the movement of the helm.

STEERAGE-WAY. Such degree of progreſſive motion of a ſhip as will give effect to the motions of the helm.

To STEM THE TIDE. When a ſhip is ſailing againſt the tide at ſuch a rate as enables her to overcome its power, ſhe is ſaid to STEM THE TIDE.

STERNFAST. A rope confining a ſhip by her ſtern to any other ſhip or wharf.

STERNMOST. The fartheſt a-ſtern, oppoſed to HEADMOST.

STERNWAY. The motion by which a ſhip falls back with her ſtern foremoſt.

STIFF. The condition of a ſhip when ſhe will carry a great quantity of ſail without hazard of overſetting. It is uſed in oppoſition to CRANK.

To STOW. To arrange and diſpoſe a ſhip's cargo.

To STREAM THE BUOY. To let it fall from the ſhip's ſide into the water, previouſly to caſting anchor.

To STRIKE. To lower or let down any thing. Uſed emphatically to denote the lowering of colours in token of ſurrender to a victorious enemy.

To STRIKE SOUNDING. To touch ground, when endeavouring to find the depth of water.

SURF. The ſwell of the ſea that breaks upon ſhore or on any rock.

To SURGE THE CAPSTERN. To ſlacken the rope heaved round upon it.

SWELL. The fluctuating motion of the ſea either during or after a ſtorm.

SWEEPING. The act of dragging the bight or looſe part of a rope along the ſurface of the ground, in a harbour or road, in order to drag up ſomething loſt.

SWINGING. The act of a ſhip's turning round her anchor at the change of wind or tide.

To TACK. To turn a ſhip about from one tack to another, by bringing her head to the wind. Thus the ſhip A paſſes from the larboard to the ſtarboard tack a.

TAKING-IN. The act of furling the ſails. Uſed in oppoſition to SETTING.

TAKEN A-BACK. See A-BACK.

TAUGHT. Improperly though very generally uſed for TIGHT.

TAUNT. High or tall. Particularly applied to maſts of extraordinary length.

TENDING. The turning or ſwinging of a ſhip round her anchor in a tide-way at the beginning of ebb and flood.

THWART. See A-THWART.

THWART SHIPS. See A-THWART SHIPS.

THUS! An order to the helmſman to keep the ſhip in her preſent ſituation, when ſailing with a ſcant wind.

TIDE-

TIDE-WAY. That part of a river in which the tide ebbs and flows ſtrongly.

TIER. One range of any thing placed horizontally.

TOPPING. Pulling one of the ends of a yard higher than the other.

To TOW. To draw a ſhip in the water by a rope fixed to a boat or other ſhip which is rowing or ſailing on.

TRIM. The ſtate or diſpoſition by which a ſhip is beſt calculated for the purpoſes of navigation.

To TRIM THE HOLD. To arrange the cargo regularly.

To TRIM THE SAILS. To diſpoſe the ſails in the beſt arrangement for the courſe which a ſhip is ſteering.

To TRIP THE ANCHOR. To looſen the anchor from the ground, either by deſign or accident.

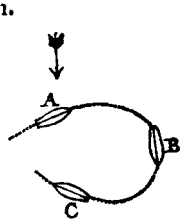
TROUGH OF THE SEA. The hollow between two waves.

TRYING. The ſituation in which a ſhip, in a tempeſt, lies-to in the trough or hollow of the ſea, particularly when the wind blows contrary to her courſe.

TURNING TO WINDWARD. That operation in ſailing, whereby a ſhip endeavours to advance againſt the wind.

VAN. The foremoſt diviſion of a fleet in one line. It is likewiſe applied to the foremoſt ſhip of a diviſion.

To VEER. To change a ſhip's courſe, from one tack to the other, by turning her ſtern to windward: thus the ſhip A veers, in paſſing from the courſe A to the courſe C. The wind is ſaid to veer when it changes more aft.



To VEER AND HAUL. To pull a rope tight, by alternately drawing it in and ſlackening it.

To UNBALLAST. To diſcharge the ballaſt out of a ſhip.

To UNBEND. To take the ſails off from their yards and ſtays. To caſt looſe the anchor from the cable. To untie two ropes.

To UNBIT. To remove the turns of a cable from off the bits.

UNDER FOOT is expreſſed of an anchor that is directly under the ſhip.

UNDER

UNDER SAIL. When a ſhip is looſened from moorings, and is under the government of her ſails and rudder.

UNDER WAY. The ſame as UNDER SAIL.

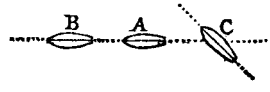
UNDER THE LEE OF THE SHORE is to be cloſe under the ſhore which lies to windward of the ſhip.

To UNMOOR. To reduce a ſhip to the ſtate of riding at ſingle anchor, after ſhe has been moored.

To UNREEVE. To draw a rope from out of a block, thimble, &c.

To UNRIG. To deprive the ſhip of her rigging.

WAKE. The print or track impreſſed upon the ſurface of the water by a ſhip in her courſe. A ſhip is ſaid to be IN THE WAKE of another, when ſhe follows her in the ſame track, or on a line ſuppoſed to be formed on a continuation of her keel. Thus the ſhip A is ſailing in the wake of B, and the ſhip C is croſſing in the wake of A and B.



To WARE. See TO VEER.

WARP. A ſmall rope employed occaſionally to remove a ſhip from one place to another.

To WARP. To remove a ſhip by means of a warp.

WATER-BORNE. The ſtate of a ſhip, when there is barely a ſufficient depth of water to float her off from the ground.

WATER-LOGGED. The ſtate of a ſhip, become heavy and inactive on the ſea, from the great quantity of water leaked into her.

WATER-TIGHT. The ſtate of a ſhip when not leaky.

WEATHER. Synonymous with WINDWARD.

WEATHER-BEATEN. Shattered by a ſtorm.

WEATHER-BIT. A turn of the cable about the end of the windlaſs.

WEATHER-GAGE. When a ſhip or fleet is to windward of another ſhe is ſaid to have the WEATHER-GAGE of her.

WEATHER-QUARTER. That quarter of the ſhip which is on the windward ſide.

WEATHER-SIDE. The ſide upon which the wind blows.

To

To WEIGH ANCHOR. To heave up an anchor from the bottom.

To WIND A SHIP. To change her poſition, bringing her head where her ſtern was.

WIND-ROAD. When a ſhip is at anchor, and the wind, being againſt the tide, is ſo ſtrong as to overcome its power and keep the ſhip to leeward of her anchor, ſhe is ſaid to be WIND-ROAD.

WIND's EYE. The point from which the wind blows.

To WINDWARD. Towards that part of the horizon from which the wind blows.

WINDWARD-TIDE. A tide that ſets to windward.

To WORK A SHIP. To direct the movements of a ſhip, by adapting the ſails and managing the rudder according to the courſe the ſhip has to make.

To WORK TO WINDWARD. To make a progreſs againſt the direction of the wind.

YAWING. The motion of a ſhip, when ſhe deviates from her courſe to the right or left.

Blank page retained for pagination

THE THEORY OF WORKING SHIPS.

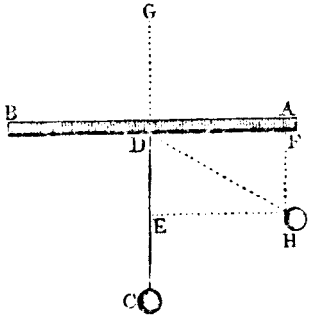
THE theory of working ſhips is nothing but the demonſtration, ſupported with proofs, of the effects of every ſail, and of the rudder, ſeparately or altogether conſidered, both with reſpect to the points where theſe machines are placed in the ſhip, and with reſpect to the different diſpoſitions which either are given them in the changes of evolutions, or which ariſe from their various obliquities, when they preſent, more or leſs obliquely, their ſurfaces to the courſe of the water or the wind.

LEMMA.

I. IF A BODY STRIKES A SURFACE, IT COMMUNICATES TO IT ALL ITS PERPENDICULAR MOTION.

DEMONSTRATION.

FIGURE I.



If the body C meets the ſurface A B, with a motion perpendicular to its middle, or centre of gravity D, it will do it

 with

with the ſtrength of all its perpendicular motion, which is the produce of its weight by its velocity; and will force it in the direction D G, perpendicular to A B. If the ſame body meets the ſame ſurface obliquely, and with the ſame velocity, it will impel it in the direction D G, with the velocity only of D E, which is equal to the angle of incidence H F. For, H F expreſſes the perpendicular velocity of the body H, towards the ſurface: and this is evident, if we conſider that the movement H D is compoſed of the two movements H F and H E; and that there is no other movement but H F only which can meet the ſurface A B, ſince the other H E is parallel to it.

But the part H F, of the motion of the body H, is perpendicular to the ſurface A B: whence it follows, that the body H impels, in the like perpendicular manner, that ſurface in the direction D G, with a force equal to the product of its weight by the velocity H F.

CHAPTER I.

OF THE ACTION WHICH WATER OR WIND HAVE, BY THEIR PRESSURE, ON SURFACES.

2. FLUIDS are formed of an infinite number of particles, the minuteneſs of which is the cauſe why they communicate, by their ſhock, but very imperceptible degrees of motion, in the firſt inſtant of their action: and ſuch is the weakneſs of their action, that it requires to be repeated a great many times before they can produce any ſenſible effect on the bodies they are to move.

It is eaſy to conceive, that the more ſpecific gravity a body is poſſeſſed of, the ſtronger its impulſe muſt be: therefore water, which weighs nearly eight hundred and fifty times more than air, ought to produce (the velocity being the ſame) an impulſion eight hundred and fifty times more than air would againſt a ſurface of the

the ſame ſize, moved in directions perfectly ſimilar. And when it is known that the impulſe of a fluid depends on its ſpecific gravity, it will be eaſily underſtood that ſuch an impulſe muſt depend alſo on the extent of the ſurface which is ſtruck. For, it is plain that the greater the ſurface is, (the gravity, the velocity, and the direction, of the fluid being the ſame,) the ſtronger the impulſe will be, admitting ſtill the ſame proportion to be kept between the extent of that fluid's ſurface and that of any other ſurface put in compariſon with it; becauſe a ſurface of twelve feet ſquare will always receive twelve times as much impulſion as would a ſurface of only one foot ſquare. We muſt obſerve here, at the ſame time, that ſuch parts of the fluid as ſtrike find more or leſs difficulty to recoil after the ſhock, according as the ſurface is more or leſs extenſive; becauſe, the greater the ſurface ſtruck, the longer is the continuance of repulſion from their former directions impreſſed on the particles, which, by that very act of repulſion, receive a new direction, by which they are made to loſe for a while the firſt movement they had during their primitive ones; whence it follows, that the ſhock of the ſubſequent particles muſt be altered: but this deviation from the direct line of the ſubſequent particles may be looked upon as almoſt nothing, ſince there is very little wanting, indeed, but all impulſions ſhould be in the reciprocal proportions which exiſt between them and the ſurfaces on which they ſtrike, allowing always all other circumſtances to be alike.

3. It muſt be obſerved, that the rapidity of the fluid contributes doubly to the force of the impulſe; for every particle ſtrikes with ſo much the more ſtrength as it acts with a greater velocity, and is at the ſame time followed by a greater number of new particles to ſhock the ſurface. So that the greater the celerity of the particles, the greater is the number of thoſe which ſhare the action, and the more powerful is the reſiſtance they oppoſe to their being put out of their direct motion. But, if the fluid is poſſeſſed of five or ſix times more rapidity, it is evident that every particle enjoys likewiſe five or ſix times more force to ſhock the ſurface which oppoſes the paſſage of them all together; as, on the ſide of the ſurface, there are five or ſix times as many particles to

encounter in the ſame ſpace of time: therefore ſuch a ſurface, thus expoſed to the ſhock of the fluid, will be ſtruck with twenty-five or thirty-ſix times more force at one time than at another, ſince there are five or ſix times as many particles employed in the act of ſtriking, and ſupported with five or ſix times as much rapidity. Whence it may be concluded, that impulſions increaſe as the ſquares of velocities; or, rather, that they are between themſelves as the ſquares of their velocities, when all other circumſtances are the ſame.

When a ſurface is expoſed to the courſe of a fluid, it is indifferent whether we conſider that the fluid ſhocks the ſurface, or that the ſurface moves the fluid: or, again, whether we conſider the fluid and the ſurface as having each their reſpective ſhare of the velocity with which that ſurface receives the impulſe of the fluid.

4. When the wind has little velocity, its action is obſerved to be but faint; but, when moving with rapidity, then it becomes capable of producing the greateſt effects. This is eaſy to be conceived; for, if to the action of every particle of air, which is ſtronger by reaſon of its increaſed celerity, be added a greater number of particles ſtriking at the ſame time, it is evident that its force will increaſe as the ſquare of its velocity; which has already been demonſtrated.

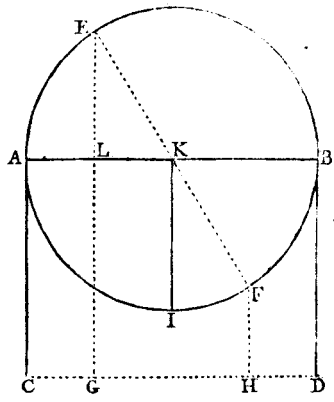
The ſame may be ſaid of water, the impulſe of which is almoſt like that of a ſolid when it acts, or is acted upon, with a great rapidity of motion. Whence we muſt conclude, that if that water meets perpendicularly a body which preſents to it a great ſuperficies, ſuch a body muſt have the greateſt ſolidity to be able to reſiſt it.

5. Experience confirms this principle. For, a ſhip which drives to leeward does not divide the fluid with her ſide in a direct line; there is always ſome obliquity in the direction ſhe purſues by her act of dividing. This obliquity proceeds from the little reſiſtance ſhe experiences from the fluid either at her ſtem or at her ſtern. So that, ſhould ſhe be driven ever ſo little to leeward, ſhe glides always obliquely on the column of water which oppoſes her under her lee, following a line more or leſs cloſe to the direction of her length,

length, than to the perpendicular which may be conceived to be drawn as lateral to her keel.

6. We have hitherto ſpoken of the impulſe of fluids upon ſurfaces only, when conſidered as perpendicular: but, when that impulſe becomes oblique, it is clear, that it muſt receive a great diminution; ſince the motion of every particle will be diſcompoſed, on account of its acting only by its motion perpendicular to the ſurface, as has been demonſtrated, (*fig.* 1, *page* 33,) where the body H may be conſidered as a particle of a fluid, the impulſe of which is proportionably leſs as the ſine of the angle of incidence H D F is diminiſhed: therefore, in this caſe, when we conſider the particle H as a body, its impulſe will be in the proportion of the different angles of incidence, which always expreſs their reſpective velocities, theſe being conſidered in a direction perpendicular to the ſurface.

FIGURE 2.



7. If, inſtead of one particle, we conſider the whole ſurface as expoſed to the courſe of all thoſe which compoſe a fluid; it will appear evident, from what has been ſaid, that the ſurface E F, (*fig.* 2,) which is oblique to the courſe of the fluid, preſents to that fluid a leſs ſurface than it would if it were perpendicular to it, like A B. So that each particle produces a leſs ſhock, and the particles which

are

are at the ſame time contributing to the ſhock are leſs in number. Now, as theſe two cauſes of diminution follow the ſame proportion, it reſults, that the impulſions of fluids are between themſelves as the ſquares of the ſines of incidence. Therefore, as ſoon as the impulſe of a fluid, which ſtrikes a ſurface perpendicularly, is known, that impulſe, when it ſtrikes the ſurface obliquely, is only to be diminiſhed in the ſame proportion as the ſine total I K is to the ſquare of the ſine of incidence L K.

The ſurface A B (*fig.* 2,) receives all the direct impulſe of the fluid which ſtrikes it perpendicularly, and which is contained between C D: but the ſame ſurface, preſented obliquely to the fluid in the direction E F, will receive but a part of the impulſe, which will be proportional to the ſine of incidence K L, compared with the ſine total I K, of the direct effort of every particle contained between the parallels E G and F H, which incloſe a much leſs ſpace than the firſt A C and B D. Whence it is eaſy to conclude, that the diminution of the impulſe of the fluid has diminiſhed on two ſides, and has conſequently followed the proportion of the ſquare of the ſine total I K to the ſquare of the ſine of incidence L K; for there is a leſs number of particles employed in ſtriking the ſurface, and with a ſmaller degree of velocity.

8. It follows, that we ought not to be ſurpriſed to ſee the velocity of a ſhip diminiſhing conſiderably, when, after having run with the wind aft or large, the veſſel is hauled cloſer to the wind. For it is evident that all the ſails, which can poſſibly be ſpread in this laſt direction, will receive but very little impulſe, on account of their great obliquity to the wind, with which they cannot make an angle more open than 30 degrees, and ſometimes much leſs, as will be demonſtrated hereafter. So that the impulſe has diminiſhed in proportion as the ſquare of the ſine total is to the ſine of incidence of 30 degrees; that is to ſay, as 4 to 1. Therefore, the ſails, receiving but a very faint impulſe, can communicate to the ſhip but a ſmall motion; and that motion is ſtill enfeebled by the reſiſtance of the water on the lee-bow; which reſiſtance increaſes, on one hand, by the inclination of the ſhip; and, on the other, by the greater ſurface which ſhe preſents to the water in the direction of her length; to which muſt be added, the decompoſition of the

abſolute

abſolute effort of the ſails, the lateral part of which is now become much greater than the direct. Hence we find the rapidity of the ſhip's way is already diminiſhed from three evident cauſes, to which another may ſtill be added; and it is this: If the ſhip has an inclination to the horizon, (as this always happens in oblique courſes, and as we have already hinted,) and if the wind has ever ſo little force, there will reſult again from that circumſtance a cauſe of diminution of impulſe of the wind on the ſails; becauſe, in ſuch a caſe, the ſails follow that particular inclination of the ſhip called *heeling*; and this diminution of impulſe will follow this particular proportion, viz. that in ſuch a direction the ſquare of the ſine of incidence will be ſmaller than that of the ſine total. Therefore, we ſee that the abſolute ſine of incidence diminiſhes in a twofold proportion, and receives that diminution from the compound ratio of the proportion which the ſine total bears to the two ſines of the obliquity of the yard with the wind and of the inclination of the ſail with the wind.

9. The impulſe of the wind, being continual, muſt neceſſarily communicate to the ſhip degrees of velocity, which, from inſtant to inſtant, are increaſing, until there happens to be an equilibrium between the impulſe of the wind on the ſails and the reſiſtance of the water on the bows, obſerving, that, in the courſes where the ſhip ſails with the wind abaft the beam, the firſt moment when the wind ſtrikes the ſails is the time when its impulſe is greateſt, and the reſiſtance of the water the weakeſt; becauſe, at that inſtant, the ſhip does not yet move in the fluid, not having yielded to the power of the wind: but, in a few moments, the velocity of the ſhip increaſing, the reſiſtance of the water on the bows increaſes alſo conſiderably: then the impulſe of the wind on the ſails is proportionably decreaſing, becauſe, the ſhip, receding, as it were, from the wind, muſt of courſe leſſen its power on the ſails. Thus the accelerating force is inceſſantly leſſening from two cauſes; firſt, from the wind ſtriking the ſails with leſs force; and, ſecond, from the greater part of its impulſe being deſtroyed by the reſiſtance of the water on the bows; a reſiſtance which increaſes in proportion as the ſhip's way accelerates; for, this oppoſition of the water is as a deduction from the effort of the wind; ſince, by its reſiſtance,

reſiſtance, the water renders part of that effort ineffectual. Therefore, the rate of ſailing will be the greateſt poſſible when the impulſe of the wind upon the ſails ſhall be ſo diminiſhed, and the reſiſtance of the water on the bows ſo increaſed, as that the two forces, acting in contrary directions, are in a perfect equilibrium. Hence we muſt conclude, that the veſſel will now enjoy a conſtant and uniform motion; for, the ſhip advances as if ſhe were not ſubject to the action of any exterior force, the wind no longer having power to increaſe her velocity, becauſe the reſiſtance of the water on her bows prevents it; and, on the other hand, the impulſe of the wind hinders the water, by its reſiſtance, from retarding her courſe.

10. If a ſhip runs on a line perpendicular to the direction of the wind, the impulſe on the ſails is always the ſame, becauſe ſhe does not recede from the point from which the wind blows; but, when ſhe ſails cloſe-hauled, the impulſe muſt be ſtronger; becauſe ſhe runs to windward, and draws nearer to that point. So that, if the rate of the ſhip's ſailing be great, the apparent angle of incidence diminiſhes in proportion to the two velocities, viz. that of the wind and that of the ſhip.

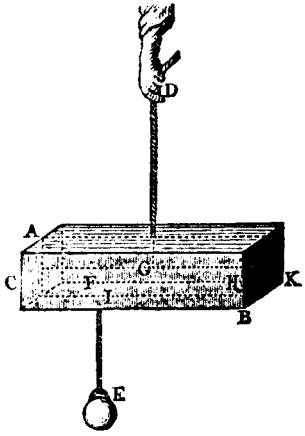
The moment a ſurface, which is ſuſpended or a-float, is ſtruck by a fluid, that is the time of the greateſt impulſion, (if it were not in motion before,) and of the greateſt reſiſtance of the ſurface.

CHAP-

CHAPTER II.

OF THE CENTRE OF GRAVITY.

FIGURE 3.



11. EVERY ſolid has a centre of gravity; that is to ſay, a point, on which, it being ſuſpended, it will have a perfect equilibrium; and on that point all the gravity of the body is united. Such, for example, is the rectangular parallelepipedon A B, (*fig.* 3,) the centre of gravity of which is exactly in the middle of the ſolid G; ſo that, if it be ſuſpended from that point, as from G to D, it will always be in equilibrium; becauſe that ſolid being conſidered as regular, one of its halves muſt exactly balance the other; and, were it not regular, the finding of this centre would be much more complicated. Without engaging, therefore, in abſtract difficulties, it will be ſufficient for our purpoſe to make it appear, that the centre of gravity of a body, heavier at one extremity than at the other, lies always in the heavieſt part, with reſpect to the point which marks the middle of the length of the body. If, to the ſolid A B, which is ſuſpended in perfect equilibrium by its centre of gravity G, be added a weight E, in the

centre of the part A G, the equilibrium will then be loſt, as it will increaſe the weight of this part, which will then overweigh the other half B G by all the weight E, of which the part B G becomes by ſo much the lighter. To find, then, the centre of gravity, which is changed from G to I, we muſt divide reciprocally to the weight of the two bodies, A G + E for the one, and B G for the other, the interval F H; for, it may be ſuppoſed that this half A + G of the parallelepipedon, *plus* the weight E, is a body ſuſpended by the centre F of the part A G; and that this point is the extremity of a lever F H, infinitely light, which bears alſo, at the other extremity H, taken for the centre of the other part B G, all the weight of that part: ſo that, if the body A G + E weighs four times as much as the other weight B G, we have but to make the interval F I the fourth part of the other I H, and the point I will then be the centre of gravity required of the ſolid A B + E, and the two bodies ſuſpended by that point will be in perfect equilibrium; for, the weight A G + E is four times as heavy as the other B G; but it acts with an arm of a lever F I, which is only a fourth part of the other I H; therefore the two weights, ſuſpended by the point I, will preſerve a perfect equilibrium in whatever ſituation they may be placed, as they make, in fact, both but one, the heavineſs of which may be ſuppoſed united in the ſingle point I.

12. It follows, from what has been demonſtrated, that a long lever is productive of a greater effect than a ſhort one, when both are actuated by the ſame force; whence we muſt conclude, that the longeſt lever, or the greateſt diſtance from the *fulcrum*, or point of ſupport, is proportional to the greateſt weight.

It is very eaſy to be convinced of this truth if we make one of the two following proportions; firſt, thus; the ſum of the two weights A G + E + B G : F H : : B G : F I; or : : A G + E : I H.

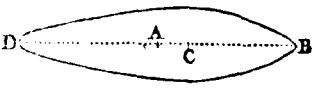
We have ſuppoſed that the weight A G + E (*fig.* 3) weighs four times as much as the other B G, which I ſuppoſe to be two pounds; ſo that the ſum total will be ten pounds. Then ſay: Ten, the ſum of the two weights, is to the whole lever F H as two pounds is to the leſs part F I of the lever, divided into five equal parts: ſo that,

if

if F I is equal to two feet, I H will be equal to eight feet, and F H equal to ten feet. But we have alſo this proportion to make: viz. Ten pound, the ſum of the two weights, is to ten feet, the whole length of the lever, as eight pounds are to eight feet; but, admitting the diſtance F H to be ten feet, the diſtance F I is found to be two feet, and of H I eight feet; which demonſtrates, that a power of two pounds on a lever of eight feet is equal to a power of eight pounds on a lever of two feet; for, the product of the extremes, in both the one and the other proportions, is equal to that of their means.

It ought alſo to be obſerved, that the centre of gravity of a ſolid follows always the greateſt weight with reſpect to the middle G, (*fig.* 3,) ſince the point I is four times as near the centre F of the heavieſt body as it is to the centre H of the lighteſt body.

FIGURE 4.



13. It follows, that the centre of gravity C of a ſhip (*fig.* 4) is always before the point A, which is the middle of her abſolute length; for, the fore part B A, having more capacity than the after part A D, muſt of courſe have alſo more weight: therefore it carries the centre of gravity C forward, in proportion to its greater weight, (which in large ſhips is from fifty to eighty tons,) and to the interval there is between every centre of gravity of each particular part both forward and aft.

14. When a ſhip is at ſea, and loaded, the centre of gravity may well be ſuppoſed not to change, unleſs the cargo be moved.

But it muſt be obſerved, that, as experience ſhows it, the fore or after part of the bottom of a ſhip plunges and labours more and more, in proportion as the wind acts with more or leſs force on the ſails; becauſe ſhips are generally not maſted according to the *point velique*:* ſo that a ſhip, which has the centre of the effort of her

 ſails

* From the centre of gravity of the floating line of a ſhip let a perpendicular be raiſed, and continued till interſected by the direction of the impulſe of the water on the

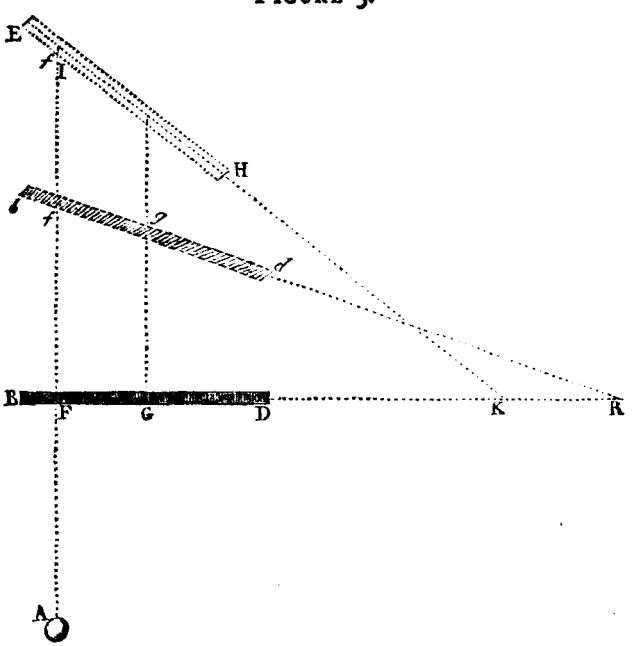
ſails ill-placed, draws always more water forward or aft, if the impulſe of the wind upon her ſails is very powerful, than when ſhe is at eaſe under her burthen.

THEOREM.

15. The centre of rotation, or the point on which a body turns freely, is always on the other ſide of the centre of gravity of that body, with reſpect to the point on which the moving force acts.

DEMONSTRATION.

FIGURE 5.



IF the body B D (*fig.* 5) be ſtruck in its centre of gravity G, when it is perfectly at reſt, it is evident (§. 1) that the two extremities B

the bows, in ſailing directly before the wind; and, where theſe two lines cut each other, there is the *point velique*, and where the centre of effort of all the ſails ſhould be placed.

and

and D will advance equally on parallels; but, if it is ſtruck in the point F, diſtant from the centre of gravity, by any mobile ſuch as A, when the body is ſubject to no friction, it will then have two motions with reſpect to its centre of gravity G, on which are collected all the weight and the reſiſtance. For, that centre, not being held by any thing, is moved in the direction G *g*, parallel to the direction A I, of the effort of the mobile A, which ſtrikes the body B D in the point F. So that the part B G of that body receives the ſhock of the mobile A, which makes it paſs from F to *f*, according to the direction of its motion A I. And, as the other part G D of the ſame body ſhares that motion only in proportion as its parts are leſs diſtant from the point of percuſſion F, (ſince the neareſt parts of that point receive the greater ſhare of the action,) in proportion as they remove from their firſt ſituation, they all deſcribe, by the firſt effect of the ſhock, parallels B *b*, G *g*, and D *d*, to the direction A I of the effort of the mobile A. Theſe parallels are greater as they are more diſtant from the part ſhocked and from its extremity B; becauſe the reſiſtance, which the body B D makes againſt receiving the motion, cannot be in equilibrium with that which the power A makes to loſe part of its own motion, but as much as the two reſiſtances are equal and directly contrary: therefore, the body B D, yielding to the impulſe of the mobile A, does not oppoſe to it a reſiſtance equal to its ſhock; it muſt then change its place and ſituation, in turning on the point R, marked by the meeting of two lines D R and *d* R, drawn from the centre of gravity of the body B D in thoſe two ſituations before and after the ſhock; and, as the circular motion of the body B D is made always round the centre of gravity, it is eaſy to conceive that the centre, having taken the velocity G *g*, muſt continue to move equally in the ſame right line prolonged; and that the body, having begun to turn, it muſt continue to do the ſame round its centre of gravity, and at the ſame time be carried in the direction A I on the parallels B E and D H, as long as the force which puts it in motion exiſts. But it muſt be remarked, that, in proportion as it ſhall remove from its firſt ſituation B D, it will loſe all the relations it had in the principle of motion

motion with the point R; that is to ſay, that the point G, being tranſported to *g*, in the firſt inſtant of the ſhock, it will continue in the ſecond and the following inſtants to be thus tranſported on the ſame line and in the ſame direction: therefore the point of rotation R will change in proportion as the body B D removes from the ſecond ſituation *b d* to take another E H; for, the line H K will cut D R in a point K, nearer the point from which the body was moved; and, although the point of rotation R be continually changing during the time of motion, it remains always on the other ſide of the centre of gravity with reſpect to the point of percuſſion, till at laſt the body B D be ſo much turned, that the effort A I may paſs through the centre of gravity G in the direction D B; then the body D E will ceaſe to turn round a point ſituated on the part G D prolonged, and will turn ſucceſſively on different points of the part G B, which will then have paſſed to the oppoſite ſide.

16. If the force of the mobile A, (*fig.* 5,) employed to turn the body B D, be greater or leſs, the velocity G *g* of the centre of gravity will be likewiſe increaſed or diminiſhed in proportion as the mobile ſhall act with more or leſs power. Conſequently, when the body B D changes its ſituation, the angle it will make with its firſt poſition will be proportional to the motion G *g*, or to the force employed in the ſhock, ſince they are correſpondent to one another. Therefore, all other circumſtances being the ſame, the rapidity of a circular motion will be always in proportion to the force employed to produce it.

17. A method of increaſing the rapidity of motion and the angle of rotation is to make the power A (*fig.* 5) act on a point more diſtant from the centre of gravity G than the given point F; for, it is clear, that, if the diſtance G F be two or three times augmented, the other diſtance G R, from the centre of gravity to the point of rotation, will become two or three times leſs; and the ſides of the angle G R *g*, becoming conſequently ſhorter, it follows, that the angle will be more open in the ſame proportion. Therefore it is demonſtrated that there are two ſure methods of augmenting both the angle and motion of rotation of a body; the firſt conſiſts

of

of employing more force in the percuſſion, in order that the angle G R *g* ſhould be as much increaſed as is the ſide G *g* which ſubtends it.

The ſecond is to apply that force at a greater diſtance from the centre of the body you wiſh to turn: for, in augmenting F G, G R is diminiſhed; and the more the ſides which form an angle are ſhortened, (the ſide which ſubtends it ſtill remaining the ſame,) the more the angle is augmented. So that the angle of rotation is in a compound proportion both to the force employed and to the diſtance of that force from the centre of gravity: this angle is then as the produce of that force multiplied by F G. Although the body be perfectly free, and take a direct motion G *g*, we muſt conſider its centre of gravity G as the point of ſupport, or F G as the arm of a lever; and the angle of rotation B R *b* is always proportional to the *abſolute force** employed in the percuſſion.

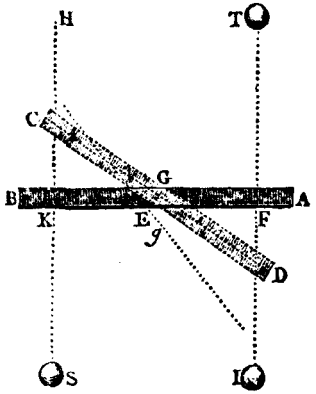
18. Let us conſider the body B D (*fig.* 5) expoſed to the action of ſeveral forces at the ſame time, and it will appear that the angle of rotation will be proportional to the ſum or difference of the abſolute forces, according as they tend to turn the body B D in the ſame or in contrary directions.

If the acting forces directly counteract each other, it is plain that their abſolute effect, with reſpect to the centre of gravity G, muſt be ſought, and then deduct the exceſs of one from the other: then the angle of rotation will be proportional to that exceſs; inſtead of which, it will be proportional to the ſum of the forces employed, if they act in concert and in the ſame manner, to augment it. But if you take no notice of the angle of rotation, and wiſh to conſider the centre of gravity only as being tranſported from G to *g*, it is not neceſſary to find the ſum of the abſolute forces of the acting powers, but only to conſider the forces in themſelves, and then G *g* will be found proportional to either their ſum or their difference, according as they contribute to produce the ſame effect, or as they are oppoſite in their efforts.

* By the term *abſolute force* we underſtand the force employed to turn the body, multiplied by the diſtance F G, from the centre of gravity.

FIGURE

FIGURE 6.



Suppoſe theſe forces equal between themſelves but acting in contrary directions on the extremities A and B (*fig.* 6) of the body A B, and on arms of equal levers. Then it is evident, that the angle of rotation is double what it would be if the body were ſtruck by only one of theſe forces, and turned on its centre of gravity; ſince the two parts, ſeparated by the centre, are ſtruck equally and at the ſame time by forces which act perpendicularly in contrary directions. To prove this, obſerve that the equal powers S and T act at the ſame time on the body A B with equal levers, G K and G F; ſo that the extremity B paſſes to C at the ſame time that A paſſes to D; and thereby the centre of gravity G remains as if it were fixed in the ſame point which ſerves as a centre of rotation; for, if one of the acting forces removes it from its firſt ſituation, the other, in oppoſing an equal force, will replace it.

If the power T exceeds the other S, it is evident that the centre of gravity G will be tranſported towards *g*, in proportion as the force T exceeds the other S; then the body A B could turn no longer on the centre of gravity G, (§. 15,) but on another point E, which would be on the other ſide of the centre of gravity G, with reſpect to the point of percuſſion.

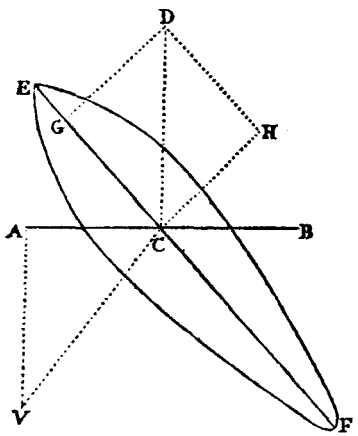
If the body A B (*fig.* 6) were ſtruck at the two points K and F by two mobiles, S and I exerting equal powers with reſpect to the centre of gravity G; it is plain that the whole body A B will be carried up on parallels, ſuch as I T and S H, and that the ſum of the

the two powers will act on the centre of gravity G, since they are equal in every respect.

THEOREM.

19. A SAIL ACTS ALWAYS TWO WAYS ON A SHIP, WHEN IT IS NOT PERPENDICULAR TO HER LENGTH.

FIGURE 7.



DEMONSTRATION.

We have only to consider the sail A B, (*fig.* 7,) oblique to the ship and to the wind, and we must be convinced (§. 1, 7) that it is impelled in the direction C D, with a force expressed by the square of the sine of incidence of the wind upon the sail. Therefore, what we are going to say here for the present case is to be understood as applicable in all others, in which the sail shall not be perpendicular to the length of the ship; for, then, she would go only in the direction of her length from C to E, or from C to F, according as the sail might be full or a-back.

If C D *be equal to the impulse of the wind upon the sail,* as expressed by the square of the sine of incidence A V, we have only to form the right-angled parallelogram G H, to be convinced that

ſuch a direction is compoſed of the two effects C H and C G, which it produces with reſpect to the body E F, upon which it acts in impelling it in the direction C D.

The more the yard A B (*fig.* 7) ſhall make the angle A C E acute, the more the effect C H will augment, and the other C G diminiſh; for, the more the angle A C E becomes acute, the more its equal D C H or C D G (§. 22) will be acute alſo; ſo that C D, which is perpendicular to the centre of the yard, will approach more to C H, the other perpendicular to the length of the ſhip E F; which cannot happen without increaſing the ſhip's tendency to fall off in the direction C H, and increaſing likewiſe the cauſe C D, which follows in that increaſe the ſame proportion as the ſquare of the ſine of incidence augments. (§. 1, 6, 7.) But this increaſe of the impulſe C D is not ſufficient to preſerve the effect of the ſail in the direction of the keel C G. On the contrary, it diminiſhes in the proportion of the decreaſe of the ſine A C E or C D G; whence it follows, that you never can augment the impulſe of the wind by ſhifting the ſituation of the ſail, when it is properly trimmed, without leſſening the rate of ſailing, (§. 28,) when neither the ſhip changes her courſe nor the wind ſhifts.

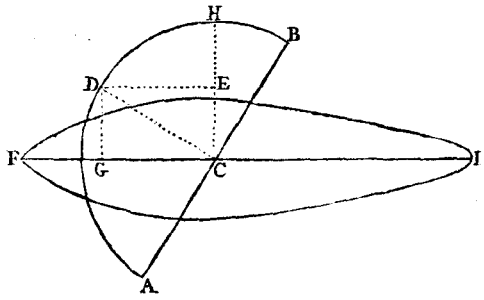
20. It might, in the ſame manner, be demonſtrated, that the more open the angle A C E of the ſail A B is with the keel, the more its effect C G, in the direction of the ſhip's length, will increaſe in the ſame proportion as the increaſe of the ſine of that angle, when the impulſe of the wind upon the ſail is the ſame; for, the ſines of the angles are in proportion to their oppoſite ſides in the triangle C D G, of which the angle C D G is equal to the angle A C E.

If the impulſe augment alſo, (§. 3,) the two effects, C G and C H, will augment proportionally.

21. If the ſail A B receive the impulſe of the wind E on its forward ſurface, it would ſtill act in two ways on the ſhip, by forcing her firſt a-ſtern in the direction C F, and then to leeward in the direction H C: to be convinced of this, reverſe the parallelogram, by tracing it on the after part of the yard towards F, and uſe the ſame reaſoning.

FIGURE

FIGURE 8.



THEOREM.

22. THE ANGLE A C F, (*fig.* 8,) FORMED BY THE YARD A B AND THE KEEL F C OF THE SHIP, IS EQUAL TO THE ANGLE D C H, COMPREHENDED BETWEEN THE PERPENDICULARS D C TO THE YARD AND E C TO THE KEEL, IN THE LIKE MANNER AS THE ANGLE C D G.

DEMONSTRATION.

The angle A C D is right, ſince C D is perpendicular on A B: the other angle F C E is right alſo; for C H is perpendicular on F I; therefore the arc A D is equal to the arc F H; and if, from theſe two equal arcs, be taken away the common one F D, the remainders A F and H D will be equal: becauſe, when equals are taken from equals, the remainders muſt be equal.

Secondly, the angle C D G in the parallelogram G E is alternate to the angle D C E: therefore it is equal to it; therefore it is alſo equal to A C E.

23. It follows, that the angle B C H is equal to the other angle D C F; for, if from the two equal arcs A D and B D be taken the other equal arcs F A and D H, the remainders F D and H B will be equal alſo.

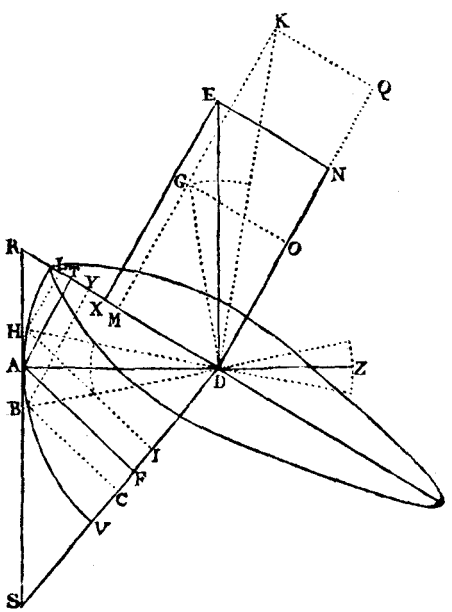
24. The few principles of geometry here given, and which will be found of great ſervice in the ſequel, ought not to diſcourage.

We make uſe of them now, only to eſtabliſh principles as ſimple as they are ſure, and to leave nothing to doubt or conjecture in the following part of this theory, which is in itſelf very abſtruſe. We ſhall however be obliged to uſe again a few more demonſtrations of this kind.

CHAPTER III.

OF THE MOST ADVANTAGEOUS ANGLE OF THE SAILS WITH THE KEEL AND THE WIND, IN ORDER TO OBTAIN THE GREATEST RATE OF SAILING ON AN OBLIQUE COURSE.

FIGURE 9.



25. IN

25. IN moſt ſhips the ſails make with the keel an angle A D R (*fig.* 9) of 40 degrees, or thereabouts, (ſome more, ſome leſs,) when cloſe-hauled. We are now to undertake to make it appear that this angle is not the moſt favourable to run with the greateſt velocity, in getting to windward. It ſhould be much more oblique; but as it is not poſſible, in practice, to attain the greateſt perfection, we muſt be contented to approach it as near as poſſible, in great ſhips, by reducing the angle A D R to 30 degrees only. This will be ſo much the more eaſily done, as in every ſhip the two foremoſt ſhrouds of each lower maſt can be ſuppreſſed. For it muſt be obſerved, that, in the movement of pitching and rolling, the maſts always incline forward, in the direction D E of the effort of the ſail; ſo that the ſhrouds which are abaft, and cat-harpened in, are ſufficient to ſupport the maſts, ſince they act nearly oppoſite to the effort of the ſail. Beſides, ſhould there be reaſon to expect bad weather, preventer-ſhrouds may eaſily be faſtened to the ſtrops which are always ready hung for that purpoſe. This practice is ſo much the better grounded, as the number of thoſe preventers can at any time be increaſed as circumſtances or neceſſity require.*

Therefore, we ſhall, for the future, conſider the angle A D R, which is the moſt oblique in practice, as fixed at 30 degrees, though, in ſome ſhips, it may happen to be more acute: a circumſtance to which particular attention ſhould be paid.

26. Among the angles A D R, B D R, and H D R, (*fig.* 9,) which the ſail A Z can make with the keel in the ſame courſe D R, it is evident there muſt be one more advantageous then the reſt, to produce the greateſt velocity poſſible in the moſt oblique courſe. That

* This recommendation of M. Bourdé, to ſuppreſs the two foremoſt ſhrouds of each lower maſt, in order to brace up ſharper, we are warranted in ſaying, cannot be followed in the Britiſh navy. It was lately determined, upon a conſultation of the officers of the King's Yards, the queſtion having been referred to them, that the preſent number and dimenſions of the rigging of ſhips could not be advantageouſly altered or ſafely diminiſhed. And, as to occaſionally caſting them off, it may be rendered, by the inevitable accidents of navigation, highly dangerous; as, for inſtance, in caſe of being ſuddenly taken a-back, this leſſening of the ſupport of the maſt might be attended with its loſs.

angle

angle of the ſail and the keel is not what we propoſe directly to determine, ſince it is impoſſible to render it more acute than 30 degrees, the term to which we have fixed it in practice: but it will ſerve us to determine the moſt favourable angle of incidence A D V of the wind upon the ſail, and which is the moſt advantageous to run with the greateſt rapidity on all oblique courſes between cloſe-hauled and wind abaft.

27. Before we enter upon the demonſtration of the rule which muſt be followed in practice, the principle which ſerves to demonſtrate its utility muſt be firſt eſtabliſhed. It may be recollected that impulſions (§. 7) are between themſelves as the ſquares of the ſines of incidence. Therefore, to judge if it is advantageous to render the angle of incidence A D S or A D V of the wind upon the ſail A Z more or leſs acute, we muſt examine if the ſquare of the ſine of incidence A F, or the total impulſe D E, increaſes more or leſs than the ſquares of the ſines of incidence B C and H I, or than their correſpondent impulſions D G and D K, proportionally to the diminution or increaſe of the ſines of the angle of obliquity of the ſail with the keel A T, B Y, and H L: for, if the ſquare of the ſine of incidence H I, or the impulſion D K, does not increaſe ſo much proportionally, as the ſine of obliquity A T diminiſhes in becoming equal to L H, it is evident that the poſition of the ſail A D is more favourable than when it is ſituated in the direction D H: and if the ſquare of the ſine of incidence B C, or its correſpondent impulſion D G, diminiſhes more in proportion than the ſine A T augments, in becoming equal to the other ſine of obliquity B Y, in the other poſition of the ſail; it is an evident proof that its ſituation A D is ſtill more favourable than if it were in the poſition B D, and that there is even no better ſituation than A D, whether the angle of incidence A D V be increaſed or diminiſhed.

28. To prove it, we ſhall conſider (*fig.* 9) the abſolute impulſions D K, D E, and D G, as correſpondent with the ſines of incidence H I, A F, and B C, and proportional to the ſquares of theſe ſame ſines; then, on theſe diagonal lines, if we draw the rectangles X N and M O, in order to diſſolve thoſe total impulſions D E and D G, it will appear evident that the direct effort D X, in the direction of the keel, is the greateſt poſſible, when the tangent

A S of the angle of incidence is double the tangent A R of the angle of obliquity of the ſail with the keel; for, if the angle of incidence be opened ten degrees, by placing the ſail in the ſituation H D, it will appear that, though the total impulſion D K is augmented in the ratio of the ſquare of the new ſine of incidence H I to the firſt A F, the partial effort D M, in the direction of the keel, will be nearly by one-tenth leſs, in this ſituation of the ſail H D, than in the firſt A D. The direct impulſions D M, proceeding from the total ones D K and D G, are equal, becauſe theſe laſt have augmented or diminiſhed in the ſame ratio as the ſines H L and B Y have leſſened or increaſed in proportion to the ſquare of the ſine of incidence A F, and to the ſine of obliquity A T. Theſe direct partial impulſions D M and D X are in a compounded ratio of the ſines of obliquity H L, A T, B Y, equal (§. 22) to thoſe of the angles D K M, D E X, D G M, and of the total impulſions D K, D E, and D G; for, if the total impulſion augment by a movement of the ſail, the ſine of obliquity diminiſhes: ſo that from the total impulſions can at any time be deduced the direct ones for every poſſible angle of incidence. We might very well verify by calculation this demonſtration, which proves that the tangent A S of the angle of incidence muſt always be double the tangent A R of the angle formed between the ſail and the keel, agreeably to the ſituation of the ſail A Z; ſince if any other poſition be given to it with reſpect to the wind V, whether it be in the direction H D ten degrees more open than A Z, or like B D ten degrees more oblique, a reſult, as D M, in the direction of the keel, will ever be found leſs than D X.

As the vanes always indicate the apparent direction of the wind, on all the courſes the ſhip can ſail, the angle which the wind makes with the courſe, or the keel, cannot fail being eaſily known if there is no lee way; let that angle with the ſails be parted into two others, ſo that the angle of obliquity of the ſails with the courſe may have its tangent equal to half the tangent of the apparent angle of incidence of the wind upon the ſails. On this foundation, it will be eaſy to form a table which will always ſhew both the apparent angle of incidence, and that of the obliquity of the ſail with the keel or with the courſe. This table will ſerve

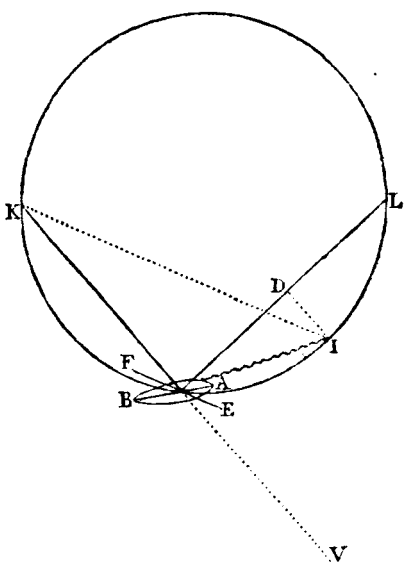
for

for all oblique courſes, provided the after ſails cover thoſe forward only in a trifling degree; for, ſhould they becalm them much, they muſt, for other conſiderations, be braced up a little more to the windward; but always leave the apparent angle of incidence of the wind upon the ſail more open than that between the ſail and the keel, or the courſe.

ARTICLE I.

REMARKS ON SAILING BY THE WIND.

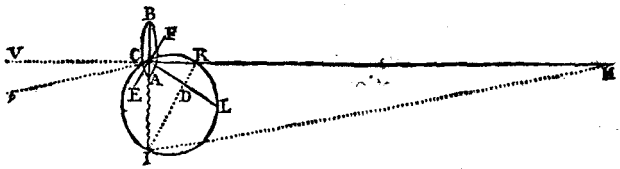
FIGURE 10.



29. When it is deſired to gain to windward as much as poſſible, without abſolutely wiſhing to ſail with the greateſt velocity, let the direction of the coaſt under the lee be ſuppoſed to make with the abſolute direction of the wind (which muſt as near as poſſible be known) an angle of 90 degrees; or, in the ſea phraſe, *blowing dead on ſhore:* let the angle A C E, (*fig.* 10,) formed by the ſail and the

the keel, be known to be 30 degrees, let the lee-way be alſo known to be 10 degrees, the angle E C I between the ſail and the courſe will conſequently be 40 degrees, which you muſt take from the total angle V C L 90 degrees; then there will remain 50 degrees, the half of which, 25 degrees, is to be taken for the abſolute angle of incidence V C E, and for its equal I C L; ſo that the ſhip A B will go 55 degrees from the wind when ſhe is cloſe-hauled, and will conſequently recede as much as poſſible from the point D on the coaſt, the direction of which makes an angle of 90 degrees with the abſolute direction of the wind V K.

FIGURE 11.



But, if the ſituation C L, (*fig.* 11,) of the point D, from which you wiſh to move, made an obtuſe angle V C L, with the poſitive direction of the wind V M; then the tangent of the apparent angle of incidence V C E muſt be made double the angle of obliquity E C I which the ſail makes with the courſe, at the ſame time that the angle I C L of the courſe and the coaſt ſhall be made equal to the angle V C E, formed by the real direction of the wind V K and of the ſail F E: ſo that two conſiderations muſt at once be attended to. For example: the angle A C E, formed by the ſail and the keel, is 30 degrees; then, according to the firſt principle, it will be neceſſary that the apparent angle of incidence V C E ſhould be 49° 6′; and if the difference between the apparent and real direction of the wind be 10°, there will be 59° 6′ for the angle which the ſail E F makes with the real direction of the wind V M: ſo that the angle L C I, of the courſe and the object ſtood from, muſt be found alſo to be 59° 6′, and the total angle L C V will then be 148° 12′, adhering to the two principles of ſailing with the greateſt velocity, and of getting to windward of the point D,

as much as poſſible, at the ſame time; while the angle L C V, formed by the apparent direction of the wind and that of the coaſt from which the ſhip moves, will be only 138° 12′. The yawing and the different velocities of the ſhip render the angle formed by the two directions of the wind (the real and the apparent) more or leſs open. If the ſhip has more velocity at the ſame time, or if the courſe approaches more to the direction of the wind, it will appear by the vanes that the wind draws forward, and the angle of the two directions of the wind will augment. If the ſhip falls off, and yet ſtill preſerves the ſame velocity, or if her velocity decreaſes without altering her courſe, the wind will ſeem by the vanes to draw aft, and the angle of the two directions will diminiſh; ſo that, whenever the ſhip ſhall have velocity or run obliquely to the wind, there will always be a difference between its real and its apparent direction. If the ſhip run exactly before the wind, or have no motion at all, there will be then no other but the real direction of the wind ſhewn by the vanes: but, in oblique courſes, the vanes, being moveable, will fix themſelves in a middle direction between the abſolute tendency of the wind and the courſe of the ſhip; whence we may eaſily conclude, as we did before, that the apparent direction of the wind, ſhewn by the vanes, is a medium between the reſpective velocities of the ſhip and of the wind; ſince that direction neceſſarily partakes more of the greater velocity than of the leſs: ſo that, if the ſhip runs eaſt, with the wind at ſouth, having the fourth part of the velocity of the wind, the vanes will ſhew S. S. E. 4° 30′ S. for the apparent direction of the wind.

ARTICLE

ARTICLE II.

THEOREM OF M. BOUGUER.

The velocity and real direction of the wind is C M; (*fig.* 11;) ſuppoſe the ſhip A B, of which E F is the ſail ſituated at pleaſure, to draw the courſe C I, while the particles of air run in the direction C M: *if*, from the point I, be drawn I K, parallel to the ſail E F, till it cuts the direction of the wind V K, in the point K, there will be given the three points C, I, K, through which draw the circumference of a circle C I L K, and that circumference will ſhew the extent of the forces acting on the ſhip, at the ſame time, in following the courſe C I, provided her ſail be always trimmed in the ſame manner with reſpect to her keel.

DEMONSTRATION.

The apparent or relative velocity of the wind is repreſented by I M (*fig.* 11) in the courſe C I; and as I K is parallel to the ſail E F, the angle M I K is equal to the apparent angle of incidence V C E. But to be more explicit: the wind ſtrikes the ſail with its apparent or relative velocity I M, (and not with its abſolute velocity, becauſe of the motion of the ſhip,) and with an angle of incidence M I K = V C E: ſo that, if the ſhip runs cloſe-hauled or perpendicular to the direct wind V C, I M will become in both caſes ſtronger than the abſolute velocity; becauſe the ſhip will either approach to the ſource of the wind, or not recede from it. But the impulſe on the ſail is proportional to the ſquare of the velocity I M, multiplied by the ſquare of the ſine of the angle of incidence M I K, equal to the angle V C E (§. 3 and 7) and the proportion M K : *ſine* K I M : : M I : *ſine* M K I, which furniſhes us the triangle K I M, ſhews us that M K × *ſine* M K I = M I × *ſine*

K I M; ſquaring the two products, and ſubſtituting the ſine of the angle V K I in the room of the ſine of the angle M K I, which is equal to it, ſince they are the ſupplement of each other, we ſhall then have this other equation: $\overline{\textit{ſine}\ \text{V K I}}^2 \times \overline{\text{M K}}^2 = \overline{\textit{ſine}\ \text{K I M}}^2 \times \overline{\text{M I}}^2$; whence it follows, that inſtead of expreſſing the actual impulſe of the wind upon the ſail by the ſquare of I M, multiplied by the ſquare of the ſine of the angle K I M, it may be expreſſed by the ſquare of M K, multiplied by the ſquare of the ſine of the angle V K I, or of its equal V C E, formed by the abſolute direction of the wind V M and the ſail E F.

We muſt not forget to be very attentive to this; viz. that the impulſe of the wind upon the ſails is in equilibrium with the effort of the water on the bows, or that they are exactly equal and contrary when the ſhip is come to an uniformity of motion (§. 9) as here we ſuppoſe her to be. Beſides, the impulſe of the water on the bows is proportional or equal to the ſquare of the velocity of ſailing C I, (§. 3,) ſo that the ſquare of the velocity of ſailing C I is equal to the actual impulſion of the wind upon the ſail expreſſed by the ſquare of K M, multiplied by the ſquare of the ſine of the angle V C E; and if S be ſuppoſed equal to the ſine of V C E, or of V K I, we ſhall always find $\overline{\text{C I}}^2 = \overline{\text{S}}^2 \times \overline{\text{K M}}^2$. The firſt term in this equation repreſents the impulſe of the water on the bows, and the ſecond expreſſes the effort of the wind upon the ſails; and, if the ſquare roots of the one and of the other be taken, it will be found C I = S × K M; that is to ſay, that the very velocity of ſailing C I will be continually equal or proportional to the product of K M by the ſine S of the angle V C E or C K I. The proportion between theſe quantities depends on the denſity of the two fluids, and on the magnitude of the ſurfaces ſtruck: but it will be the ſame in all the different courſes.

The different velocities of ſailing C I have a conſtant and given proportion with the products S × C R and C I × *ſine* C I K; for the triangle C I K gives S : C I : : *ſine* C I K : C K, which forms this equation, S × C K = *ſine* C I K × C I; and all the angles C, I, K, are conſtant and known, ſince they are equal, being alternate to that which the ſail makes with the courſe. But, as the velocity

velocity C I bears a continual and conſtant proportion with the product S × K M, and as it bears alſo a conſtant proportion with S × C K, it follows that S × K M : S × C K : : K M : K C; ſo that the point K always divides C M in the ſame proportion: the point K is then invariable when the ſail, as well as the lee-way, are both the ſame; (which never happens, however, as will be made appear (§. 47) hereafter;) but, in admitting theſe two hypotheſes, which never can deviate from the truth but in reſpect to the lee-way, which is always variable in the ſame ſhip, according to the different circumſtances of wind, ſea, velocity, ſail, and courſe, it ought then to be concluded that all the points, I, &c. will be ſituated on the circumference of a circle; for, without that, the angles C I K, equal to thoſe which are formed by the courſe and the ſail, and which are ſupported on the ſame chord C K, would not be equal.

COROLLARY.

Admitting therefore, *(fig. 11, page 57,)* that the velocities are continually proportional to the ſines (whatever they be) of the angles V C E, which the ſail makes with the abſolute direction of the wind, provided the ſail be always trimmed in the ſame manner with reſpect to the keel, and that, in the triangle C I K, the ſide C K and the angle C I K are conſtant, and the velocities of ſailing C I are proportional to the ſine of the angle C K I, equal to the angle of incidence V C E; it follows, that, all the other conditions being the ſame, the more the ſine of the angle V C E is augmented, the greater will the rate of ſailing be; ſo that, if you want to carry it to the greateſt rapidity, you have only to make a right angle of the angle V C E formed by the abſolute or real direction of the wind with the ſail; then the velocity C I will no longer be a ſimple chord in the circle C K I, but a diameter. This holds good for all the ſhips which have but one ſail ſet; but, whenever they ſhall have ſeveral, the greateſt velocity will be when the apparent angle of incidence of the wind upon the ſail makes a right angle with the courſe; becauſe then the ſails will eaſily make, with the appa-

rent

rent wind, an angle, of which the tangent will be double that of the angle they make with the courſe, without their becalming one another; while, at the ſame time, the ſhip will receive all the abſolute impulſe of the wind, becauſe ſhe does not recede from it; and it is the time when the greateſt ſurface of ſail is expoſed to its impulſe. The ſame advantage of the greateſt velocity will ſtill be had, when the apparent direction of the wind makes an angle of a hundred degrees with the courſe; and, in this ſituation, the velocity will in ſome degree be increaſed. In a word, whenever the after-ſails do not becalm thoſe forward, the ſhip's rapidity may always be increaſed, by trimming the ſails as directed (n. 28): but when the ſails take the wind from one another, an increaſe of velocity can no longer be pretended to.

We are now going to demonſtrate the exactneſs of the rule given before. (§. 29.) When it is required to get off ſhore, or recede from a given right line with all poſſible expidition, or to keep abſolutely as cloſe to the wind as the ſhip will lie; C M (*fig.* 11, *page* 57) is the abſolute direction of the wind; the circle C K L I marks all the points at which the ſhip can arrive with the ſame ſail, the ſame diſpoſition, without alteration of lee-way, and at the ſame time; and C L is the right line from which ſhe is to move. Knowing the angle that line makes with the abſolute direction of the wind V M, it is evident that the point I of the circumference, where the courſe ought to end, is in the middle of the arc C I L, of which C L is the chord: and all the points from one part to the other of C I, where the ſhip can come to at the ſame time, are leſs diſtant from C L, ſince D I, perpendicular to C L, divides it into two equal parts, and is the longeſt of all the perpendiculars which can be drawn from the circumference C I L; but the point I cannot be taken without rendering the angle L C I equal to the angle C K I, which itſelf is equal to the angle V C E.

ARTICLE

ARTICLE III.

A TABLE OF THE SITUATION OF THE SAILS TO RUN WITH THE GREATEST VELOCITY.

M. BOUGUER.

Angles of the apparent direction of the wind and course.		Angles of the sails with the keel.		Angles of apparent incidence of the wind on the sails.	
D.	M.	D.	M.	D.	M.
180	00	90	00	90	00
176	15	87	30	88	45
174	37	86	25	88	12
172	30	85	00	87	30
168	44	82	30	86	14
164	58	80	00	84	58
161	10	77	30	83	40
157	22	75	00	82	20
153	33	72	30	81	03
149	41	70	00	79	41
145	48	67	30	78	18
141	53	65	00	76	53
137	55	62	30	75	25
133	54	60	00	73	54
129	50	57	30	72	20
125	42	55	00	70	42
121	31	52	30	66	01
117	14	50	00	67	14
112	53	47	30	65	23
108	26	45	00	63	26
a					*b*
103	53	42	30	61	23
99	13	40	00	59	13
94	25	37	30	56	55
89	28	35	00	54	28
84	23	32	30	51	53
79	06	30	00	49	06
73	39	27	30	46	09
68	00	25	00	43	00

The foregoing TABLE can be of no great service, except in the eight last circumstances under the line *a*, *b*; because, in all the cases mentioned above that line, the sails will cover one another too much.

When

When a faſt-ſailing ſhip (ſuch as will, on a direct courſe, or right before it, take a third or a fourth part of the velocity of the wind) comes to run with the ſame quantity, or more ſail, on a perpendicular to the apparent direction of the wind, then ſhe acquires a greater rapidity of ſailing with reſpect to the velocity of the wind; the angle made by the two directions, the apparent and the abſolute, is at that time very conſiderable; it may be from 18° to 22° 30′; and if the ſhip hauls quite cloſe by the wind, the angle will ſtill be nearly the ſame; for, her velocity diminiſhes: but, as it is in ſailing by the wind that it is moſt eſſential to know the greatneſs of the angle between the two directions of the wind, let the angle between the directions of the ſhip's head on the different tacks be obſerved, without paying any regard to the lee-way, but juſt to the exact point on which the ſhip ſtands, before and after going about, when ſtrictly by the wind, neither too much to leeward nor to windward; and, when you have determined that angle, from two or three obſervations, halve it, and then you will have the angle formed by the keel and the abſolute direction of the wind; by which you will know the quantity ſhe will come to upon the different tacks, and will never be deceived with reſpect to the lying on after having gone about: a miſtake pretty commonly made by thoſe who pay attention only to the apparent direction of the wind, which always makes with the real one an angle more or leſs open in a compound ratio of the greateſt velocity with the greateſt obliquity of the courſe of the ſhip, with reſpect to the direction and the abſolute velocity of the wind; things which vary in all ſhips, becauſe they have not all the ſame advantage of ſailing with the ſame rapidity in ſimilar circumſtances.

CHAP.

CHAPTER IV.

OF THE SAILS WHICH ARE BEFORE THE CENTRE OF GRAVITY OF A SHIP.

30. THE ſails which are before the centre of gravity of a ſhip are the ſprit-ſail, ſprit-ſail top-ſail, the jib, the fore-top-maſt ſtay-ſail, and the fore ſtay-ſail.

Beſides theſe ſails there are, on the foremaſt, the foreſail, fore-topſail, fore-topgallant-ſail, and fore-topgallant-royal-ſail, with their reſpective ſtudding-ſails. Now theſe four laſt ſails may be regarded as only one large ſail, wide at the foot and tapering towards the head, and which can be reduced, as occaſion requires, either by taking in the royal, or by reefing the fore-topſail, or even taking it quite in, if neceſſary, to have the foreſail only ſet; or by hauling the foreſail up, if nothing but the topſail is wanted. It muſt notwithſtanding be obſerved, that the different parts of the whole ſail may, in certain caſes, be worked differently the one from the other; as, for example, in reefing the top-ſail, or in taking in either the one or the other. But, when you want to ſet them to work all together, either for making a courſe, or performing ſome evolution, they muſt all be braced and trimmed in the ſame form, and with the greateſt uniformity poſſible. Therefore, whatever we ſhall ſay concerning one of them in any operation, is to be underſtood to be the ſame with reſpect to all the reſt.

The main-ſtay-ſail, the main-top-maſt ſtay-ſail, the middle-ſtay-ſail, and the main-top-gallant ſtay-ſail, are likewiſe ſails of the fore-part of the ſhip's centre of gravity.

ARTICLE I.

OF THE EFFECT OF THE FORE-AND-AFT SAILS, WHICH ARE ON THE FORE PART OF THE CENTRE OF GRAVITY OF A SHIP.

31. The jib and ſtay-ſails being of a triangular figure, their centre of gravity is eaſily found; and that point is to be conſidered as the part, in all theſe ſails, on which the whole effort of the wind is united, when they are expoſed to its impulſe, in whatever way it ſtrikes them.

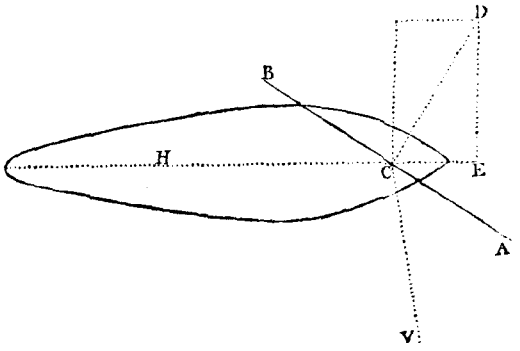
The particular effort of each fore-and-aft ſail being on the fore part of the centre of gravity of the ſhip, it follows that the total effort of all theſe ſails muſt be there too; and that, if the ſhip was in a perfect equilibrium with reſpect to the wind, before her ſails were ſet, ſhe will loſe it immediately after (§. 11) they make the fore part of the ſhip obey the wind, whenever it ſtrikes them perpendicularly or obliquely. For, it muſt be obſerved, that almoſt all theſe ſails have their tacks in the middle of the ſhip, and their ſheets lead to the ſides; ſo that they make with the keel a very acute angle: whence it is eaſy to conceive, that the perpendicular which would be raiſed on the exterior ſurface of theſe ſails, in the direction of their efforts to leeward, from their centre of gravity, would differ but very little in the lateral direction from a perpendicular to the keel. From this we may therefore conclude, that theſe ſails would have but very little effect to accelerate the rapidity of ſailing with reſpect to their poſition, if it was not demonſtrated that they are very advantageous in going by the wind. They make the ſhip ſteer well, and are particularly uſeful when a ſhip gripes much: and, when they do not take the wind out of any of the lower ſails, they ought to be uſed, particularly when one is obliged to ſail by the wind, or to run not very large. The jib and fore-

fore-top-maſt ſtay-ſail muſt be preferred, becauſe they are at all times uſeful when they can receive the wind; for, by their poſition, they cannot take the wind out of any of the other ſails, and their particular effect in veering is conſiderable, not only on account of their great ſurface, but becauſe they act before the point on which the ſhip turns with a very long arm of a lever. (§. 17.) Beſides, all ſails, which raiſe a ſhip's head, aſſiſt her progreſs: for the direction of their effort aſcending obliquely towards the horizon, they do not make her plunge in the water, which is an advantage peculiar to theſe ſails. Experience has confirmed their utility on all occaſions when they can be employed without taking the wind out of the other ſails.

ARTICLE II.

OF THE EFFECT OF THE FORE-SAIL, FORE TOP-SAIL, FORE TOP-GALLANT-SAIL, AND SPRIT-SAIL, IN THEIR DIFFERENT SITUATIONS.

FIGURE 12.



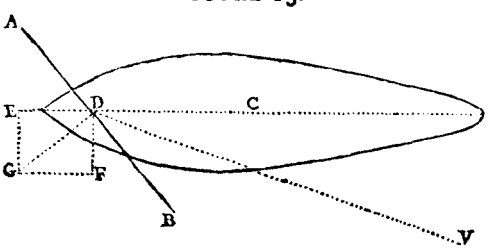
32. When the ſail A B (*fig.* 12) is trimmed cloſe to the wind which blows from the point V, it is impelled in the direction

C D (§. 7) with a force expreſſed by the ſquare of the ſine of incidence, and compoſed of the two effects C E and E D. (§. 19.) But, as the centre of effort of that ſail A B is on the fore part of the centre of gravity of the ſhip H, and as its power C D is always decompoſed between thoſe two effects C E and E D, it follows, that the effect of this ſail is to cauſe the ſhip to bear away; while it keeps up at the ſame time, and even augments, the rapidity of ſailing.

33. If the fore-ſail A B received the impulſe of the wind perpendicularly, it would ſtill produce the effects of bearing away, and augmenting the rate of ſailing, for the reaſons juſt given above, but more effectually would it do ſo (§. 29) on account of the increaſe of the impulſe of the wind upon the ſail.

34. It follows, from what has been ſaid, that when the ſails upon the fore-maſt are full, on the ſame ſide they are tacked, being braced obliquely to the keel, there is always one part of their effort, in proportion to the obliquity, which acts to make the ſhip bear away; while the other part of their effort acts at the ſame time to accelerate or keep up the rate of her ſailing.

FIGURE 13.

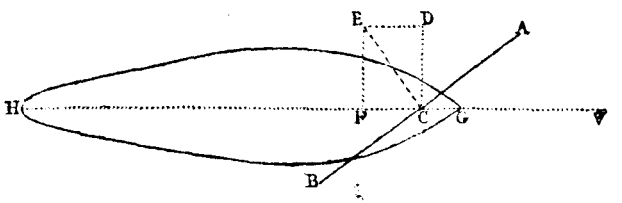


35. When the ſails A B of the fore-maſt (*fig.* 13) are ſituated obliquely with reſpect to the keel, and receive the wind in them, on the ſide of the ſheet B, they act upon the ſhip in bringing her up to the wind, becauſe their effort D G being diſcompoſed, as cuſtomary, the lateral part D F carries the fore part of the ſhip towards the ſource of the wind V, in carrying her from D to F.

36. In

36. In general, when the yards are ſquare or perpendicular to the keel, it is evident that they will act on the ſhip, only by impelling her right in the direction of the keel, from ſtern to head, or from head to ſtern, with more or leſs velocity, in proportion to the impulſe of the fluid which ſtrikes them.

FIGURE 14.



37. When the ſails A B on the fore-maſt (*fig.* 14) receive the impulſe of the wind V on their ſurfaces forward, they will make the ſhip both go a-ſtern and fall off; becauſe the direction C E of their effort, being turned towards the after-part, ſerves as a diagonal to the parallelogram F D; which, by diſcompoſing it, will ſhew us thoſe two effects C F and C D; the firſt of which takes its direction with that of the keel from forward aft, while the ſecond takes it in a lateral direction in making the ſhip to turn.

38. When the wind blows between the keel and the yard, the ſhip comes to, until the point G (*fig.* 14) is in the direction of the wind V. But, as ſoon as this is done, it is evident that ſhe falls off; for the point G recedes farther and farther from the direction of the wind. Whence we may remark, that, as ſoon as the weather-part of the ſail catches a-back, on the tack ſide, the angle of incidence of the wind on it goes continually increaſing, till the ſhip has fallen off ſo much, that her ſail becomes perpendicular to its direction: and, if the veſſel continues to fall off, then the angle of incidence diminiſhes more and more, till the ſail is parallel to the courſe of the wind which comes from the tack B, or, as it is called, *ſhivering*.

CHAP-

CHAPTER V.

OF THE SAILS WHICH ARE ABAFT THE CENTRE OF GRAVITY OF A SHIP.

39. THE main-ſail, main-top-ſail, main-top-gallant-ſail, and main-top-gallant-royal-ſail, and their reſpective ſtudding-ſails; the mizen-ſtay-ſail, mizen-top-maſt-ſtay-ſail, the mizen-courſe, mizen-top-ſail, mizen-top-gallant-ſail, and mizen-top-gallant-royal-ſail, are all ſails which are placed abaft the centre of gravity of a ſhip, the point round which the total effort of the ſails is placed.

ARTICLE I.

OF THE EFFECT OF THE FORE-AND-AFT SAILS ABAFT THE CENTRE OF GRAVITY OF A SHIP.

40. The centre of effort of theſe ſails being abaft the centre of gravity of the ſhip, it follows that they always force the after-part of the ſhip to leeward, and conſequently contribute to bring her to the wind, as ſoon as they receive its impulſe; for, that movement of the after-part of the ſhip cannot happen, without the head approaching to the direction of the wind.

The fore-and-aft ſails being in general ſituated very obliquely, *it follows, conſiſtently with principles, that they are very advantageous* for ſailing by the wind. Therefore, we muſt not neglect augmenting them: obſerving, at the ſame time, that they do not take the wind out of one another, nor becalm the principal ſails.

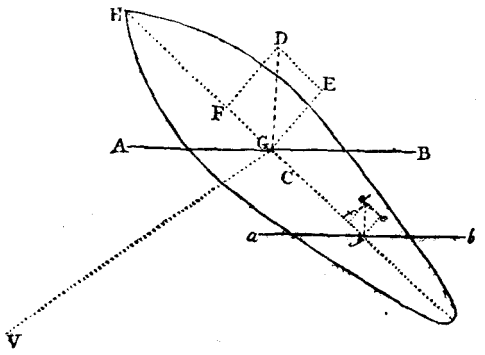
They

They are only to fill up the ſpace between the maſts fore and aft, in ſailing near the wind, in order that no wind may be loſt.

ARTICLE II.

OF THE EFFECT OF THE SQUARE SAILS OF THE MAIN-MAST, AND OF THE MIZEN-TOP-SAIL, IN THEIR DIFFERENT OBLIQUITIES.

FIGURE 15.

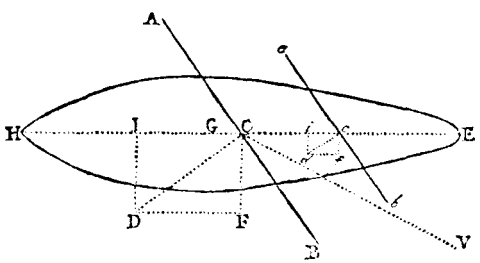


41. As we have already demonſtrated (§. 19) that when the ſail A B (*fig.* 15) is trimmed obliquely to the keel, it produces evidently two effects on the ſhip; it muſt therefore follow, that, in diſſolving its power C D, we ſhall find its compound effects, the one C F, in the direction of the keel which produces the velocity, and the other C E lateral, which (in forcing the after-part of the ſhip to leeward, by its action on the point C abaft the centre of gravity G of the ſhip) occaſions her to come to the wind; for that motion of the ſtern from C to E cannot take place, unleſs the fore-part H acts contrarily in coming towards the point from which the wind blows, V.

42. If

42. If the ſails A B were more or leſs oblique to the keel, they would ſtill have the ſame effects of keeping up the ſhip's velocity, and bringing her to the wind. And, if they receive its impulſe perpendicularly, it would ſtill be the ſame thing, producing thoſe two effects, however, with greater efficacy than in any other ſituation with reſpect to the wind, becauſe then they receive its greateſt poſſible impulſe for the time.

FIGURE 16.

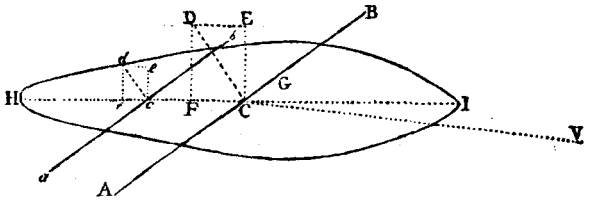


43. When the ſails A B, (*fig.* 16,) of which the centre of effort C is abaft the centre of gravity of the ſhip, receive the impulſe of the wind V on the ſheet ſide, being placed obliquely to the keel, they will cauſe the ſhip to fall off, by forcing the after-part, from C to F, towards V, the ſource of the wind, while they will, at the ſame time, keep up the velocity C I. For, this motion of the after-part E towards V cannot be executed without the fore-part H going, as it moves off, in a contrary direction; and ſhe will continue to fall off till the keel E H be right in the direction of the wind V C, or right aft; then the ſhip will come to the wind, as ſhewn in the two preceding articles.

It may be remarked that, in this movement of the ſhip, the angle of incidence goes continually increaſing till the wind is perpendicular to the ſails.

FIGURE

FIGURE 17.



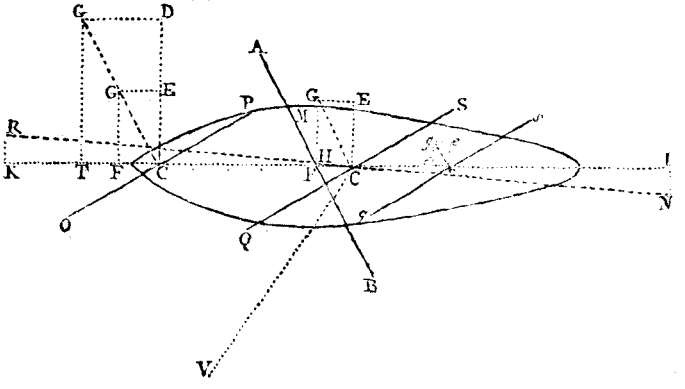
44. When the ſails A B, (*fig.* 17,) of which the centre of effort is abaft the centre of gravity G, ſhall receive the impulſe of the wind V on their forward ſurfaces, they will make the ſhip come to the wind and go a-ſtern at the ſame time. For the direction of their efforts C D may be diſſolved between the two efforts C F, in the direction of the keel, from forward to aft, and C E lateral and perpendicular to the keel; ſo that the after-part C H is forced to leeward from C to E, while the fore-part I approaches, by a contrary motion, the point of the wind V. In this caſe, therefore, the ſhip comes to, and goes a-ſtern.

45. When the ſhip is ſo far come to the wind, that the fore-part I (*fig.* 17) has come into its direction, it is evident, that ſhe will fall off more and more; for, that point I will conſtantly move from the point of the wind V; therefore, it is demonſtrated that, in this caſe, the ſine of incidence is continually decreaſing more and more, till it is reduced to nothing. But, if the direction of the wind had made an obtuſe angle V B C, the ſine of incidence would have augmented until the direction of the wind had been perpendicular to the ſails; and it is at that moment only it would have begun to diminiſh, as we have ſhewn before.

CHAPTER VI.

OF THE EQUILIBRIUM NECESSARY TO BE KEPT IN PRACTICE, BETWEEN THE SAILS BEFORE AND ABAFT THE CENTRE OF GRAVITY OF A SHIP, IN ORDER THAT THE SAILING MAY BE THE MOST DIRECT AND THE MOST RAPID.

FIGURE 18.



46. AFTER having demonſtrated the different effects of the ſails both before and abaft the centre of gravity, it is clear that if either the head or after ſails only were ſet, in ſailing by the wind, the ſhip would not only ſteer badly, but conſequently ſail not ſo faſt as ſhe could under the ſame quantity of ſurface differently diſpoſed. For, if the ſhip be ſuppoſed (*fig.* 18) to be under her head-ſails, and one half be retrenched and ſet on the maſts abaft, it will evidently appear that the velocity C T they produced is the ſame, ſince the direction and the velocity of the wind act always in the ſame manner on the ſame quantity of ſurfaces; the only difference which will be found is, that the primitive effect

is

is divided, and acts now on the points C, C, E, before and abaft the centre of gravity of the ship. It is not the same with respect to the effect C D, which acted only on the head of the vessel in the first disposition of the sails; because, that effect being now divided on the after-masts, it is diminished one-half C E forward, by reason of that force being transported aft; where, balancing the effect of falling-off produced by the head-sails, it keeps the ship to the wind; by equality in the movements (§. 34 and 42) I say that it *balances*, because, when the weather permits, we may at any time either increase or diminish the sails, so as to preserve an equilibrium between their powers, and fix the ship on her course. When this point of equilibrium is obtained, we then possess the most advantageous disposition the sails can have for the vessel to run with the greatest celerity; provided that they have been trimmed in the most favourable manner to receive (§. 28) the greatest impulse of the wind.

This equilibrium between the powers of the sails forward and aft is likewise advantageous with respect to the rudder; because, as there is less occasion to use it to regulate the movements of the ship, its surface opposes itself but little, and less often to the shock of the water, which glides along the ship's bottom. It is then of the greatest importance, in endeavouring to increase the ship's way, to combine, as much as possible, the reciprocal effect of the sails fore and aft; either in setting them to the wind, or in disposing more advantageously, forward or abaft, a greater or a less quantity of sails, according as the ship is more or less inclined to fall off or come to, in order to make as little use of the helm as possible; the whole power of which, however, at the time of performing any evolution, must be put in action, as we shall make appear hereafter.

47. When there is an equilibrium between the sails fore and aft, the resistance of the water from A to B (*fig.* 18) on the bows is equal to the power of the sails, whether it passes through the centre of gravity H of the ship, or through another point of the axis, more or less forward or aft; then a ship, thus situated, finds no more difficulty to veer than to come to the wind, with respect to the resistance of the water under her lee; since all things are

equal, viz. the resistance of the water upon the bottom to leeward, and the impulse of the wind upon the sails. But it must be considered that the power, composed of those of all the sails united, acts upon the ship according to the direction B A, perpendicular to their surfaces, the origin of which is the point H, a middle between all the effects C G of the sails fore and aft, which ought to correspond exactly with the resistance of the water from A to B: so that the ship is pushed to leeward of the course I K, which she holds into the direction B A of the effort of her sails; but the resistance which she finds from the water on the lee-side of her bottom, from A to B, sets her to rights again by its opposition, which is greater by reason of the greater facility she finds in dividing the fluid with her stem than with her side; so that she runs on the true course N R, which approaches nearer to that on which she steers than B A. Therefore the angle K H R of the lee-way is proportional to the greater or less resistance the ship finds laterally from the fluid under her lee; which resistance depends entirely on the more or less facility she finds in dividing the water with her bows; so that the lee-way can never be considerable but when close-hauled; for this reason, it is not much taken notice of when the course is less oblique than the wind on the beam. We might pursue this reasoning still farther, from an experienced fact, which will prove that the lee-way depends, not only on the form of vessels, but still more on their greater or less velocity, and seldom or never on the entire disposition of their sails more or less oblique to the keel, as some authors have advanced. For, when a fine sailing vessel is trimmed sharp, with all her sails set, in a very light breeze, with which she scarcely obeys the rudder, the lee-way is considerable, though the sea be perfectly smooth. This great lee-way is made by the ship, because the vessel being only gently impelled, and with little force, the water, not being shocked with violence, offers little resistance, and she is then carried easily by her sails in the direction of their effort B A: and, if we consider the side of the ship, in the act of sailing, as presenting a very great surface of sails above the water, it will visibly appear the lee-way will become still more perpendicular to the keel. But, let the wind begin to freshen, then the rapidity of sailing augments considerably;

rably; the ſhip ſhocks the water with a force expreſſed by the ſquare of ſix or nine knots of velocity from B to A (*fig.* 18) in the ſpace of an hour, while the water repels her effort in a contrary direction: the water repels then in the ratio of this ſquare to the ſquare of her firſt velocity, and now no longer yields with facility (§. 4); the lee-way is ſuddenly diminiſhed, and is reduced to five or ſix degrees, and ſometimes leſs, if the rapidity of ſailing continues to increaſe; if, at the very time when the ſhip has acquired already a very great velocity, ſhe be kept away 12° or 15°, or even 20° 30′, without altering the ſails, their obliquity remaining the ſame, the ſhip ſhould then fall off in the ſame proportion, according to the opinion of ſome who have written on the theory of the working of ſhips. This, notwithſtanding, never happens; the velocity augments, becauſe the ſails then receive the wind with a greater ſine of incidence, and thereby acquire more power, while the bows continue to be ſtill ſhocked by the fluid in the ſame parts, and with the ſame ſine of incidence; ſo that the lee-way diminiſhes again, becauſe the water makes a greater reſiſtance from the increaſe of velocity; and that reſiſtance is greater on the ſhip's ſide than on her bows, which is leſs expoſed to the ſhock. Whence it muſt be concluded that the lee-way, in the ſame ſhip, does not depend alone on the diſpoſition of her ſails, and that in different ſhips it is always diſſimilar, from their not having the ſame form, or their ſails not trimming equally in the ſame oblique courſes; and becauſe, in ſhort, they have different velocities with the ſame weather and under the ſame ſails. Which proves, in a word, that the lee-way is always in a proportion compounded of the velocity of the ſhip; of her form, which gives her more or leſs reſiſtance on her ſide than on the bows; and of her ſails, trimmed more or leſs obliquely.

To return to the conſideration of the action of the water on the bottom from A to B, (*fig.* 18,) it muſt be remarked, that it acts forward, and that it muſt conſequently contribute very much to the tendency which almoſt all ſhips have to come to the wind, whenever the after-ſails are in the ſmalleſt degree more powerful than thoſe forward: for, the ſhock of the water is then a power which is to be added to that of the impulſe of the after-ſails, ſince this

this action of the fluid is so much the stronger as it acts before the centre of gravity of the ship at the point M, (*fig.* 18,) in impelling the fore-part towards the wind, which always makes ships difficult to ware, because all the effort A B of the water's resistance upon the bows is opposed to this movement, in forcing this part to windward with a very great effort. It is not therefore to be wondered at when ships veer with difficulty or slowly, especially such as have a large cut-water; because there are two forces acting one against the other, and the force which comes from the sail must surmount (§. 18) that which comes from the water; which will always easily happen, whenever, in suppressing some of the after-sails, those forwards shall be disposed favourably enough to produce that effect; and when the rudder is used at the same time; the power of which is considerable, whether the ship goes a-head or a-stern rapidly. But if the ship, being abandoned to her own proper movements in an oblique course, had on a sudden all her sails suppressed, the vessel would come to the wind, should even the rudder never be used; because the water, acting on the fore-part of her bottom more on one side than the other, impels the head to windward against the smaller resistance, until its power is entirely destroyed by the total cessation of the ship's velocity.

When the ship runs so large that the after-sails becalm part of those forward, this is again another reason for the ship having an inclination to come to the wind; for, the sails forward receive a much less impulse from the wind than in a course more oblique; because the sails abaft, by increasing in their power, prevent those forward from having as much wind as their surfaces would take, since all the lee-parts of these sails become useless for the moment, being becalmed by the weather-part of those on the main mast; so that the power of the sails forward diminishes, while that of the after-sails increases; for the sine of incidence is greater. The ship ought then, for these reasons, to have more inclination to come to the wind; but, regard must be paid to the direction of the power of the sails in general, which now approaches nearer the direction of the keel: so that the greatest part of their effort is in that direction, while their force in the lateral one diminishes.

It

It ſhould be farther obſerved, that when the ſhip has as much ſail as the weather will permit her to carry, that is the moment of the greateſt velocity of ſailing, provided that (the ſails having at the ſame time received the moſt favourable diſpoſition) an exact equilibrium has alſo been placed between thoſe afore and thoſe aft, ſo that there ſhould be little occaſion for the uſe of the rudder.

APPLICATION.

48. One may readily diſcover, from what precedes, how to diſtinguiſh the degree of quickneſs with which different operations ought to be performed. For example, being obliged to run for a road-ſtead, the wind being large, and to let go an anchor as ſoon as come to it, it is evident this ought to be executed but under little ſail, which ſhould be all on the part before the centre of gravity; becauſe, in the firſt place, a ſhip has always velocity enough when ſhe ſails large; ſecondly, becauſe ſhe is to overcome the effort A B (*fig.* 18) of the water which oppoſes her *movement*. If, on the contrary, being obliged to come to the wind in anchoring, as many ſails as can conveniently be managed at that moment may be ſet, becauſe that movement of the ſhip is always very quick, and as ſoon as the ſails are taken a-back, the rapidity of the ſhip's way diminiſhes, and *in a few moments entirely* ceaſes, whereas it always augments when the ſhip falls off.

ARTICLE I.

REMARKS ON THE EFFECT OF THE MAIN-SAIL.

49. In the uſe of the ſails, attention ſhould be paid to the effect of the main-ſail, which perhaps may not be that of bringing the ſhip to the wind; for, if the ſhip be too much loaded a-ſtern, the

centre

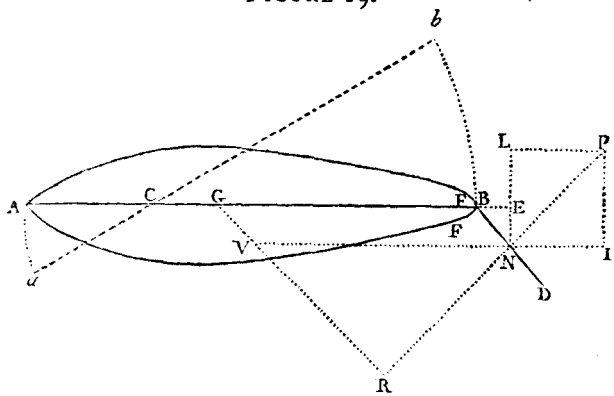
centre of gravity H (*fig.* 18) of the ſhip might be abaſt the main-maſt, and then the direction of the effort of that ſail, quitting the point C before the centre of gravity, ought to make the ſhip fall off in lieu of keeping her up to the wind. But, for this to happen, the ſhip muſt be either very ill conſtructed or very badly loaded; or, in ſhort, there muſt be great error in the poſition of her maſts. Notwithſtanding the main-ſail may always be made to aſſiſt the ſhip in veering, though the centre of gravity H be (as it is almoſt always) before the effort C of the main-ſail; yet, to do it, the effect of that ſail need only be changed, by making it to paſs before the centre of gravity of the ſhip: which will ſuddenly happen, if, when cloſe-hauled, the main ſheet be let go a-main, becauſe the weather-part of the ſail being fixed forward by the tack, its effect is likewiſe before the centre of gravity of the ſhip, though it has loſt in that part much of its power, in becoming leſs expoſed to the impulſe of the wind; while the lee-part, bellying out more, can receive a great impulſion of the wind, which will ſtrike it more and more perpendicularly as the ſhip falls off with more and more rapidity. In this caſe, it may happen, that if the direction of the effort C G of the main-ſail do not paſs before the centre of gravity H of the ſhip, it comes ſo near that point, that it may be ſaid to have no longer the effect of an after-ſail.

ARTICLE

ARTICLE II.

OF THE RUDDER.

FIGURE 19.



50. The rudder is a machine known to all the marine world; it is ſupported by the ſtern-poſt, to which it is affixed by braces and pintles, which operate as hinges. It acts by means of a lever, called a tiller, which enters nearly horizontally into the ſhip, paſſing under the upper or middle deck tranſom; ſo that if, inſtead of leaving the rudder exactly in a right line with the keel, and as it were a prolongation of it, it be turned to one ſide or the other, as B D, (*fig.* 19,) it receives an immediate ſhock from the water which glides along the ſhip's bottom, in running aft from A to B; and this fluid impels it towards the oppoſite ſide, while it continues in that ſituation, ſo that the ſtern, to which the rudder is confined, receives the ſame movement; and, the ſhip receiving an impulſe ſideways, her ſtern turns accordingly from B to *b*, on any point whatever C, (§. 18,) while her head paſſes from A to *a*. It muſt be obſerved, that the water ſtrikes the rudder obliquely, and only with that part of its motion which acts according to the ſine

of incidence, in impelling it in the direction N P with a force which depends not only on the rapidity of failing, but alſo on the greatneſs of the ſine of incidence: a force which is conſequently in the compound ratio of the ſquare of the greater or leſs velocity of the ſhip's motion, and of the ſquare of the larger or ſmaller ſine of incidence, which depends upon various circumſtances. So that, if the veſſel runs three or four times more ſwiftly, the abſolute ſhock of the water upon the rudder will be nine or ſixteen times ſtronger under the ſame angle of incidence, and will be augmented in a greater proportion, if the ſine of incidence be increaſed. This impulſion, or, what is the ſame, the power of the helm, is always very feeble, when it is compared with the whole weight of the veſſel; but it acts with a very long arm of a lever, which occaſions it to work very advantageouſly in turning the ſhip; for the helm is fixed at a very great diſtance from the centre of gravity G, as well as from the point C, upon which the ſhip is ſuppoſed to turn, with reſpect to the point of percuſſion B: and, if the direction P N of the impreſſion of the water upon the rudder be prolonged, it is evident that it will paſs perpendicularly at the point R, widely diſtant from the centre of gravity G; therefore the abſolute effort of the water is very powerful. It is not therefore ſurpriſing, that this machine impreſſes the ſhip with a conſiderable circular movement, by forcing the ſtern from B to *b*, and the head from A to *a*, and even much farther, when the velocity of the ſhip is preſerved; becauſe the effect of the helm always keeps pace with the rapidity of the ſhip's way.

51. Amongſt all the obliquities which may be given to the rudder, there is one ſituation which is more favourable than any of the others, to make it produce with more rapidity the effect of turning the ſhip, in order to change her courſe. To be convinced of this, we have only to conſider that, if the obtuſe angle A B D (*fig.* 19) were to be leſſened, the impulſe of the water on the rudder would augment, at the ſame time that it would more oppoſe the ſailing of the ſhip, ſince the angle of incidence would be more open, and would preſent a greater ſurface (§. 7) to the ſhock of the water, by oppoſing its paſſage more perpendicularly: but then the direction N P of the effort of the helm upon the ſhip would paſs

at

at a ſmaller diſtance from the centre of gravity G towards R, and would leſs approach the perpendicular N L, according to which, it is abſolutely neceſſary that the power ſhould act with greater effect to turn the ſhip. Therefore, it is evident that, if the obtuſe angle A B D were too much leſſened, the greater ſhock of the water could not counterbalance the loſs occaſioned by the diſtance between the direction N P and N L, or by the great obliquity which would be given to the ſame direction N P of the abſolute effort of the helm with the keel A B. If, on the other hand, the angle A B D were made more obtuſe, the direction N P of the effort of the rudder would become more advantageous to turn the ſhip, ſince it would approach more the perpendicular N L, and ſince the prolongation of N P would augment G R, by paſſing at a greater diſtance from the centre of gravity G. But the rudder would then be ſtruck too obliquely; for the angle of incidence would be more acute; ſo that it would only preſent a ſmall part of its breadth to the ſhock of the water, and would of courſe receive but a faint impulſion. All this proves that the greateſt diſtance G R from the centre of gravity G will not counterbalance the too great obliquity of the ſhock of the water. Whence it muſt be concluded, that when the water ſtrikes the rudder too obliquely or too perpendicularly, a great deal of the impulſion, or of the effect it ſhould produce, is loſt. Therefore, between theſe two extremes, there is a middle poſition, which muſt be the moſt favourable.

52. The diagonal N P of the rectangle I L (*fig.* 19) repreſents the abſolute direction of the effort of the water upon the rudder: N I expreſſes the portion of this effort which oppoſes the ſhip's head-way, or which forces her a-ſtern in the direction of the keel. It is eaſy to preceive that this portion N I of the whole power of the helm contributes little to turn the veſſel; for, if I N were prolonged, it would be ſeen that its direction paſſes at a very ſmall diſtance G V from the centre of gravity G, and that the arm of the lever B N = G V, to which the force is as it were affixed, is at moſt equal only to one-half of the breadth of the rudder. But, it is not ſo with reſpect to the relative force N L, which acts perpendicularly to the keel. If the firſt force N I is almoſt uſeleſs, and even hurtful, by retarding the velocity, the ſecond N L is capable

of a very great effect, ſince it is applied at a great diſtance from the centre of gravity G of the ſhip, and acts on the arm of a lever G E, which is very long. Thus, it appears, that, between the two effects N L and N I, which reſult from the abſolute effort N P, there is one which is always oppoſing the ſhip's head-way, contributing but little therefore to the motion of her turning; whilſt the other alone produces that movement of evolution without retarding her velocity.

53. Geometricians have determined the moſt advantageous angle made by the helm with a line prolonged from the keel, and fixed it at 54° 44′, on a preſumption that the ſhip is not wider at her floating-line than at her keel. But, as that ſuppoſition is abſolutely falſe, ſince all veſſels augment their breadth from the keel upwards to the extreme breadth where the floating-line, or higheſt water-line, is terminated; it follows, that this angle is too large by a certain number of degrees. For the rudder is ſhocked by the water, at the height of the floating-line, more perpendicularly than at the keel, ſince the fluid exactly follows the outlines of the bottom: ſo that one could almoſt ſay, that a particular poſition of the helm might be required for each different ſine of incidence upwards from the keel. But, as a middle poſition may be taken between all thoſe points, we need only conſider the angle formed by the ſides of the ſhip and her axis at the higheſt water-line, in order to determine afterwards the middle point and the middle angle of incidence. It appears, from Mr. Bouguer's *Traité de la Manœuvre*, Sect. I. Liv. II. that, in moſt ſhips, the angle of the rudder with the prolonged line of the keel ſhould be made to be 46° 40′. Without following the calculations of that able geometrician, we ſhall perhaps be able to explain what he has diſcuſſed in a more abſtruſe manner.

54. When it is required to turn the ſhip by means of the rudder, and, at the ſame time, keeping the head-way as much as poſſible, it is evident that the angle 54° 44′, which ſome have determined to be the moſt favourable with the line of the keel prolonged, is in that caſe too open; becauſe the water ſtrikes the rudder with too great a ſine of incidence, and which is equal to that of the angle which it makes with the line prolonged from the keel below.

Above,

Above, the ſhock of the water is almoſt perpendicular to the rudder, on account of the width of the ſhip's ſides, as has been ſhewn before. But, if the rudder oppoſes the fluid by making only with the line prolonged from the keel an angle of 45° 1′, the impulſe, by becoming weaker, will be leſs oppoſed to the ſhip's head-way; and the direction N P (*fig.* 19) of the abſolute effort of the water on the rudder, approaching nearer to the lateral perpendicular N L, will be more advantageouſly placed; ſince the prolongation of the abſolute effort paſſes at a greater diſtance G R from the centre of gravity G. On the other hand, experience every day ſhews us that ſhips ſteer well, when they do not even make the angle D B E more than 35°. If this angle be made 45°, as we require it, and then we ſhould diſcompoſe the abſolute effort N P, we have the ſide N I equal to the other ſide N L of the ſame ſquare; ſo that the part of the total power which oppoſes the head-way is only equal, in this caſe, to that which produces the movement of rotation: inſtead of which, if D B E were 54° 44′, N I would become much greater than N L, in proportion to the ſines of the angles which are oppoſed to them in the triangles P I N or P L N, and the ſhip would conſequently loſe much more of her velocity than in the firſt ſituation of the rudder, to which we ſhall confine ourſelves, as being that which is beſt adapted to the generality of veſſels, but which nevertheleſs muſt be occaſionally altered, according as they ſhall make an angle more or leſs open with their ſides aſtern.*

The angle of the rudder with the keel may always be determined with ſufficient preciſion, by obſerving the rule we have preſcribed (§. 28) for the determination of the angle of the ſails.

55. As the water often ſtrikes the rudder with a very great force, the tiller has a certain length, in order to leſſen the labour of the helmſman.

But, to lighten his labour ſtill more, there is in moſt ſhips, on the quarter-deck, directly over the extremity of the tiller, a vertical wheel (*fig.* 19) which has the effect of a capſtern, and which

* It may be taken as a general poſition that the moſt advantageous angle will always be formed between 35° and 45°.

is

is connected with the tiller by means of ropes and blocks. So that, if the wheel be turned either one way or the other, the extremity of the tiller appoaches towards one of the ſides of the ſhip, and expoſes the rudder to the ſhock of the fluid.

56. The longer a lever is, the more effect it has when it acts with the ſame power: therefore, the longer the ſpokes of the wheel are, in proportion to the radius of the cylinder round which the tiller-rope is wound, the more advantage the helmſman will have; for, if the ſpokes of the wheel be three or four times longer than the radius of the cylinder, the helmſman will act with three or four times more force, ſince he works on a lever which is three or four times longer than the radius of the cylinder, the extremity of which is ſuppoſed to be the fulcrum of the lever on which he works. So that, if he employs a force of 30 pounds weight, he will produce an effect of 90 or 120 pounds, by the diſpoſition of the wheel alone. On the other hand, the impulſe of the water is collected in the middle of the rudder's breadth, which is very narrow, compared with the length of the tiller; therefore, the effort of the water is very little diſtant from the point of ſupport B upon which it turns: whereas the tiller forms the arm of a lever 10 or 15 times longer, which ſtill increaſes the power of the helmſman in a ſimilar proportion to that which exiſts between the length of the tiller and that of the lever on which the impulſe of the water acts. This force is therefore 10 or 15 times ſtronger; and the effort of 30 pounds, which before gave the helmſman a power of 90 or 120 pounds, will become one of 900 or 1800 pounds on the rudder. This advantage proceeds from the water's acting on a very ſhort arm of a lever, while the helmſman works on one very powerful, in compariſon; and becauſe this lever is moved by a wheel which multiplies its force. This demonſtration ought to remove all ſurpriſe at the prodigious effect of the ruder, when its mechaniſm is not attended to; for we have only to conſider the preſſure of the water, which acts at a very great diſtance from the centre of gravity G of the ſhip, as well as from the point C upon which ſhe is ſuppoſed to turn, (§. 15,) and there will eaſily be perceived the difference which exiſts between the effort

of

of the water against the helmsman and the effect of that same impulsion against the ship. With respect to the helmsman, the water acts with the arm of a lever N B very short, of which B is the fulcrum: on the contrary, with respect to the ship, the impulse of the water is exerted in a direction N P, which passes perpendicularly at a very great distance from the centre of gravity G, in acting on a very long lever E G, which renders the action of the rudder very powerful in turning the ship: so that, if in a large ship, the rudder receives an impulse from the water 2700 or 2800 pounds, (as very often happens, provided that the ship sail at the rate of 9 or 12 knots, and that this power, applied at E, be 100 or 110 feet from the centre of gravity G,) it will act upon the vessel, to turn her, with a power equal to 270,000 or 308,000 pounds, while the helmsman need not act with a greater power than 30 pounds on the spokes of the wheel.

57. It is proper to remark, that the great length which is given to the tiller, in order to facilitate the work of the helmsman, is an obstacle to the play of the rudder; since that length hinders its presenting itself sufficiently to the shock of the water to produce all the effect which might attend it. For, this inconvenience does not, in most ships, allow the angle D B E (*fig.* 19) to be more open than 30°; whereas it should be 45°, as we have before shewn. But, as this most favourable determination has not yet come into use, and the coarse dimensions commonly given the tiller have always been followed, we shall endeavour to propose something better for practice.

It must be considered, that, if the tiller were shorter, the rudder would have more play, because its extremity, in describing the arc of a smaller circle, would occasion the rudder to make an angle more open, with the keel prolonged: and this new augmentation would be so much the more advantageous, as it would approach nearer to the angle of 45°. And as, in all ships, the length of the tiller might certainly be cut a fifth shorter, or perhaps more, it is evident that, thereby, the angle of the rudder and the keel prolonged might be rendered very near 45°, which would increase its force in a proportion of nearly 3 to 5, since the square of the sine of incidence of 45° is to the square of the sine of incidence

of

of 30° : : 5 : 3, or thereabouts. This augmentation of the impulſe is often of the greateſt importance, eſpecially when ſhips are of a large ſize, as their motions are but ſlow on account of their length.

If the tiller be ſhortened, the helmſman will be obliged to employ more force in proportion to the length taken from the lever on which he works: but this loſs may be repaired by the facility with which the helm will be handled, if the diameter of the cylinder of the wheel be conſiderably leſſened, augmenting at the ſame time the length of its axis, without diminiſhing that of its ſpokes, which ought on the contrary to be lengthened as much as poſſible, and two more turns of the tiller-rope ſhould be wound round the barrel.

Theſe forces would be ſtill multiplied, if two ſheaves were fixed in the end of the tiller, in two mortiſes which might be made for that purpoſe, and which might work on an iron pin paſſing through their centres, taking care to have the end of the tiller ſtoutly hooped with iron, in order to ſtrengthen it; then the tiller-rope might be reeved through the blocks which are for that purpoſe on each ſide the ſhip, thence through the two ſheaves at the end of the tiller, and the ſtanding-part to be affixed cloſe to the blocks on each ſide. By theſe means nothing would be loſt with reſpect to the force; becauſe, if the lever be ſhorter, the forces which cauſe its action are likewiſe multiplied in proportion.

58. After what has been ſaid reſpecting the helm, it is eaſy to conceive, that the greater the ſhip's velocity is, the more powerful is the action of the rudder, ſince it acts againſt the water with a force which increaſes as the ſquare of the velocity of the fluid, (§. 3,) whether the ſhip has head-way or ſtern-way; obſerving always, that in theſe two circumſtances the effects are contrary; for, if the ſhip goes a-ſtern, the rudder will be ſtruck from I to N; (*fig.* 19;) and, inſtead of being puſhed from N to P, it will be ſo from N to R; ſo that, the ſtern being moved in the ſame direction, the head will take a contrary one, and move towards the ſame ſide as the tiller B F.

59. It ſhould be obſerved, in the uſe of the rudder, that there is one part of its effort which impedes the ſhip's ſailing when it is ſtruck

ſtruck by the water which runs rapidly along the ſhip's bottom. If it makes an angle of 45° with the keel prolonged, it receives only half the impulſion it would if acted upon perpendicularly; becauſe the abſolute impulſe diminiſhes from two cauſes: (§. 7:) The ſurface which oppoſes the ſhock of the water is reduced to a leſs extent than it was at firſt, and the angle of incidence diminiſhes likewiſe: ſo that, by this, the impulſe has diminiſhed one half. Conſidering next the impulſion N P, which remains, (*fig.* 19,) it will appear that there is only one part N I which is oppoſed to the ſailing, (§. 54,) and which is leſs than N P, in the proportion as the ſine total is to the ſine of 45°, the meaſure of the angle of incidence V N B equal to N P I; for the angle V N L is right, as well as the angle P N B; ſo that, if you take away the common angle L N B, two angles P N L and V N B will remain equal between themſelves; but, as the angle I P N is equal to its alternate angle P N L, it follows that I P N is always equal to V N B, whether the angle made by the rudder be more or leſs open with the keel prolonged. So that, if the ſurface of the rudder which receives the ſhock be 80 feet ſquare ſuperficies, it will firſt be reduced, by its being expoſed to the courſe of the fluid, to an effort of 40 feet ſurface, then to 28 or 29, becauſe, in the firſt place, there is only one part of the velocity of the water which contributes to the ſhock, and that is proportional to the relation of the ſquare of the ſine total to that of the ſine of incidence; and, ſecondly, becauſe out of the abſolute impulſe N P, which reſults from this laſt oblique ſhock, there is only a part N I which oppoſes the velocity of the ſhip proportional to the abſolute N P, in the ſame relation as there is between the ſine total and the ſine of incidence; that is to ſay, that, when the rudder makes, in the largeſt ſhips, an angle of 45°, it impedes the ſhip's rapidity of ſailing, in the direction of the keel, with an effort N I equivalent to the impulſion which a ſurface of 28 or 29 feet ſquare might receive if it were expoſed perpendicularly to the ſhock of the water. So that, if the ſhip ſails 12 knots an hour, or 19 feet a ſecond, the effort of the rudder N I, which oppoſes the ſhip's way, will be 12,499 or 12,945 pounds; ſalt water weighing $\frac{1}{35}$th more than freſh.

60. It follows, from all that has been ſaid of the rudder, that it ought to be employed as little as poſſible; that is to ſay, the ſhip and her ſails ought to be ſo diſpoſed, that the ſmalleſt motion of this machine may bring her to her courſe, if ſhe deviates from it, or make her perform any evolution which may be thought proper.

ARTICLE III.

THE TIME EMPLOYED BY DIFFERENT VESSELS TO PERFORM THE SAME EVOLUTION IS PROPORTIONED TO THEIR LENGTHS.

61. All that ſerves to produce motion in ſhips has more force in larger than in ſmall ones; but the difficulty which large ſhips have to receive the motion is greater, in a greater proportion, than that which oppoſes the motion of ſmall ſhips. For, if the dimenſions and machines which compoſe a large veſſel are twice as large as thoſe which conſtitute a ſmall one, (ſolidities being in ratio of their cubes,) the firſt will be eight times as great. Yet the obſtacle which the large will oppoſe to its being put in motion will be two-and-thirty times as great as that of the ſmall one. For, if both ſhips were conſidered as divided into an equal number of vertical ſections, thoſe of the large would appear to have four times as much ſurface as thoſe of the ſmall, beſides that they would be twice as thick, ſince the dimenſions are in general twice as large; conſequently they will have eight times the ſolidity; which anſwers already to the relative effort of the rudder and ſails.

Farther, the parts of the large ſhip are twice as diſtant from the centre of gravity as thoſe of the ſmall one, ſince thoſe diſtances are proportional to the other ſimple dimenſions of the two ſhips. So that if the evolution be ſuppoſed of the ſame number of degrees,

grees, the ſtern and head of the large ſhip will have to deſcribe arcs twice as large as the ſmall one; and this greater velocity being multiplied by the ſolidity of the parts of the large ſhip, which is eight times as great as that of the ſmall one, the product will give 16 times more motion; the reſiſtance will act conſequently 16 times as much on the large as on the ſmall; and as that reſiſtance operates on the arm of a lever twice as long, the total reſiſtance of the large ſhip will be 32 times as great. Thence it follows, that if the forces which act on the large ſhip be augmented only in proportion to her ſolidity, ſhe will have ſtill four times more difficulty than the ſmall one to get into motion: and therefore the large ſhip, inſtead of making in the ſame time an angle of rotation as great as the ſmall one, will only make an angle of one-fourth, or three times leſs. Now, that the great ſhip ſhould deſcribe an angle of rotation equal to the other veſſel, it will require only thrice as much time: but that angle, or the velocity with which the ſhip obeys the impulſe of her rudder and ſails, will follow the laws of acceleration, ſince the velocity acquired in the firſt inſtance is continually augmenting in arithmetical progreſſion; ſo that the time which ſimilar veſſels of different ſizes take in performing the ſame evolution will be in proportion to their lengths. But the heavier body parts with its velocity not ſo readily as the lighter body, becauſe the reſiſtance of the maſs is greater, being three times heavier than that of the ſmall ſhip; which, being moved with thrice the facility, is alſo brought to reſt with the ſame degree of eaſe. So that, if a veſſel 100 feet long takes four minutes to perform an evolution, a ſimilar veſſel of 150 will take ſix minutes or thereabouts to perform the ſame circular movement. For as 100 : 150 : : 4 : 6.

CHAPTER VII.

OF THE HEIGHT OF MASTS.

THE correct height of the masts of ships is still a problem which remains to be solved for the builders. The most skilful of them have not paid attention enough to the solutions and determinations which are contained in the works of the late Mr. BOUGUER on that subject. It seems, on the contrary, as if they had endeavoured to deviate as much as possible from the true principles in that respect, by raising the masts a great deal more than they were formerly, although they were already much too high, as the learned author I have just mentioned has asserted. An experience, confirmed by repeated observations, has convinced me of this truth; viz. that "as soon as a ship inclines, her velocity "diminishes in proportion as her inclination increases." This principle has been verified on different vessels and at different times by several officers, and in various oblique courses. I had no share in those various experiments, and therefore cannot be suspected of partiality: but, as they have always proved, to those who have made them, that the present mode of masting is generally too high, I will not hesitate a moment longer to deliver here an epitome of my own experiments on that subject.*

Having all the sails out, and being hurried on by a strong gale, I have ordered all the top-gallant-sails, the studding and stay sails, to be taken in, without the ship losing the least perceptible degree of her velocity; nay, I have seen it sometimes to increase by a twentieth, and that at a time when the ship ran already at the rate of nine or twelve knots an hour.

* We have thought it proper to give the reasoning of M. Bourdé upon this subject, although the practice of high-masting prevails in the British navy. It has been very justly remarked, that high masts have the advantage of giving an option; because they *enable* a ship, without *obliging* her, to carry a greater quantity of sail than ships with shorter masts.

These

Thefe trials, which I have made with care, and which were performed fo quickly, that the wind fhould not have time to increafe or diminifh in ftrength, are fufficient to prove the neceffity of lowering the centre of effort of the fails in general, and confequently all the mafts. Thefe experiments have been repeated by augmenting the number of fails, fometimes at the rifk of fatiguing the mafts; and it has always been found that the velocity did not increafe, when the fhip was more inclined; but that fhe laboured more and more in all her parts, as her movements became ftronger and the concuffions of her pitching rougher, although the fea was not more fwelled. At other times, when the fhip inclined pretty much, though the wind was not quite ftrong enough to hurt the mafts, I have leffened the number of fails; and it happened that the fhip, after that fuppreffion of the top-fails, was eafier in her movements, fteering better, and was, in fhort, more quiet, though the fwells of the fea were ftill the fame; an attention which muft not be neglected in thefe kinds of obfervations, which fhould be often repeated before a pofitive decifion. However, we do not recommend any diminution in the furface of the fails, in leffening their height: but, it will often happen that we fhall rather recommend to increafe it upon the whole. For that which is loft in height may be regained by the width. There will even refult, from that operation, another advantage: the top-fails, by this reform, being fhorter, and, thereby, proportionally wider, than the lower fails, will be more eafily cut to their fhape; and, their fides being formed with lines exactly ftrait, the fail will be the more tight, by which a much greater effect on the fhip will be produced. The maft being fhorter and the fails wider, with lefs fall, the furface will be the fame: but the effort of that furface will, with the fame wind, act on fhorter levers, the fulcrum of which will not be altered; therefore, it will operate at a fhorter diftance from that fulcrum; and therefore much lefs will be the power which makes the fhip incline: and the fhip, being more upright, will fail with more velocity, becaufe her water-lines will be then more advantageous than when fhe heels. On the other hand, the fails being lefs inclined, they prefent a wider furface to, and receive a ftronger impulfion from, the wind; an advantage which muft always

always produce an increaſe of ſwiftneſs and a decreaſe of drift. Add to this the real advantages of trimming the ſails better, of working them with more eaſe, of rendering the maſting in general more ſolid, and more capable of reſiſtance in bad weather as well as in battle.

But how muſt we determine the height for the maſts? or, in other words, how much they are to be ſhortened? The *Treatiſes on the perfect maſting and working of ſhips*, by Mr. BOUGUER, teach us that method. It is from thoſe Treatiſes I have imbibed the notions of my principles on that ſubject. But, in order to give a previous idea of that inquiry, and to engage the builders and ſeamen to bring to perfection this part both of the building and working of ſhips, upon which, almoſt as much as from their bottom, their ſteerage undoubtedly depends, I will ſubjoin here what M. BRUE, a learned and ſtudious officer, made me conceive on that ſubject.

" That maſting," ſaid he, " is abſolutely perfect, when the " centre of effort of the ſails is preciſely oppoſite to, or at the " ſame height as, or parallel with, the *point velique*. What is the " *point velique?* It is that point in a perpendicular, (raiſed from " the centre of gravity of the horizontal ſurface of the ſhip at the " floating-line,) which is interſected by the direction of the abſo- " lute impulſe of the ſea on the head of the veſſel. This is the " *point velique* in direct courſes."

It is clear. No great effort of imagination is neceſſary to conceive this principle, which appears ſo evident, that it may be ſurpriſing why it has not yet been made uſe of. For, this *point* once known, the centre of effort of the ſails will be ſo too; and their right height, as well as that of the maſts, will be determined. A little more calculation, and an attention to the plan of the ſhip, will be neceſſary, in order to find out that abſolute direction of the effort of the impulſion of the water on the bows. But that ſhould not prevent the inquiry. On the contrary, it ſhould be an additional inducement to thoſe, who, building ſuch good veſſels as we are now poſſeſſed of, and which might ſtill be of a more advantageous form, will be deſirous to make them more perfect, by maſting them more advantageouſly. This would undoubtedly be the

caſe;

caſe; for, ſeveral veſſels have had their maſts cut ſhorter, and the practice has been attended with decided ſucceſs. Theſe facts, which could be atteſted by many able ſeamen, will always ſpeak highly in favour of this principle; although, when that ſhortening was made, the ſails were not widened in proportion.

"But," continues M. BRUE, "in carrying this inquiry far-
"ther than it ever was, the interſection of the two above-men-
"tioned lines (viz. that of the abſolute impulſe of the water on
"the bows, and that of the perpendicular of the centre of gravity
"of the ſurface of the floating-line of the ſhip) cannot take place
"unleſs in a direct courſe; and, as ſoon as the courſe becomes ob-
"lique, they no longer meet. The centre of gravity of a float-
"ing-line's ſurface of the ſhip paſſes to the leeward of the axis, on
"account of the inclination which always occurs in that ſort of
"courſe: and the direction of the ſhock of the fluid, which then
"takes its origin a little to leeward alſo of the bow, paſſes, in its
"prolongation, to windward, without meeting the perpendicular
"at the centre of gravity of the floating-line's ſurface;" (which is eaſily conceived, if we repreſent to our imagination the horizontal edge of that floating-line's ſurface but ever ſo little inclined;) "whence it reſults, that no *point velique* will be found in
"any courſe but a direct one. Which is true, unleſs we could
"fancy ſuch a ſhip as would neither drive nor incline in an ob-
"lique courſe. But that is not poſſible; and hence no perfect
"mode of maſting could be diſcovered in the laſt caſe of the ob-
"lique courſe."

This is true, ſtrictly ſpeaking; for, in each inſtant of a courſe, a different point of the bow is ſtruck by the water; which is owing to the pitching of the ſhip, the continual variations in the ſtrength of the wind, and the greater or ſmaller inclination produced by the rolling motion of the ſhip.

"But," ſays again M. BRUE, "the *point velique*, relative to
"theſe various circumſtances, varies therefore in the proportion
"of the almoſt infinite variety of thoſe circumſtances, which ac-
"company the courſe of a ſhip; that is to ſay, according to all
"the degrees of drift, all the degrees of inclination on either
"board, forward and abaft; as many times, in ſhort, as there are

"new

" new points of the bow either ſtruck or no longer ſtruck, the " *point velique* aſcends or deſcends.

" I paſs over the minute examination I could make of each par- " ticular cauſe which contributes to lower that *point* from its ut- " moſt height, which is in the direct courſe, to its loweſt, which " takes place in the moſt oblique courſe, accompanied with the " greateſt lateral inclination of the ſhip. And there is no method " to get out of that common road which is purſued in determining " the dimenſions of the maſts, but that of attending to the fol- " lowing conſiderations; viz. Such a ſhip, being intended for " ſuch a latitude, the wind ſhe is moſt commonly to expect there " will be nearly of ſuch a ſtrength, and generally oblique to her " courſe by ſo many degrees; ſo that her moſt common drift will " be nearly ſo many degrees, and her lateral inclination ſo many, " &c. To give her, therefore, the moſt ſuitable maſting, making " her relatively perfect, we muſt ſeek for her *point velique* in what " ſituation we ſhall think moſt convenient, and there place the " centre of effort of her ſails."

All this reaſoning tends evidently to the ſhortening of all the maſts, and proves the neceſſity of doing it, at the ſame time as it determines their height. The moſt difficult point in that operation is to find out the direction of the abſolute impulſion of the water on the bows, when the ſhip ſteers a courſe cloſe-hauled and one with the wind on the beam, with ſuch an inclination as the ſhip could be ſuppoſed to have in either of theſe two courſes; when the wind would allow to have four ſquare-ſails ſet, together with the mizen top-ſail. Conſidering theſe two ſuppoſitions of the wind on the beam, and cloſe-hauled, it will be eaſy to determine the height of the maſts proper for that double ſituation; becauſe, if the gale blows harder, one may leſſen the number of ſails; if weaker, one may increaſe it by adding ſtay-ſails, top-gallant ſails, jib, &c. If the wind gets more aft, then the ſurface of the ſails may be increaſed again by adding the ſtudding and top-gallant-royal ſails: finally, it is very clear that top-gallant and top-gallant-royal ſails will always be of ſervice when the centre of effort of the ſails ſhould aſcend.

CHAP-

CHAPTER VIII.

OBSERVATIONS ON THE DIFFERENT INCLINATIONS GIVEN TO THE MASTING OF SHIPS, WITH RESPECT TO THE WATER-LINE.

THE maſts are hardly ever ſtepped in the ſame manner in all ſhips. This too is one of thoſe things which are rather regulated by cuſtom than reaſon. Some will have them perpendicular, while others chooſe to have them rake forward and others aft. Each party brings, to ſupport their opinion, reaſons drawn from ſome experiments which chance has ſometimes rendered ſpecious.

In this reſpect, we ſhould rely on the judgement of the builder, who ought to know the qualities of his ſhip, even before he puts her on the ſtocks. If one has not an opportunity of taking directly from him the neceſſary inſtructions, it is proper to obſerve, that, if the maſts are made to rake forward, the direction of effort of the ſails will be inclined towards the bottom, obliquely with the horizon; which will conſequently make the head of the ſhip plunge whenever they receive a ſtrong impulſe from the wind: and this may diminiſh the head-way of the ſhip, while it increaſes the celerity of the pitching; the ſails alſo will be with more difficulty trimmed, eſpecially when cloſe-hauled, ſince the bracing of the yards will be more confined. Therefore, the only advantage, which can be drawn from this oblique maſting of ſhips, is only to render the ſhips more ready to fall off.

If the maſts are perpendicular the direction of effort of the ſails will be horizontal, always ſuppoſing the ſhip to be in an upright poſition. Therefore, this effort, not being diſcompoſed, it will preſerve a much greater action, and the ſhip will ſail with the greateſt velocity ſhe is capable of.

If the maſts rake aft, the ſhip will be more ready to come to the wind, becauſe the ſails will be a little more aft; theſe will alſo be more eaſy to trim ſharp, becauſe the braces will not be ſo much confined. As this poſition of the ſails will raiſe obliquely above the horizon the direction of the effort on the ſhip, it follows, that, by their power, the ſhip will be eaſed away from the water; for, it is certain that ſhe will not prolong her courſe, unleſs ſhe heels too much; therefore, ſhe will riſe more lightly over the waves, pitch leſs, keep better the wind, and tack quicker. This is nearly all that can be ſaid in reſpect to practice.

CHAPTER IX.

OF THE TENSION OF SAILS, AND THEIR TENDENCY TO FIX THEMSELVES PERPENDICULARLY TO THE DIRECTION OF THE WIND.

I. IT is clear that ſails are never perfectly flat. But every one is not perſuaded that the more extended is the ſail, the greater impulſion it receives from the wind which ſtrikes it perpendicularly, and the more effectually, of courſe, the ſail acts on the veſſel. It is aſtoniſhing that any ſeamen ſhould be of opinion that a bag muſt be left at the foot of the ſail to lodge the wind in. A hauled-down top-ſail has as much cloth diſplayed in it as when hoiſted up and well extended. It forms, then, by its convexity, a conſiderable kind of bag, in which the wind may play at eaſe; and it is obſerved, that the rapidity of the ſailing decreaſes very much; whence we muſt neceſſarily conclude, that the impulſe of the wind muſt have greatly diminiſhed, ſince the ſail produces no longer the ſame effect upon the veſſel. To know demonſtratively the cauſe of that diminution in the impulſe of the wind, we have only to

pay

pay attention to the air which acts against the foot and the head of the sail; for, that part of the wind which strikes at the head makes an effort to re-act towards the foot against that which, having struck at the same instant at the foot, endeavours to re-act towards the head. From this shock results (though the air escapes at each side) a compression in the sail. But, after having acted inwardly, in the same manner as if it were shut up, it finds itself more and more compressed by that which succeeds to the first; and, though it escapes by the sides, it is evident that it tries to extend, and that it impels, consequently, with an equal power, all the parts of the sail perpendicularly; and this is the cause of the sail taking the form of a circle's arc. Therefore the sail will produce no greater effect than if it had no greater height than the space contained between the two yards; it may not even, strictly speaking, have that whole effect; for, that sort of whirlwind, which is made in the centre, by the re-action of the wind which strikes the upper and lower parts, cannot fail to diminish the shock of those particles, which, succeeding the former, would have struck the sail with all their primitive power; instead of which, this power is now almost entirely destroyed by this barrier which opposes for a while their passage. To which may be added, that the sail, having the form of the arc of a circle, very little wind can strike it perpendicularly; and that it must, of course, have much less effect than another sail, of the same height and width, which should be very exactly stretched out.

The sails of a ship should be cut in such a form as to present as flat a surface as possible.

II. The centre of effort of the impulse of the wind upon the sails, exposed perpendicularly to the course of the wind, answers exactly to the centre of gravity of the surface, struck in that direct situation. But, as soon as it is presented obliquely to the course of the fluid, and kept so, the centre of effort of the total impulse will pass on the weather-side of its centre of gravity; because the particles of air, which at first met the surface, have been re-acted, and, by that re-action, they stop part of the passage to the succeeding ones, which diminishes, of course, both the strength of the shock and the impulse they would have communicated to

the ſail, if their movement had not been interrupted. But this deviation of re-action in the firſt particles of air which have ſtruck is repeated afterwards. For, all thoſe which ſucceed them, while the ſurface is kept obliquely to the wind, continue to re-act to leeward; ſo that, from the firſt vertical line, (taken from the windward ſide,) out of all thoſe which form together the ſurface, there is a continual ſeries of obſtacles which change the ſhock of immediate and ſucceeding particles, and which alters it ſo much the more as they ought to ſtrike the parts of the ſail moſt to leeward, and ſo much the leſs as they will ſtrike thoſe which are moſt to windward. Therefore, the leeward-ſide of ſails, obliquely expoſed to the wind, is always leſs ſtruck than that which ſtands to windward. Whence it reſults, that the centre of effort of the abſolute impulſe of the wind on the ſail is lodged in the weather-ſide of the ſail, (for it is ſuppoſed to be equally divided in two,) ſince that is the part which receives more impulſion. Therefore, the centre of effort is alſo to windward of the centre of gravity of the ſurface; and the removal of this centre of effort towards the wind is in proportion to the impulſe received on the weather-ſide of the ſail and that received on the lee-ſide. The truth of this aſſertion is continually demonſtrated by daily experience of ſhips at ſea. The ſails are carried by the yards and by the maſts, which divide them perpendicularly into two equal parts, from top to bottom, through their centre of gravity. When, being placed obliquely to the wind, they are left at liberty, without being confined by their braces or bowlines, they immediately range themſelves perpendicularly to the courſe of the wind, becauſe their weather-ſide receives more impulſe than the lee-ſide: and there they remain conſtantly, unleſs their poſition be altered; becauſe all their parts are ſtruck equally, and an equilibrium is kept among them; for, the power of the wind, whether it increaſes or decreaſes, acts always the ſame on them all.

This proof, which ſhews the difference between the centre of gravity and the centre of effort in the ſails, requires much attention in the uſe of that knowledge in practice. For example, in the middle of the yards on their aft-ſide, there might be fixed a cleat or bolſter, which, in oblique courſes, puſhing them to leeward,

ward, would eafe them off from the fhrouds, and facilitate their bracing in carrying their centre of gravity, as well as the centre of the abfolute effort, a little to leeward; which operation would of courfe draw that centre of gravity nearer to the axis of the fhip, from which it is fo effential to remove it as little as poffible.

CHAPTER X.

GENERAL OBSERVATIONS ON THE EFFECT OF MORE OR LESS SURFACE OF SAILS EXPOSED, IN VARIOUS WEATHERS, TO THE WIND.

I. WHEN a fhip, with a certain quantity of fail, has acquired the utmoft velocity with the power which then puts her in motion, it is certain, that, if the furface of the fails is either increafed or diminifhed, the rapidity of the headway will likewife augment or leffen in a very complicated ratio. In order to find out the degree of impulfion of the wind on the fails, multiply their furface by the fquare of the excefs of the velocity of the wind on that of the fhip, or, which is the fame thing, by the fquare of the apparent velocity of the wind. Then a fecond multiplication of that product is to be made by the fquare of the fine of the angle of abfolute incidence, or, in the fecond cafe, by the fquare of the fine of apparent incidence. And this fecond product will give the degree of the abfolute impulfe of the wind on the fails, in the actual ftate which we have fuppofed.

In order to find in what ratio the furface of the fails is to be augmented to make the fhip acquire a certain degree of velocity above that which fhe poffeffed under a fuppofed particular quantity of fail, it muft firft be known by how much the velocity of the wind exceeds

ceeds that of the ſhip; then, knowing how many degrees her head-way is wiſhed to be accelerated, the ſails muſt be increaſed in the ratio of the ſquares of the two velocities of the ſhip; viz. that which was known before the alteration of the ſails, and that which ſhe is afterwards to acquire. But, as the ſhip recedes ſo much the more from the action of the impulſe of the wind as her velocity increaſes, it is evident the ſurface of the ſails muſt be increaſed alſo in the ratio of the ſquare of the two exceſſes, that is, the different exceſs of the wind over that of the ſhip both before and after the increaſe of the ſails; then the ſhip will acquire the wiſhed-for velocity; provided no other cauſe happens to oppoſe it, as we have already hinted before, and as we ſhall have an opportunity to ſhew more particularly hereafter.

Suppoſe the wind has 12 degrees of velocity, and the ſhip, under a certain ſet of ſails, has 3; the velocity of the wind, in the direct courſe, will exceed that of the ſhip only by 9 degrees. If the velocity of the ſhip is intended to equal the third part of that of the wind, and to have therefore 4 degrees for head-way; then the ſails are to this effect to be increaſed in the ratio of the ſquares of the two velocities 9 to 16, becauſe the reſiſtance of the water on the bows will increaſe in that very proportion. But, in the firſt caſe, the velocity of the wind exceeded that of the ſhip by 9 degrees, while, in the ſecond caſe, it exceeds it no more than 8. Hence it reſults, that the impulſe of the wind on the ſails has diminiſhed in the ratio of the two ſquares 81 to 64; and, in order to repair that loſs in the impulſion of the wind, the expanſion of the ſails is alſo to be increaſed in that laſt ratio of 64 to 81; then the ſhip will be able to run with the degree of velocity deſired.

II. When the maſting is perfect, that is to ſay, when the ſhip is maſted according to the *point velique*, ſhe will riſe from the water parallel to herſelf by a certain quantity relative to her velocity, and ſhe will riſe always more and more in proportion as ſhe acquires new degrees of velocity in her head-way. Becauſe ſhe is moved by forces which ſtand exactly and continually in equilibrium with the action of the water on her bows, the inclination of which forward contributes ſo much the more to that riſing out of the water as it is more remote from the perpendicu-

lar.

lar. For, then, the vertical impulſion will have more power, ſince it acts more directly on a very oblique bow than it would on a vertical one. This reaſoning may be as exactly applied to the direct impulſion, the abſolute effort of which may be decompoſed, ſince it acts leſs againſt the velocity of the ſailing on an oblique bow than on a vertical one, while the other part of its action joins with the vertical impulſe to raiſe the head of the ſhip, which ſhocks the water with very great ſtrength when ſhe is arrived to a very great velocity, and which water oppoſes her ſo much the more as it is ſhocked with violence. So it is eaſy to conclude that, in any ſhip whatever, the more rapid the head-way is, the more parallel to herſelf ſhe riſes above the water, if the centre of effort of her ſails is at the ſame height as the *point velique:* for, the point of the bows, on which may be conſidered as united the action of the water which oppoſes its progreſs, may be taken alſo as the point of bearing. So that all the ſails acting from abaft to forward on different points of the axis of the ſhip, (ſhe being conſidered as a lever in the direction of her length,) they raiſe the after-part of that point, and place it on a level with the elevation of the bows; which never can happen, if the centre of effort of the ſails is above or below the *point velique.* If it is placed above, the power of the ſails, acting on too long levers, will raiſe the after-part of the point of bearing of the bows above the level of the elevation of the ſhip's head. If it is placed below, the power of the ſails, acting on too ſhort levers, the after-part of the ſhip will remain plunged in the water, without being able to riſe on a level with the bows. Therefore, in either of theſe two caſes, when the centre of effort of the ſails is either above or below the *point velique*, the ſhip, however well-built, will loſe ſome of the qualities of ſailing, either in her readineſs to obey the helm, or in her ſteadineſs to carry ſail, eſpecially if ſhe is over-maſted: for, in this laſt caſe, ſhe will gripe, incline eaſily, and loſe much of her head-way, ſince her bows will plunge in the fluid, or, rather, her ſtern will riſe too much out of it; which will diminiſh the action of the water on the rudder and increaſe it on the bows. In the laſt caſe, (an inconvenience of which ſhip-builders ſeldom, if ever, have been guilty,) the ſhip will be ſlow to obey,

obey, and her head-way will be ſlackened, becauſe ſhe will never preſent her moſt advantageous water-lines to the fluid, nor have a ſufficient ſurface of ſails, as, although their width is the ſame, their height is not ſo. The point of perfection then is this, viz. when the centre of effort of the ſails is placed at the height of the *point velique*.

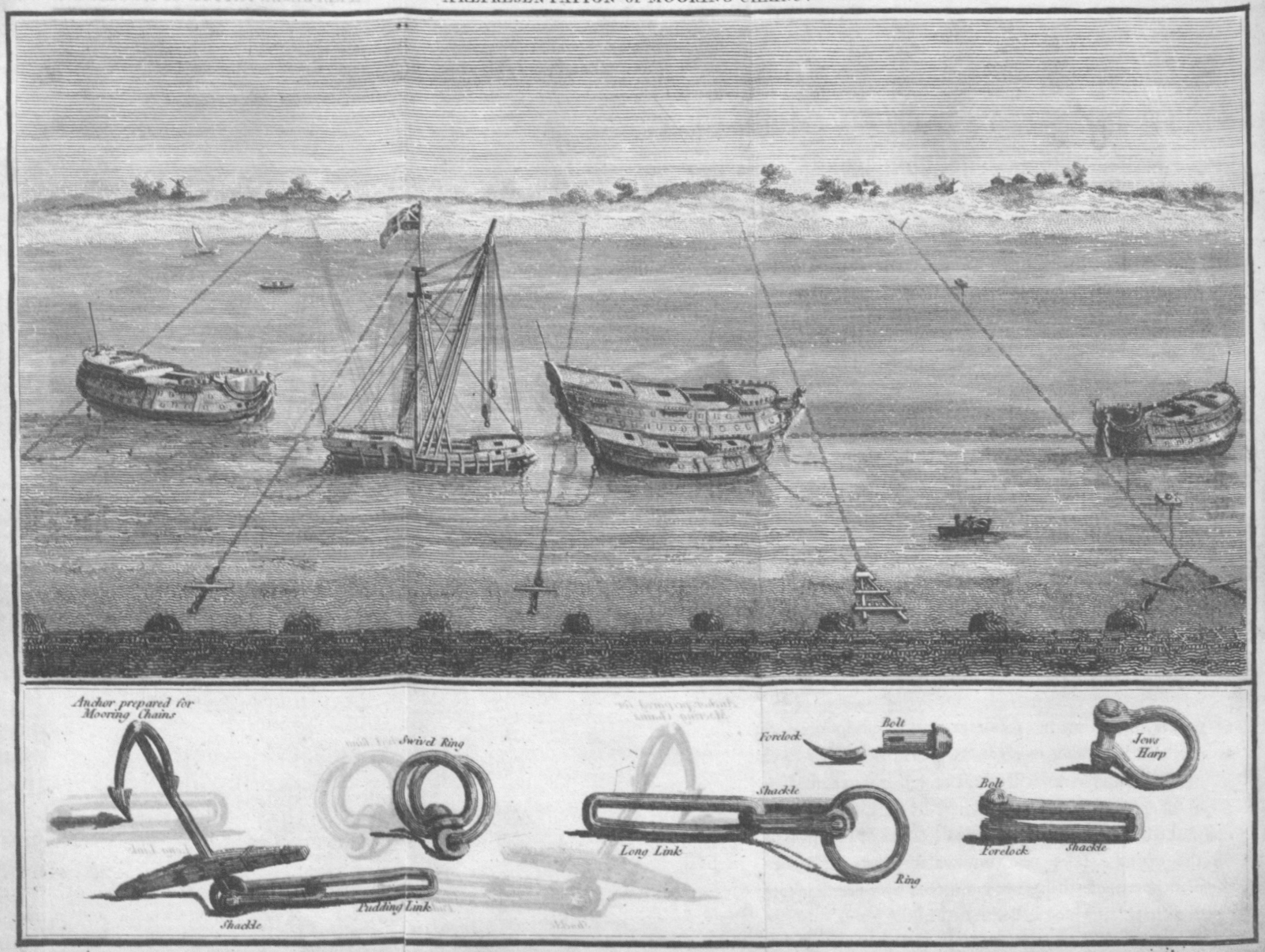
III. The next propoſition will appear a paradox to many ſeamen. But, it is no leſs ſelf-evident.

There are many caſes in which the adding of a few ſails, inſtead of increaſing a ſhip's velocity, retards it. It is however an error into which all ſeamen almoſt continually fall, when, in a ſtrong gale, they want either to diſtance or approach a ſhip. When their own ſhip is arrived to a very great velocity, (ſometimes of twelve and more knots an hours,) if they have to do with an adverſary the rapidity of which is nearly equal to that of their own ſhip, they fancy that, by adding more ſails to thoſe they have already, at the time when their ſhip is perhaps beſt diſpoſed and arrived at its utmoſt degree of ſwiftneſs, they ſhall increaſe the rapidity of her head-way; and, accordingly, they hoiſt up ſome additional ſtay or ſtudding ſails, eſpecially if the wind happens to be on the beam or a little more aft. But, by this their expectations are baulked; for the ſhip becomes more inclining, her head plunges, and the reſiſtance of her bows increaſing in the direction of the keel more than the effort of the ſails in the direction of the courſe, the rapidity decreaſes in ſo much as the water acts more powerfully than the ſail does. Beſides all this, thoſe forward and lateral inclinations of the ſhip, produced by the effort of the new-added ſail, which have cauſed the centre of effort of the ſails to aſcend and the *point velique* to deſcend, (if the new-added ſail has been ſet above it,) cauſe alſo the ſhip not to riſe from the water parallel to herſelf; ſhe riſes her ſtern and plunges her head; whence it reſults that ſhe gripes from two cauſes: firſt, becauſe, as her ſtern lies leſs in the water, the rudder is of courſe expoſed to a leſs ſhock; and the ſtern, which always acts as a ſail, is more eaſily maſtered by the wind which ſtrikes it then on the beam with a great deal more efficacy than it does her head: on the other hand, as the reſiſtance of the water on the lee-bow has increaſed

increaſed by the inclining of the head, plunging thereby that part of the ſhip which is the moſt full in its ſhape, and increaſing alſo the ſurface on which the water acts, which has both diminiſhed the head-way and increaſed at the ſame time the lateral impulſe on the ſide of the bow; ſo that lateral impulſion forces the ſhip to windward more at the head, than ſhe is impelled to fall off by the lateral part of the effort of the new-added ſail. Whence it follows that the ſhip becomes ſtill more griping, which is an additional cauſe of the decreaſe of her head-way; becauſe, the helm being more a-weather, in order to hold the ſhip better to her courſe, more of the rudder itſelf is preſented to the run of the water; and, by the great ſurface it offers more directly to its ſhock, retards the velocity of the ſhip. Whence we are to conclude that as ſoon as any more ſails are added to a ſhip which carries already a ſufficient quantity of them, ſhe will loſe her qualities of ſteering well and making good head-way, whether thoſe additional ſails are ſet forward or a-ſtern.

Blank page retained for pagination

A REPRESENTATION OF MOORING-CHAINS.



Published as the Act directs, for D. Steel Sep.6th 1794.

THE PRACTICE OF WORKING SHIPS.

THE uſeful part of a ſeaman's duty is the application of his theoretic knowledge to the various evolutions of a ſhip. We are now about to ſhew how thoſe various evolutions ſhould be performed, conſiſtently with the principles upon which the ſcience of navigation is founded.

A ſhip, when launched from the ſtocks, is furniſhed with one ſtream-anchor, and another which is termed a launching-anchor, ſomewhat heavier than the ſtream-anchor, hanging by ſtoppers to the catheads: by one or both of theſe ſhe is firſt brought up, and afterwards warped to what are termed

HEAD AND STERN MOORINGS;

of which the following is an accurate deſcription. Acroſs the bottom of the harbour or river, two chains (parallel to each other, if the bed of the river will admit of it) are extended at the diſtance of 200 feet from each other, by means of anchors, having one fluke only, which is ſunk, and ſecured in the ground by piles, on the oppoſite ſides near low-water mark. To the rings of thoſe anchors theſe chains are connected by a peculiar ſort of link, called a ſhackle, which is delineated in the plate.

Each of theſe chains has, at about one-third of its length, a large iron ring, to which is faſtened a chain, called an up-and-down ſpan; which, lying on the ground, connects the parallel chains, and ſerves to keep them ſteadily in their places. At about 30 or 40 feet diſtance from each other, along each chain, chain-pendents (from 5 to 9 in number) are faſtened, having, at the end which connects with the ground-work, a ſhackle; and, at the other end, a link called a jew's harp, through which the bridle or hawſer of the ſhip, when moored, is paſſed. The centre chain-pendent is fixed to the ring of the chain; and the number of the chains muſt depend upon the number of tiers required, each tier occupying two chains, becauſe the ſhips are moored head and ſtern. But every tier does not always occupy two whole chains; becauſe, unleſs a paſſage between the tiers is requiſite, the chain, to which the head chain-pendent of one tier is affixed, has likewiſe faſtened to it the ſtern chain-pendent of the next tier. A reference to the plate will elucidate this.

Theſe moorings are calculated for and uſed in rivers or harbours of ſmall extent; but in other places, where either many ſhips do not frequent, or the extent of which is conſiderable, there is another ſort in uſe, called

SWINGING MOORINGS.

Theſe differ from the former only in this; the ground-work being the ſame, to the ring of the chain is fixed one chain-pendent, the end of which is paſſed through a large buoy; and to that is connected a ſwivel ring by a ſhackle; and thus kept conſtantly from ſinking to the ground. This is uſed for mooring one or two ſhips to. Near each end of the chain is fixed one more chain-pendent, ſupported likewiſe by a buoy, which is uſed only for the purpoſe of warping ſhips from the middle to any intended place.

OF MOORING TO HEAD AND STERN MOORINGS.

To theſe moorings ſhips are thus faſtened: Clench the end of a bridle to the jew's harp of the chain-pendent, and paſs it into the hawſe-

hawſe-hole; then heave it up and bit it. Take the after-bridles into the gun-room port, or in upon the quarters; and take a round turn round the beam of the after-hatch, and croſs it with a throat and round ſeizing; or, if more convenient, round the jeer bits.

OF MOORING TO SWINGING MOORINGS.

Paſs out the ends of the bridle; one on each ſide, through the hawſe-hole next the ſtem; then paſs them through the ſwivel-ring of the chain-pendent; then return them into the ſhip through the after hawſe-holes, and bit them.

In this ſituation a ſhip is fitted for ſea, by regularly ſtowing her ballaſt, and getting on board her rigging, ſtores, &c.

We ſhall therefore proceed to diſcuſs the theory and practice of ballaſting, and ſhall afterwards treat of the manner of getting on board and ſtowing the anchors and cables, before we enter upon the method of navigating a veſſel in various ſituations.

OF THE BALLAST AND LADING.

WHEN a ſhip is loading, it ſhould be conſidered, that her tendency to pitch or roll depends not alone on her form, but even more upon the more or leſs advantageous diſtribution of the heavieſt parts of her cargo.

Particular attention is to be paid to moderate her pitching, as that is what moſt fatigues a ſhip and her maſts; and it is moſtly in one of theſe motions that maſts are ſeen to break, particularly when the head riſes after having pitched. Although the rolling be proportionably a more conſiderable movement than pitching, it is ſeldom any accident is ſeen to ariſe from it, as it is always a ſlow one. It is however not leſs proper to prevent it as much as poſſible. This will in general be eaſily obtained, without being any way

way detrimental to the ſhip's ſtiff carrying of ſail, if, when the ballaſt is iron, you ſtow it up to the floor-heads; becauſe it will recall the ſhip with leſs violence after her having inclined, and it will act on a point but little diſtant from the centre of gravity. To make this clearer, let us conſider it by the aſſiſtance of a figure.

Firſt, let it be underſtood, that the CENTRE OF GRAVITY of a body is that point by which it may be ſuſpended, and the parts remain in perfect equilibrium.

That the CENTRE OF CAVITY is the centre of that part of the ſhip's body which is immerſed in the water; and which is alſo the centre of the vertical force that the water exerts to ſupport the veſſel.

That the CENTRE OF MOTION is the point upon which a veſſel oſcillates or rolls when put in motion.

That the METACENTRE is that point, above which the centre of gravity muſt by no means be placed; becauſe, if it were, the veſſel would overſet.

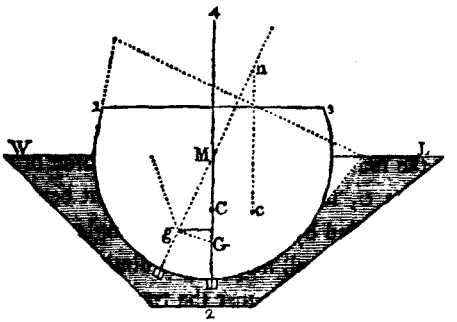
Various methods have been recommended to find all theſe different points; ſome of them are in their nature fixed, others varying. Thus, when a ſhip is completely loaded, the centre of gravity is fixed, howſoever the veſſel may alter her poſition.

The centre of motion is always in a line with the water's edge, when the centre of gravity is even with or below the ſurface of the water; but, whenever the centre of gravity is above the water's ſurface, the centre of gravity is then the centre of motion. This muſt be underſtood of bodies not perfectly circular; for, if circular, the centre of motion will be the centre of the circle.

The centre of cavity varies with every inclination of the ſhip, becauſe that depends upon the ſhape of the body immerſed.

The metacentre (which has been likewiſe called the SHIFTING CENTRE) depends upon the ſituation of the centre of cavity; for it is that point, where a vertical line, drawn from the centre of cavity, cuts a line paſſing through the centre of gravity and being perpendicular to the keel.

Let



Let the ſegment of a circle 1 2 3 repreſent the tranſverſe ſection of a veſſel's bottom; W L, the ſurface of the water; M, the metacentre, as well as the centre of motion, becauſe this is a circle; C, the centre of cavity; G, the centre of gravity; and the line 2 4, the vertical axis of the veſſel which may be turned round the point M, as on a fulcrum ſupported by the centre of cavity. By thus ſimply conſidering the veſſel as a lever in the direction of her vertical axis playing round her centre of motion, it is plain, that, if the centre of gravity was placed above the point M, being the metacentre too, the veſſel would upſet; therefore, that the ſhip may have ſtability, the centre of gravity muſt be below this point. And it may be obſerved, that, the farther G is removed from the metacentre, the greater muſt be its force, as the gravity then acts with a greater length of lever, conſidering the fulcrum of that lever to be at the centre of motion; or, if the weight at G be augmented, it will likewiſe increaſe the force; therefore the force of G may be expreſſed by multiplying the balance of weight, beneath the centre of motion, by the diſtance of the centre of gravity from the centre of motion.

The centres of cavity and motion (in circular bodies) will ever be in a line perpendicular to the horizon, but the centre of gravity may be either on one ſide or the other of this line. When ſuch a body is at reſt, the centre of gravity will be in this line; but, if in motion, it will be diverted from it. Thus the points M and C will always be perpendicular to W L; but the point G, by the body's rolling, may be on either ſide; for inſtance, at g. While G

is

is perpendicularly beneath the centre of motion, its action can only tend to *preſerve* this circular body in her erect poſition; but, if it is removed to either ſide, as to g, its action is to *return* it to the erect poſition; and this action increaſes as the diſtance G g, which is the ſine of the angle of roll g M G, the diſtance M G being conſidered as the radius. Thus, to gain the force of gravity with any roll, as g M G, let the balance of weight beneath the centre of motion be multiplied by the ſine of the angle of roll G g.

But the tendency to roll may be alſo diminiſhed by the ſhape of the hull. For, let us ſuppoſe that the tranſverſe ſection be allowed more beam and increaſed by the dotted lines. Now, when this veſſel is rolled over, it is plain that the cavity will be augmented towards the ſide L, of courſe its centre muſt remove towards L, ſay to *c*; and, if from *c* be erected a perpendicular to the horizon, it will cut the vertical axis at n, which will, in this caſe, be the metacentre, above which, if the centre of gravity were placed, it would act in conjunction with the centre of cavity to overſet the veſſel: but, as the centre of gravity is here below it at g, her ſtability will be increaſed by the increaſed diſtance of G from n, the metacentre; and the veſſel will roll round the point M as her centre of motion.

When ſailing in ſmooth water, the greater the ſtability the better; but, if a veſſel with a heavy cargo, ſtowed low in her bottom, be ſent out into a rough tempeſtuous ſea, where every wave will throw her from her equilibrium, ſhe will return with ſuch violence as to endanger her maſts; and, ſhould ſhe be diſmaſted, her roll will then be with ſtill greater force, poſſibly to the deſtruction of her hull. Was the cargo in this labourſome veſſel to be removed higher up towards the centre of motion, ſo as to leſſen her ſtability, ſhe would be found conſiderably eaſier; her roll would be by ſuch deliberate motions, as to leſſen the danger to her maſts and hull.

The ballaſt is placed round and very near the centre of gravity of the ſhip, becauſe it will prevent the motion of the pitching being ſo hard as it would, if that weight were diſtant either afore or abaft that point. Whenever the ſea runs a little high, the ſhip is never carried by a ſingle wave; there are generally two or three always

always paſſing under at the ſame time, unleſs when the ſea is extremely long, the ſwells coming from a great diſtance, and in latitudes very remote from land: for, then, it happens that the largeſt ſhips are ſometimes carried by one ſingle wave. But, in either circumſtance, the ballaſt ought not to be ſtretched afore or abaft the centre of gravity, as ſoon as the ſhip is in the parallel to her draught of water marked for the ballaſt, which it is abſolutely eſſential to pay attention to. To prove this principle, ſuppoſe in either caſe a long or ſhort ſurge, and that the water ſtrikes the ſhip forward, that thereby ſhe may be expoſed to the greateſt and hardeſt pitching: for, when the wave takes a ſhip under the ſtern, her motions, if ſhe has got a little head-way, are not dangerous; becauſe, as ſhe flies before the wave, ſhe recedes in ſome meaſure from its impulſe; while, in the firſt caſe, ſhe increaſes on the contrary that ſame impulſe in the ratio of the ſquare of all her velocity.

First, the ſhip, whoſe extremities are light or little loaded, being ſuppoſed to run with any velocity whatever againſt the wave which comes to her a-head, ſhocks that wave with a force expreſſed by the ſquare of the ſum of the two velocities: ſhe divides it and goes through it, at the ſame inſtant that ſhe is raiſed by the vertical impulſe of that column of water, which oppoſes to her a ſupporting power too conſiderable for her weight to diſplace: the wave which follows produces the ſame effect in receiving the fall of the ſhip, becauſe the firſt is already under the middle of the ſhip, whence it paſſes to the ſtern, which is ſupported by it, while the ſecond takes its place in the middle, and the third is come to ſupport the head; and this is an uninterrupted ſucceſſion. This motion continuing thus as long as the ſea is agitated, it follows that the ſhip is never at reſt: no ſooner has ſhe been raiſed by a wave, but ſhe falls again when that wave is gone, which falling is proportionably leſs ſharp as her head is leſs heavy: the ſhake is then leſs violent, ſince ſhe ſhocks the water with a leſs maſs, which prevents her pitching ſo deep as ſhe would if ſhe were more heavy; conſequently the maſting does not ſuffer, and the head-way is leſs delayed, as the fulleſt part of the bows is not ſo much expoſed to the ſhock of the water.

SECONDLY, When the ſhip is carried by one ſingle wave, her fall is ſtill leſs ſharp, if little loaded a-head, than when ſhe is carried only by the middle. She riſes, therefore, more eaſily at the moment the other wave comes to ſtrike her, and the ſhake is not ſo violent. Were ſhe to plunge deeper into the fluid, it might happen that the column of water would become higher than her head, and, paſſing partly over it, would expoſe her to the danger of foundering.

In the ſtowing of the cargo, it is proper to place the heavieſt part of the ſtowage as low as poſſible, taking care to preſerve that draught of the ſhip which is moſt advantageous for her, whether ſhe be in ballaſt or when laden. Thoſe points are marked both at the head and ſtern: in a word, the great art of ſtowing lies, in endeavouring that each of the vertical parts, in which the extremities of a ſhip may be ſuppoſed to be equally divided, be lighter, when her lading is complete, than the weight of the maſs of water they are to diſplace; obſerving always, that the vertical parts of the middle admit of being loaded more heavily than the weight of water they are able to diſplace.

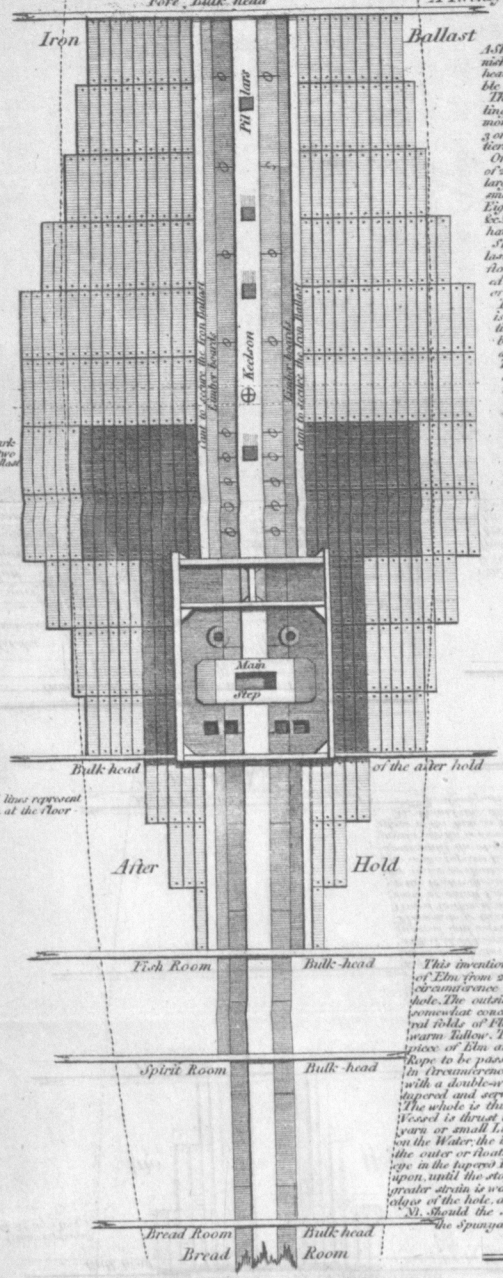
THE PRACTICE OF STOWING BALLAST, &c.

In the royal navy, the iron ballaſt is firſt ſtowed fore and aft, from bulkhead to bulkhead in the main hold, next to fir cants nailed on the limber-ſtrakes on each ſide the kelſon, five or more inches clear of the limber-boards; and is winged up 3 or more pigs above the floor-heads in the midſhips, or bearing part of the ſhip, and there are two tiers of pigs in the wake of the main hatchway and well-wings. Ships, built with a very clean run aft, ſeldom have any iron ballaſt ſtowed abaft the pump-well or after-hold. Ships, that have floor and futtock riders, have the iron ballaſt ſtowed, either lengthways or athwart-ſhips, agreeably to the length of the chambers, which are the clear ſpaces between the riders.

The

PRACTICE of STOWING a SHIP'S BALLAST &c. and of STOPPING GUN-SHOT LEAKS.

A Twenty Gun Ships Iron Ballast and Ground Tier.



A Ships tendency to pitch or roll may be greatly diminished by a judicious distribution of her stowage; the heaviest part of it should therefore be as near as possible to the centre of gravity.

The Iron ballast is first stowed, upon the foot waltings in the main hold, next to the cants nailed at 5 or more inches from the timber boards. It is winged up 3 or more pigs above the floor heads in midships. Two tiers of pigs are in the wake of the main hatch, upon the well wings.

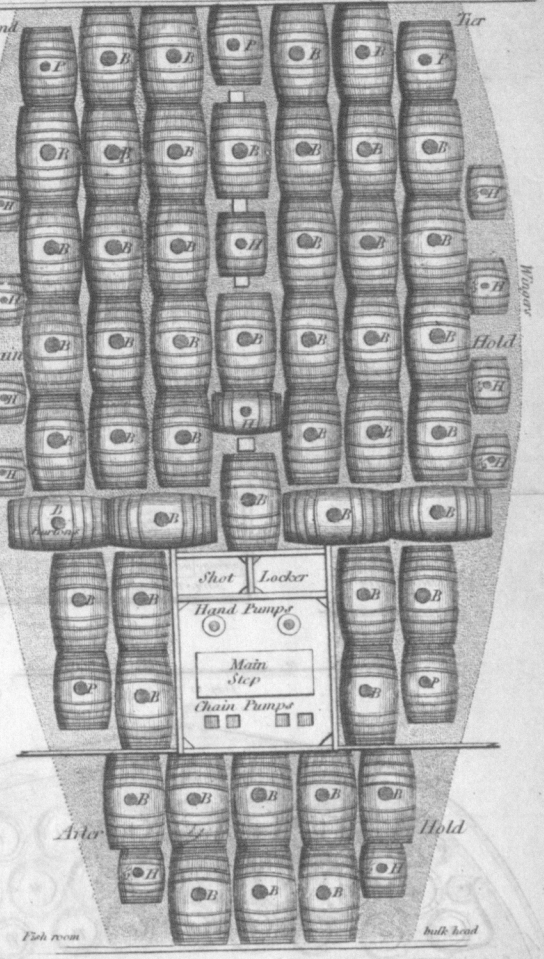
Of Iron ballast there are two sorts; one of 7, the other of 12 pigs to the ton. Sloops &c use the latter only. The large pigs are 3 feet long and 6 by 3 inches square; the small are one foot 6 inches long & 3 by 4 Inches square; Eight or more pigs are reserved for ballasting boats &c. & are placed conveniently for use, down the main hatch way after the hold is stowed.

Ships having a clear run aft, seldom have Iron ballast abaft the pump well. Large Ships, that have slow and sullock sailers, have the Iron ballast stowed lengthwise or athwartships, according to the length of the chambers.

The quantity of shingle ballast is discretionary. It is spread and levelled over the Iron. The ground tier of water is then stowed; the Casks have their bungs upwards; are wedged free from each other, and are sunk ¼ of their diameter into the shingle. They are stowed either chine and chine or bilge and chine; beginning at the foremast or coal room bulkhead; the breakage, if any is made at the well bulkhead; the midship tiers, fore & aft, are first laid down; and the sides are filled with wingers of small Casks, as half Hogsheads &c. which must not be raised above the level of the tier, or they will cause a breakage in the tier above, which is stowed in the cant line of the ground tier. The stowage is thus continued for as many tiers as will lie sufficiently clear of the beams; a proper quantity of shingle being laid between every tier.

Abreast the well over the ground tier are stowed wet provisions; above the ground tier in the after hold are stowed dry provisions; and between the Casks are wood & shingle ballast. The fish room will commonly take one longer of pipes; in it are stowed some of the spirits and Wines sometimes. Casks in the spirit room are the Wine and spirits for the Ships use.

* In Merchant Ships the various Casks packages &c must be wedged off from the bottom sides pump well &c.

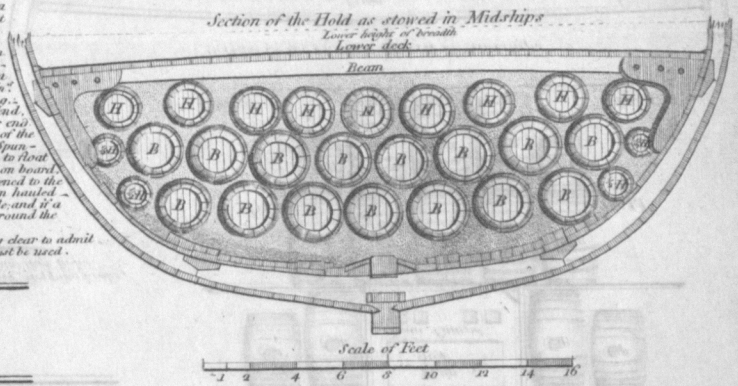


Mr. Hill's invention for Stopping Leaks, occasioned by Gun-shot holes.

This invention consists of a circular piece of Elm from 2 to 4 Inches thick and of a circumference sufficient to cover the shot hole. The outside convex and the inside somewhat concaved; to be lined with several folds of Flannel or Kersey dipped in warm Tallow. Through the Centre of this piece of Elm and Flannel is a hole for a Rope to be passed through, from 2 to 4 In.s in circumference and about Six Feet long, with a double-wall-knot on the outside end tapered and served to an eye at the other end. The whole is thus used. From the inside of the Vessel is thrust through the Shot Hole, Spunyarn or small Line, of a sufficient length to float on the Water; the inner end being retained on board; the outer or floating one is taken up, & fastened to the eye in the tapered Rope; the Spunyarn is then hauled upon, until the stopper covers the Shot hole; and if a greater strain is wanted to press the flannel round the edges of the hole, a Tackle must be used.

N.B. Should the Shot hole not be sufficiently clear to admit the Spunyarn through it, an auger must be used.

Section of the Hold as stowed in Midships.



Dimensions &c of Casks used in Victualling									
Casks	Length	Diam.r of the Bunge	Diam.r of the Chine	Contains gallons of Beer	Pieces of Beef 4 lb.s each	Pieces of Pork 2 lb.s each	Flour	Pease	Oatmeal
	F. I	F. I	F. I	N.o	N.o	N.o	lb.s	Gall.s	Gall.s
Leager	4.6	3.0	2.5	150					
Butt	4.4	2.8½	2.2	108					
Puncheon	3.5	2.6½	2.1	72	170	310	672	76	
Hogshead	3.0	2.3	1.11	54	124	220	448	64	84
Barrels	2.7	2.0	1.11	36	86	154	336	48	72
Half Hogs.d	2.4	1.11	1.7	28	64	120	224	32	48
Pipes	4.1	2.11	2.4	for Wine					
Breakers	2.0	1.1	0.10						
	large	deep							
Vatts	5.1	3.0							
for Sails	4.7	2.0							

Gang Casks is a name given to small Casks, as Barrels &c

Victualling Measures.

One leager and a half is one Ton and 9 Gallons
Two Butts are one Ton
Three Puncheons are one Ton
Four Hogsheads are one Ton
Six Barrels are one Ton
Eight half Hogsheads are one Ton
216 Gallons are one Ton of Beer

Ballast allowed to the following Ships							
Guns	Tonnage	Iron Tons	Shingle Tons	Guns	Tonnage	Iron Tons	Shingle Tons
110	2290	180	370	36	870	65	160
100	2090	180	370	32	700	65	140
98	2110	160	350	28	600	60	100
90	1870	160	350	24	500	50	80
80	1620	140	300	22	450	50	70
74	1700	80	270	20	400	50	60
64	1370	70	260	Sloop	300	30	40
50	1100	65	170	Brig	160	20	15
44	900	65	160	Cutter		20	Seldom
38	830	70	170	Sloop		15	any

Contractions Explained.

B. Butt.
b. Barrel.
b.s Breakers.
H. Hogshead.
½ H. Half Hogshead.
P. Puncheon.

Published for the Elements & Practice of Rigging and Seamanship; and Published as the Act directs, June 10 1794, by David Steel London.

The ſhingle ballaſt is next ſpread and levelled over the iron ballaſt, on which is ſtowed the ground tier of water; bung up and bilge free from the ſides, either chine and chine, or bouge and chine, beginning at the coal-room bulkhead, that being the foremoſt, and making the breakage, if any, at the main hatch: the midſhip tiers, fore and aft, are the firſt laid down, and the caſks are ſunk about one quarter of their diameter into the ſhingle; the ſides are filled-in with wingers of ſmall caſks, as half-hogſheads, gang-caſks, or breakers; obſerving not to raiſe the wingers above the level of the tier, to cauſe a breakage in the next tier above, which is ſtowed in the cuntline of the ground tier: bung up and bilge free; and ſo on, for as many tier as can be ſtowed ſufficiently clear of the beams.

In the after-hold, between the aft-ſide of the pump-well and fiſh-room bulkhead are ſtowed the proviſions above the ground tier; between the caſks, billet, or other wood, and ſhingle ballaſt.

In the fiſh-room are ſtowed ſome of the ſpirits, or wine, and ſometimes coals; and, in the ſpirit-room, are ſtowed the wine and ſpirits for the ſhip's uſe.

In the merchant-ſervice, the ſtowage conſiſts, beſides the ballaſt, of caſks, caſes, bales, boxes, &c. which are all carefully wedged off from the bottom, ſides, pump-well, &c. and great attention paid that the moſt weighty materials are ſtowed neareſt to the centre of gravity, or bearing of the ſhip; and higher or lower in the hold agreeably to the form of the veſſel. A full low-built veſſel requires them to be ſtowed high up, that the centre of gravity may be raiſed, to keep her from rolling away her maſts, and from being too ſtiff and labourſome; as, on the contrary, a narrow high-built veſſel requires the moſt weighty materials to be ſtowed low down, neareſt the kelſon, that the centre of gravity may be kept low, to enable her to carry ſail, and to prevent her overſetting.

By the 19th Geo. II. it is enacted, that if, after June 1, 1746, any maſter or owner, or any perſon acting as maſter of any ſhip or other veſſel whatſoever, ſhall caſt, throw out, or unlade, or if there ſhall be thrown out, &c. of any veſſel, being within any

haven, port, road, channel, or navigable river, within England, any ballaſt, rubbiſh, gravel, earth, ſtone, wreck, or filth, but only upon the land, where the tide or water never flows or runs; any one or more juſtices for the county or place where or near which the offence ſhall be committed, upon the information thereof, ſhall ſummon, or iſſue his warrant for bringing, the maſter or owner of the veſſel, or other perſon acting as ſuch, before him, and, upon appearance or default, ſhall proceed to examine the matter of fact, and upon proof made thereof, either by confeſſion of the party, or on view of the juſtice, or upon oath of one or more creditable witneſſes, he ſhall convict the ſaid maſter, &c. and fine him at his diſcretion for every ſuch offence any ſum not exceeding 5l. nor under 50s. &c. and, for want of ſufficient diſtreſs, the juſtice is to commit the maſter, or perſon acting as ſuch, and convicted as aforeſaid, to the common goal or houſe of correction, for the ſpace of two months, or until payment of the penalties.

Beſides the above general act relating to ballaſt, there are the 6 Geo. II. c. 29. and the 32 Geo. II. which regulate the ballaſting of merchant-veſſels in the river Thames, placing it under the direction of the corporation of the Trinity-houſe.

MANNER OF GETTING ON BOARD AND STOWING THE ANCHORS AND CABLES.

ANCHORS, though they bear different names on board of ſhips in the royal navy, as ſheet, beſt bower, ſmall bower, and ſpare, are of the ſame weight. The ſtream and kedge anchors are ſmaller, and grapnels are for boats.

Ships of 110, 100, 98, and 90, guns, have 7 anchors; from 80 to 20 guns incluſive, 6 anchors; ſhips of 300 tons and ſloops have 5; and brigs and cutters 3 anchors.

In

In fitting out ſhips, the anchors are brought in craft near the bows, being moſt convenient to the hawſe-holes, through which the cables paſs to be clenched.

The BOWER-ANCHORS are firſt catted; which is performed by hooking the hook of the cat-block into the ring of the anchor, and bowſing upon the fall that leads in through a ſnatch-block on the forecaſtle; the cat-falls being previouſly reeved through the ſheaves of the cat-head and cat-block, keeping the hook of the cat-block downwards and its point inwards. They are then fiſhed, by means of the half-davit, pendent, and tackle, thus: The davit is firſt ſtepped in the channel on the ſide wanted, and ſupported by guys: the maſthead-guy goes over the end of the davit, with an eye. The other end faſtens round the fore-maſthead, with a round turn and two half-hitches. The foremoſt guy goes over the end of the davit, the other end faſtens round the cat-head, with two half-hitches, and is ſecurely ſtopt. The after-guy goes over the end of the davit, and makes faſt with two half-hitches, through an eye-bolt in the after-part of the fore channel. At the outer end of the davit is hung, by its ſtrap, a large ſingle block; through which is reeved the pendent, with a large iron hook ſpliced in the lower end, to hook the anchor within the flukes; then, to the inner end of the pendent, is made faſt a tackle, by thruſting a toggle through an eye in the block-ſtrap: after that has paſſed through an eye in the pendent, the other block of the tackle is hooked in an eye-bolt in the fore part of the quarter-deck; the effort of the tackle is communicated to the hook, by means of the pendent, by men's bowſing on the tackle-fall. Thus the flukes of the anchor are raiſed and placed on the gunwale, where it is made faſt by the ſhank-painter chain. That the flukes may lie level, the ſhock is bowſed upon by the anchor-ſtock tackle, the double block of which is hooked to a ſelvagee, faſtened round the ſtock of the anchor under the firſt hoop, and connected by its fall to a ſingle block, hooked to a ſelvagee faſtened round the laniard of the main ſtay: the fall leads in upon the fore-caſtle.

The BEST BOWER is then placed forward near the bows on the ſtarboard ſide, the SMALL BOWER near the bows on the larboard ſide,

ſide, a little abaft their reſpective cat-heads, and are ſecured by their ſtoppers, from the cat-heads and ſhank-painters. The ſtopper has one end clinched round the cat-head; the other end paſſes through the ring of the anchor, returns upwards, and leads over a large thumb-cleat bolted to the cat-head, and is made faſt with ſeveral turns, and the end hitched round the head-rail and timber-head, on the fore ſide of the cat-head. The ſhank-painter hangs the ſhank and fluke of the anchor to the ſhip's ſide outboard; and, when ſtowed, the ſhank-painter is paſſed under the inner fluke round the ſhank of the anchor, and made faſt with two or three turns, and the end ſtopped round timber-heads on the forecaſtle. With theſe two bower-anchors ſhips are generally moored when lying in a tide's way or in a fleet.

The SHEET and SPARE ANCHORS are hoiſted by runners and tackles, main ſtay and yard tackles, and are ſtowed ſecurely with ſtock and bill laſhings at the after-part of the fore ſhrouds, before the cheſs-trees on each ſide of the ſhip, with one of their arms reſting on a chock, bolted to the gunwale; the ſtock being bowſed-to by the anchor-ſtock tackle. The ſheet-anchor is ſtowed on the larboard-ſide, and is the firſt reſource in a gale of wind, after parting with either of the bowers; for which reaſon, when in port, the ſheet-cable is kept bent, and the anchor is over the ſide, ſuſpended by the ſtopper and ſhank-painter, ready for cutting away in caſe of neceſſity. The ſpare anchor is ſtowed on the ſtarboard-ſide, and is ſeldom uſed, but when one of the others is loſt.

The STREAM-ANCHOR is ſtowed on the ſpare anchor; and, when uſed, it is ſent in the long-boat or launch, with its cable bent, and let go at any particular ſpot, either for ſteadying the ſhip, when riding by only one bower, or to aſſiſt a ſhip when in ſhore, or to warp her, &c.

The KEDGE is ſtowed on the ſtream and ſpare anchors, and is frequently uſed to ſtop a ſhip for a tide in little winds; but, if the wind is too powerful for the kedge, the ſtream-anchor is ſubſtituted. The kedge is ſometimes uſed, in moderate weather, to warp the ſhip ſo as to ſhift her birth.

The

The CABLES alſo are brought in craft alongſide; and, ſhould they be new from the rope-walk, let them be coiled down in the craft, the ſame way they are to be coiled on board.

It is recommended to merchant-ſhips, eſpecially of the ſmaller ſize, that their cables ſhould be coiled the way they bit, or the way they run round the windlaſs; and their tiers ſhould be on the ſide oppoſite to that on which they lead. But this practice cannot be approved of for the royal navy, nor is it indeed there adopted; becauſe, when heaving in upon one cable, and veering out upon another, the cables, by being croſſed, are apt to foul in the hatchway. The beſt bower, which is moſtly the working cable, ſhould lead foremoſt up the hatchway on the ſtarboard-ſide; then the ſmall bower on the larboard-ſide; and, afore the latter, the ſheet; which, being the leaſt uſed, can be triced cloſe round the fore-part of the hatchway, out of the way.

A cable generally grinds or kinks from more turns being forced into it by the coiling than it had when firſt made; and the only way to get rid of thoſe grinds or kinks is to coil the cable acroſs the hatchway, from ſide to ſide, in large flakes, with the ſun; then take the upper end through the coil, and coil the cable down in the tier the way required. By this means, as many turns will be taken out of the cable as there are flakes coiled round the hatchway.

It ſhould be a rule in coiling cables, never to lay out near the hatchway, but to keep that part of the tier as low as poſſible, that the bends may have ſufficient room to upſet.

Were all ſtore-cables firſt coiled down from the rope-walk againſt the ſun, they would be better adapted to coil on either ſide of the ſhip; for a cable coiled againſt the ſun will more eaſily reverſe, and have leſs grinds or kinks in it than a cable coiled with the ſun.

Anchors (except when at ſea) ſhould always have a cable clinched to the ring ready for letting go, and a buoy-rope with a buoy.

To CLINCH A CABLE; run it through the hawſe-hole and the ring of the anchor three or four fathoms in length; then haul the bight up in the head, and paſs the end of the cable over the

the bight, and through the ring, between it and its own part: then pafs the cable-bends, and crofs them with ftrands, well greafed, one at the end, and the other about one foot from the end; and be careful not to form the clinch larger than the ring of the anchor.

From the MOORINGS a fhip, when fitted, removes, in order to take in her guns and proceed to fea; but, before fhe finally fets fail, fhe generally comes to anchor, and is moored once with her own anchors and cables, which will be treated of hereafter. At prefent it is fufficient to give the following caution at

GETTING UNDERWAY FROM RIVER-MOORINGS.

If it be in a tideway and with a leading wind, fo that the fhip can ftem the tide; let it be a rule, when the tide ferves, to get underway, and fail againft the flood; which gives time to clear a fhip of her moorings, and affords a more powerful effect to the helm, to fteer the veffel clear of other fhips and any particular danger.

PREPARATIONS NECESSARY TO BE MADE FOR ANCHORING.

On approaching an anchorage, the anchor and buoy are got clear, and a range of cable ftretched along the deck fuitable to the depth of water. Care fhould be taken, that nothing is in the way to check the cable, or ftop its running out: then, at a proper diftance, a turn is taken round the bits with the cable, thus: Firft pafs the cable from the anchor underneath the crofs-piece, then take up a bight of the cable abaft the bits, and throw it over the bit-head. The end of the cable is clinched round the orlop-beams in the royal navy, and round the main-maft in the merchant-fervice.

It

It is neceſſary to have water near the bits to prevent its firing by the friction. Stoppers and ring-ropes of all kinds ſhould be ready for uſe.

The ſtock-laſhing being caſt off, and nothing but the anchor-ſtopper and ſhank-painter retaining the anchor, men are ſtationed to ſtand by them, and let go at the moment ordered.

To ſecure the cable when out, DECK-STOPPERS are thus previouſly prepared: They are turned into the ring-bolts on the deck round a large iron thimble, and faſtened with a throat and end ſeizing. Each ſtopper has a laniard ſpliced round the head, under the knot, by which ſeveral turns are taken round the cable, and the end ſtopt.

BESIDES the deck-ſtoppers, others are uſed as an additional ſecurity to the cable; ſuch are the BIT-STOPPERS, &c.

BIT-STOPPERS. Each ſtopper is reeved through a hole in the ſtandard knee, againſt the fore-part of the riding-bits, and is turned-in or ſpliced. It has a laniard ſpliced round the head, under the knot. When uſed, ſeveral turns are taken with the laniard round the cable, and the end ſtopt. It is to check the cable in bringing up the ſhip. Another bit-ſtopper much approved of is about four fathoms long, and tailed out like a nipper at one end, and knotted at the other. Let this ſtopper be rove through the hole in ſtandard knee. To paſs it, let it be held aft, inſide, over the cable, and under the bits, outſide the cable; then worm it round the cable before the bits. Then, as the cable runs out and it is required to check the ſhip, haul tight the worming; and, by the cables drawing forward, it will tighten the ſtopper, and bend the cable ſo cloſe to the bits as effectually to bring the ſhip up. This ſtopper is not likely to jamb, therefore is extremely well calculated for bringing a ſhip up with eaſe; as, by ſlacking, and hauling tight the worming, the cable may be ſuffered to run out, or be checked at pleaſure.

In heaving up in a heavy ſea, when, by a ſudden pitch of the ſhip, the meſſenger or nippers give way, this kind of ſtopper will be found extremely ſerviceable; for, upon theſe occaſions, this ſtopper may be always paſſed ready, and the bight triced up abaft the bits with a rope-yarn clear of the cable.

Another bit-ſtopper, made with a large eye, that it may be thrown over the bit-head, and ſhifted over from ſide to ſide, is alſo much approved of.

DOG-STOPPERS. One end is clenched round the main-maſt, and the other end wormed in the cuntlines of the cable, and ſtopt in ſeveral places; then brought back with ſeveral turns over its own part, and the end ſtopt. It is of little ſervice, unleſs it be long enough to clap on above the coamings.

WING-STOPPERS. One end is clenched round the orlop-beams in the wings, and the other end is clapt on as the dog-ſtopper.

RING-ROPES are occaſionally made faſt to the ring-bolts in the deck and to the cable, by paſſing the ends through the ring of the bolt, and through the bright, then clapt on the cable with croſs turns, and the ends ſtopt. Ring-ropes may be better ſingle than double; they are paſſed with leſs confuſion of turns. To paſs a ſingle ring-rope, and have it in readineſs to check upon veering away the cable, take alſo three ſlack turns through the ring-bolt and round the cable, one before the other, and hold up the parts fair; then take as many ſlack turns of worming round the cable, before the ring, and they held up fair, leaving ſufficient room for the cable to paſs through. When the cable is to be checked, haul tight the worming; and, by the cable's running out, it will readily draw the turns tight through the ring, and bind the cable ſo cloſe to the ring, as to prove an excellent ſtopper. Ring-ropes are ſimilar to the laniards of ſtoppers, to check the cable when freſhening the hawſe, or to add ſecurity to the ſtoppers in a heavy ſea.

LENGTHENING OF CABLES. Cables are lengthened by ſplicing one to the end of the other, thus: The cloſeſt and beſt method is to put the ends in twice each way; then, to pick out the ſtrands, and worm part of them round the cable, and taper away the reſt; which ſhould be cloſely marled down, and a good throat and end ſeizing clapt on of ſix-thread ratline.

The ſtrands of the beſt bower and ſtream cable had better be pointed, that theſe cables may be more quickly ſpliced and unſpliced in caſes of neceſſity.

To

TO PREVENT CABLES FROM CHAFING by friction in the hawſe, and againſt the ſtem or cutwater, they are rounded or ſerved thus: They ſhould be ſerved againſt the lay. The moſt expeditious way of clapping on rounding is with a top, where room to work it will admit; otherwiſe it muſt be beaten on with mallets; and care taken to ſtop the ſervice with ſpun-yarn at every ſix or eight turns.

Mooring-ſervices are clapped on about fifteen fathoms from the end or cable ſplice. Large veſſels ſhould have twelve or fourteen fathoms of ſervice, half of it rounded and the reſt plaited and keckled. Upon the beſt bower or working cable, there ſhould be a ſhort ſervice of eight or ten fathoms at the half-cable.

Mats of the width of the cable's circumference, and about three fathoms long, are very convenient to have ready to lace on the cable with expedition, in caſes of neceſſity, in the way of the hawſe or cutwater.

The beſt ſervice to prevent a cable's chafing is cut from a tanned horſe-hide, big enough to wrap two or three times round the cable. The method of putting it on is, firſt to parcel the cable with two or three turns of old canvas, the length of the leather ſervice; which, if too ſtiff to put on, only requires dipping in water and beating, which makes it ſoft and pliable: then paſs it tight and ſmooth round the canvas, and ſtop it on with ſennit or three-yarn knittles, well greaſing them, and the ſervice, before veering it into the hawſe-hole. Avoid raiſing the ſurface of the leather by knittles, &c. underneath the canvas.

OF COMING TO ANCHOR.

A ſhip ought always, unleſs under ſome particular circumſtances, to be brought to anchor under an eaſy ſail, ſuch as the three topſails, jib, or fore-topmaſt-ſtayſail, and ſometimes the mizen, according as the veſſel has more or leſs inclination to fall off or come to the wind.

There are, no doubt, cases when more sail may be required; but they are exceptions to and do not destroy the general principle. Nor should an anchor ever be dropt to leeward of the place you mean to bring up in; because that would often occasion a necessity of casting two anchors at once, for fear of dropping still more to leeward.

When the wind is so violent as to bring the anchor home, and make the vessel drive, the cable is veered away; and, in veering away, the turns of the stopper-laniards are slackened, and a portion of the cable suffered to go out of the hawse, to let the vessel farther a-stern of her anchor; in which situation she bears less strain on the flukes, and is less liable to drag the anchor; for, the more cable is out, the flukes become deeper buried, and the ship rides in greater safety.

In letting go an anchor, great care should be taken that the water be not so shoal as to endanger the ship hurting herself upon it, and that the anchor be not fouled by the cable getting about the fluke or stock.

Nor should the water be too deep, because the cable, when out, should approach as near as possible to a horizontal direction. Indeed, this principle is so true, that three cables spliced together, an-end of each other, are kept bent to the best bower-anchor, to be used in cases of necessity; and it is found, that one good anchor, with a long range of cable, is a safer anchorage than two anchors with short cables. However, when the ship has not room to drive, and if the night be dark, let fall a second anchor under foot, with a range of cable above the deck. At all events, the deep-sea lead should be thrown over the gunwale, and the line frequently handled, to be certain that the ship does not drive.

In hard and rocky bottoms, where anchors cannot have much hold, cables are chafed and cut to pieces. When necessitated to anchor in such places, a chain should be run up the cable from the ring of the anchor to a certain distance, to secure it from danger. When a chain is not to be had, (although the top chains may serve,) empty casks well bunged are good substitutes, slung and fastened to the cable at equal distances, to support and keep it from the bottom.

When

When ground is ſoft and oozy, and anchors will not hold ſecurely, but come home with little wind, it is common to cover the flukes with a broad triangular piece of plank much larger than the fluke. Sometimes the anchor is backed, or retained, by carrying out the ſtream, or kedge, a-head of the anchor the ſhip uſually rides by. In this ſituation, the bower-anchor is confined by the ſtream, or kedge, in the ſame manner as the ſhip is reſtrained by the bower-anchor.

In preparing to come to anchor, when the wind is not violent, the topſails ought always to be clued up at the maſt-heads; that is, let go the ſheets and haul the clue-lines and bunt-lines cloſe up; lower away the topſails and take in the ſlack of the braces as the yards come down. In this manner you run leſs danger of ſplitting and tearing the ſails than by any other method.

In all operations hereafter treated of, it ſhould be obſerved, that whether the wind is moderate or blows freſh, it makes this only difference, viz. The velocity of the ſhip's movements, in the latter caſe, being conſiderably increaſed, the ſails will require an earlier diminution to ſtop the head-way; and that of courſe leſs time in general is taken up in performing every operation.

TO ANCHOR IN FINE WEATHER IN A PLACE WHERE YOU WILL RIDE HEAD TO WIND, BEING CLOSE-HAULED.

Being under the three topſails, fore-topmaſt ſtay-ſail, and mizen, ſtand on until you are within about two ſhips' lengths of the place where you mean to drop your anchor; then put the helm a-lee, and haul down the fore-topmaſt ſtay-ſail. As ſoon as the topſails ſhiver, clue them up briſkly, before you lower; except the mizen topſail, which is to be laid to the maſt, and the mizen ſheet hauled flat aft, the inſtant the ſhip begins to have ſtern-way, by reaſon of the wind being a-head. Then ſhift the helm to windward, and let

let go the anchor, veering away the cable, to give it time to ſettle in the ground, until the veſſel falls off, when ſhe is to be checked, to bring her head to the wind. When that is done, right the helm, and haul up the mizen.

DEMONSTRATION.

The ſhip is hove up in the wind by hauling down the fore-topmaſt ſtay-ſail (§. 31) when nearly two ſhips lengths from the ſpot where the anchor is to be dropped, becauſe the head-way is ſufficient to ſhoot her that diſtance; and as, by this movement, the ſhip is generally found to ſtop a little to windward of the place where you mean to bring up, you wait till ſhe begins to go a-ſtern a little before you let go the anchor, and the helm is at the ſame time ſhifted hard over the other way (§. 58) to moderate the ſhip's falling off when ſhe is head to the wind. The topſails are clued up as ſoon as they begin to ſhiver, not only becauſe it can at that time be done eaſily, ſince they come in of themſelves as they lower; but becauſe, if delayed longer, the ſtern-way would become too rapid, ſince the ſails would be all a-back, and would ſoon drive the ſhip to leeward of her intended anchorage. Beſides, the celerity of her falling off would be ſuch, as to cauſe her to drag the anchor before it had got a proper hold of the ground; and that is the reaſon why the cable is veered away in order to give the anchor time to ſink into the bottom by its weight. The mizen topſail is braced perpendicular to the keel; becauſe, in that ſituation, the ſhip is impelled (§. 36) a-ſtern exactly in the direction of her keel. The mizen ſheet is hauled flat aft, to bring the ſhip's head ſooner to the wind; (§. 40;) and, as ſoon as ſhe arrives at that point, that ſail ſhivers; in which caſe it is immediately brailed up, as being no longer of uſe. The helm is righted, having no longer any power; ſince the veſſel is now brought up, and all the ſails are furled, except the mizen topſail, which is flat a-back to the maſt, to keep the ſhip ſteady at her anchor.

TO

TO ANCHOR IN FINE WEATHER IN A PLACE WHERE YOU WILL RIDE HEAD TO WIND, THE WIND BEING LARGE.

If you have the wind large, whether on the beam or more aft, the operation is ſtill the ſame, only hauling up a little ſooner to keep to windward, becauſe it is in your power to drift as much as you think requiſite, and becauſe the ſhip will be entirely ſtopped as ſoon as all her ſails begin to catch a-back, and you will have done cluing them up when they begin to ſhake. The mizen top-ſail is next to be heaved to the maſt, the helm put a-weather, (§. 58,) and the anchor let go, as ſoon as the head-way ceaſes: then, after giving her a ſufficiency of cable, bring the ſhip up. If ſhe has been going large, ſhe will not range preciſely head to wind, ſince her headway ceaſes as ſoon as the ſails are taken a-back, and the effort of the wind acts on all the rigging of the ſhip to impel her both a-ſtern and to leeward, which is indeed augmenting the effect of the rudder, as the helm is a-weather to bring the veſſel to the wind: (§. 58:) but, as the power of the wind is very great to pay the ſhip's head off, it balances wholly or partly (according as the ſhip goes a-ſtern with more or leſs velocity) the effort of the rudder and that of the mizen: thus ſhe drifts, and remains as it were lying-to with all her ſails a-back. This is the reaſon why we keep a little to windward, and let go the anchor, to bring the ſhip head to wind at the proper time; which ſhe will do the more readily as ſhe is withheld forward only by the cable, while the wind on her ſide forces her to leeward.

TO ANCHOR IN FINE WEATHER IN A PLACE WHERE YOU ARE TO RIDE HEAD TO THE STREAM AND WIND, THE WIND BEING LARGE.

If you are obliged to ride with the head to the ſtream, you muſt, when it comes from to windward, put the helm a-lee in ſetting the mizen, then clue up the ſails; and, when the ſhip's head is right in the direction of the ſtream, let go the anchor, provided ſhe has quite loſt her head-way; for, elſe, you would get foul of the anchor-ſtock by runing over it. This muſt never be neglected, unleſs you find yourſelf under the neceſſity to bring up in any ſituation in which you may happen to be, which is almoſt always the caſe when you are taken too ſhort to have time to ſtop the veſſel; a reaſon why there is often a neceſſity of caſting a ſecond anchor, which generally catches the ground by aſſiſtance of the firſt, which has begun to diminiſh the velocity of the ſhip; and as many of the ſails are to be hauled down as you can, and as quick as poſſible.

TO ANCHOR IN FINE WEATHER IN A PLACE WHERE YOU WILL RIDE HEAD TO THE STREAM, WHICH COMES FROM LEEWARD, THE WIND BEING LARGE.

When the current comes from to leeward, you muſt keep the ſhip away till her head comes to the ſet of the ſtream, and take in all the ſails, to diminiſh as ſpeedily as poſſible her head-way, which always continues of itſelf long enough when the wind is aft or very large; and when the ſhip is ſtopped by the effort of the water, let go the anchor, without waiting for the veſſel gathering ſtern-

ſtern-way, if the current is rapid; and, in this caſe, as well as all thoſe wherein there is a ſea, or blowing freſh, the ſhip requires a great length of cable.

TO COME TO AN ANCHOR WITH THE WIND AFT.

Firſt, hand the main topſail, and then lower the fore topſail down on the cap; and, when you are within a reaſonable diſtance of the place where you mean to drop anchor, (which diſtance is to be judged of from the readineſs of the ſhip to obey the helm, and from her velocity,) the tiller may be put either one way or the other, (§. 50,) the fore-topſail and fore-topmaſt ſtayſail clued up and taken in, the mizen-topſail braced ſharp up, and the mizen-ſheet hauled flat aft. When the ſhip ranges cloſe to the wind, ſhe is, as it were, lying-to under the mizen and mizen-topſails, with the laſt-mentioned ſail full or a-back, according as you may have occaſion to ſhoot a-head or drop a-ſtern; ſo that, if you are too much to windward of the ſpot where you mean to bring to, you drift till you arrive at it: if you are preciſely in the proper birth, you let go the anchor in lowering down the mizen-topſail, which is to be furled as ſoon as the veſſel is brought up; then the ſhip will come head to wind by the power of the mizen, which muſt be brailed up as ſoon as it ſhakes.

DEMONSTRATION.

The main-topſail is taken in, and the fore-topſail lowered down, to diminiſh the great velocity which a ſhip commonly has when the wind is aft, in order to eſtimate the diſtance with greater preciſion, and to have her movements more under command. When you think yourſelf at the neceſſary diſtance the ſhip requires to ſtop cloſe-hauled, at the place you wiſh to anchor, you put the helm on board one way or the other (§. 50); you brace ſharp the

mizen-topsail for the tack you haul upon, (§. 41,) and haul the mizen out to bring the ship rapidly to the wind. (§. 40.)

In the same moment, the fore-topsail is to be clued up and handed, and the fore-topmast staysail hauled down, because they oppose the movement of the ship (§. 31, 32, and 33) as she is coming to. When you are close to the wind, the anchor is let go, if you are in the birth you wish: if still too far to windward, you can drift, keeping the mizen-topsail full; and, when you are to windward, should you find yourself too far a-head, lay the mizen-topsail a-back, to go a-stern, (§. 44,) putting at the same time the helm a-weather. (§. 58.) When the vessel has drifted sufficiently, let go the anchor, and furl the mizen-topsail; because the cable might be injured, should it blow fresh: then the ship will soon range head to wind, though the mizen be still out; (§. 40;) and, when that is attained, the mizen is brailed up to prevent the ship sheering; and the helm is righted for the same reason.

In some cases you are obliged to come to an anchor with the wind aft, standing end-on, because there is not always a space necessary to deaden the ship's way. In this situation the sails are to be taken in as soon as possible, in order to lessen the velocity of the ship. When come to your birth, let go the anchor, and veer away the cable plentifully, that the anchor may have time to take the ground; then begin to check her gently, veering still more cable as the ring-ropes or stoppers, placed on it before-hand, break away; for they should be permitted to break, in order that you may not be exposed to drag your anchor, by bringing the vessel up at once.

SCUDDING UNDER A FORESAIL, TO COME TO AN ANCHOR.

The *foresail* must be clued up when at some distance from your birth; and, some part of the way, run under bare poles. When near enough to sheer to the wind, you execute it by putting the helm hard a-lee; and, as soon as the ship is come-to, let go the anchor, giving her a large scope of cable, and observing to check her handsomely, in order to make her ride head to wind: as stopping her at first too short might very well endanger her cable or anchor. Should the first not bring her up, a second may be let go.

DEMONSTRATION.

As you cannot run for an anchorage under a foresail, unless before the wind, or very free, you are necessarily obliged to furl that sail at a great distance; because, in that position, the velocity of the ship will, by the violence of the wind, be but too much kept up, so as to make you run the rest of the way, which may perhaps be a quarter or half a league, under bare poles, the wind being nearly aft. If you were obliged to run at that distance close-hauled, you would never reach your birth, should the foresail even be set; because the ship would be laid-to, as was shewn before. You put your helm over to sheer to windward when you think you are at the necessary distance, that you may have time to deaden the ship's head-way: and as, when she stops coming to, her head-way ceases, you let go the anchor, and veer away a great extent of cable; because, when it blows hard, there is commonly a great swell, and the pitching motion it gives to the ship, joined to the effort of the wind on the rigging, would bring home the anchor. You are therefore obliged to veer away a great length of cable, to give the anchor time to settle, and to cause the cable to make a very acute angle with the ground, by which the strain is much reduced.

TO ANCHOR WITH A SPRING, IN ORDER TO PRESENT THE VESSEL'S SIDE TO A PLACE OR SHIP YOU WISH TO CANNONADE.

This is executed when you know that the wind or current will bring your head, when at anchor, towards the object you mean to attack: for, ſhould the wind or tide bring your broad-ſide to bear on the object you mean to cannonade, the ſpring would only be a precaution, to get under way more quickly in caſe you were obliged to retreat, or in caſe the wind or tide ſhould ſhift.

Get a large ſnatch-block in the aftermoſt port, on the ſame ſide you wiſh to preſent to the wind or current, and on the ſame ſide with the anchor and cable with which you mean to bring up; then, through the block, reeve a hawſer, the end of which is to be clinched to the ring of the anchor you mean to let go; the other part is brought to the capſtern, with neceſſary ranges of the cable and hawſer on deck. That done, and the ſhip being arrived at the birth, you are to deaden her way according to circumſtances: you let go the anchor, and veer away enough cable and hawſer, now a little more of the one, and then a little more of the other, according as you wiſh to preſent more head or ſtern; which you can do by heaving on the ſpring, or, what is the ſame, veering away more cable. Should you find it requiſite to ſhift your poſition, you have only to veer out more of the hawſer.

TO COME TO AN ANCHOR IN ROADS THAT ARE OFTEN CROWDED WITH SHIPS, AND TO LEAVE CLEAR BIRTHS FOR OTHERS.

The beſt anchoring-births in theſe places are moſtly known by marks, and of courſe are occupied by the firſt ſhips.

In

In a tide or trade-wind road-ſtead, the next ſhip that comes ſhould not anchor right a-head or a-ſtern of the firſt ſhip and ſo as to lie in the other's hawſe, but ſhould come-to on the bow and quarter at a ſufficient diſtance to prevent other ſhips from coming between, and in a ſlanting direction from the tide or wind. This might contribute to the ſafety of ſhips when it blows ſtrong upon a lee-tide or in ſtrong ſea-breezes, as each ſingle ſhip may then veer away what cable neceſſary, and keep clear of the other ſhip's hawſe a-ſtern; or, in caſe of driving or caſting, they have a better chance of keeping clear of each other.

A good anchoring-birth in a crowded road-ſtead is obtained by firſt running down through the middle of the fleet, and taking notice where a good birth is left vacant by ſome ſhip that has ſailed from the middle of the fleet; then ſteer out from among the ſhips, and turn to windward ſo far, as to give time to take in and furl all the ſails, and run down before the wind amongſt the ſhips without any ſail, and let go the anchor at the intended birth.

TO COME TO AN ANCHOR WITH THE WIND ACROSS THE TIDE.

The ſhip ſhould, if poſſible, be put upon the tack that ſtems againſt the tide when the anchor is let go; and, if it be deſigned to continue at a ſingle anchor, in order to keep it clear, ſheer the ſhip and keep her to leeward of the anchor, by keeping the helm a-weather and the fore-topmaſt ſtayſail ſet, with the ſheet to windward.

Much benefit may reſult from letting go the anchor ſtemming againſt the tide, eſpecially with a rapid tide; for it gives an opportunity to obſerve at what rate the ſhip drives a-ſtern, ſo as to judge whether it may not be neceſſary to keep ſail ſet, in order to bring the ſhip up to ride eaſy in a rapid tide, and keep her clear of ſhoals, &c. a-ſtern.

TO

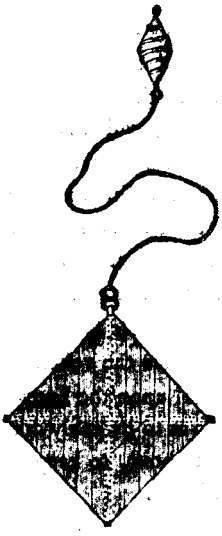
TO COME TO AN ANCHOR WHEN THE WIND IS RIGHT AGAINST THE TIDE, THE SHIP DRIVING WITH THE STRENGTH OF THE TIDE AGAINST THE WIND.

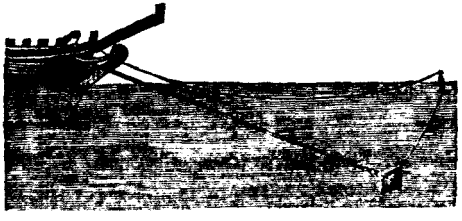
Shoot the ſhip a-head of her anchor, or ſheer her clear of it, upon the ſame tack as ſhe is meant to ſhoot upon the next tide, always endeavouring to keep the ſhip, in ſwinging with the tide, on one ſide of the anchor, to clear it. Suppoſe that the ſhip, driving to windward, has got to an anchoring-birth, or that the tide is ſo far ſpent that ſhe will drive no farther to windward, and muſt come to an anchor on the ſtarboard-tack. In letting go the anchor, the ſhip ſhould be ſhot a-head of it, and kept a-head with the helm a-weather, the yards braced full with the larboard-braces, the fore-topmaſt ſtay-ſail and mizen ſet full, till the windward tide is done; then ſhe falls to leeward and rides windroad, with the wind and anchor right a-head; in which poſition ſhe will lie clear of the anchor till the next windward tide.

TO COME TO AN ANCHOR WITHOUT TENDING.

If it happens that a ſhip is to be brought up in a place where there is not ſufficient room to tend her, reduce her head-way as much as poſſible before ſhe comes to her anchoring-birth, ſo that a leſs ſcope of cable will bring her up.

DESCRIPTION OF A FLOATING ANCHOR TO RIDE BY IN A GALE OF WIND.





This ſimple machine is made to dive beneath the ſwell of the ſea, and retain the veſſel where there may be no other anchorage.

It conſiſts of two flat bars of iron, each in length half the breadth of the midſhip-beam of the veſſel for which it is uſed, and rivetted

rivetted together in the middle by an iron ſaucer-headed bolt, clenched at its point, that they may be ſwung parallel to each other for eaſy ſtowage. At each end of the bars is a hole for a rope, or ſwifter, to paſs through, which muſt be hove tight, to extend the bars at right angles. To this ſwifter is marled a double or four-fold canvas cloth, made of N°. 1, of the ſame ſhape, ſo as to be on that ſide of the iron bars neareſt the veſſel when uſed.

In each bar are two holes, at equal diſtances from the centre; and to theſe holes the ends of two pieces of rope are faſtened: the ropes are ſeized together in the middle ſo as to form a crowfoot, having an eye in the centre, which is well ſerved with ſpunyarn, and to this is bent, when the anchor is uſed, a cable or hawſer, by which it is made to ſink and incline in the water.

In the end of one of the bars is fitted an iron ring, to which a buoy is made faſt, by a rope about 12 fathoms long, to prevent the anchor from ſinking to the bottom. When it is thrown overboard, the cable and a rope, made faſt to the head of the buoy, are veered away ſufficiently to ride the veſſel.

To get it on board, haul upon the buoy-rope, which will bring it to the water's ſurface ſo as to be eaſily drawn to the veſſel. Have the mizen-ſtayſail ready to hoiſt, to keep the veſſel to the wind till the anchor is hauled on board.

INSTRUCTIONS

INSTRUCTIONS FOR THE MANAGEMENT OF SHIPS AT SINGLE ANCHOR.

OF SHEERING A SHIP.

If the ſide of a ſhip at anchor is preſented to the tide by any means, the water will act upon her two ways; one in the direction of her keel, the other in the direction of her beams; the laſt will cauſe her to ſheer out to one ſide of her anchor, which was a-head before. Suppoſe, for example, the power which preſents the ſhip's ſide to the tide to be a ſpring; from the anchor coming in aft on the ſtarboard-ſide upon heaving in the ſpring, the ſhip will ſheer over to port, bringing the anchor upon the ſtarboard-bow: the more the ſpring is hove in, the more the ſhip will go a-head, and over to port, until her ſide makes an angle with the tide of 45 degrees, as the fartheſt ſhe can go over from her anchor: for the ſpring hove in after this will cauſe the ſhip to return, and be in the ſtream of her anchor when ſhe is hove round a broadſide to the tide. Now, if the helm is put over to ſtarboard, it will act as the ſpring, by forcing the ſhip's ſtern to ſtarboard; and thus, by cauſing the water to act upon her ſtarboard-ſide, the ſhip will be forced over to port: on the contrary, had the helm been put to port, the larboard-ſide would be preſented to the action of the water, and the ſhip will go over to ſtarboard; but the power of the rudder being according to the ſtrength of the tide, its action leſſens upon the rudder, as the ſhip ſheers obliquely to the ſtream, and cannot produce ſo great an effect as the ſpring.

RIDING AT ANCHOR IN MODERATE WEATHER.

When riding in a tideway with a freſh wind, the cable ſhould have a ſhort or windward ſervice, of about 45 or 50 fathoms from the manger-board outwards, always ſheered to leeward, (not to windward, as thought by ſome,) not with the helm hard down conſtantly, but more or leſs ſo, according to the ſtrength or weakneſs of the tide. Many ſhips have ſheered their anchors home, driven on board other ſhips, or on ſands near which they rode, before the anchor was diſcovered to have moved from the place where let go.

TO BACK A SHIP.

When the wind is croſs, or nearly off ſhore, or in the oppoſite direction, ſhips will always back by the mizen-topſail, aſſiſted if neceſſary by the mizen-ſtayſail. If no mizen-topſail, the main-topſail is uſed.

In backing, always keep a tight cable to wind the ſhip, that the anchor may be drawn round. If the wind is not ſufficient for this purpoſe, the ſhip muſt be hove a-peek.

OF BRACING THE YARDS.

Riding with the wind afore the beam, brace the yards forward: if abaft the beam, brace them all a-back.

OF

OF RIDING WHEN IN DANGER OF BREAKING THE SHEER.

If the wind is so far aft that the ship will not back, she must be set a-head; but never attempt to back, if, when the tide ceases, the ship forges a-head, and brings the buoy on the lee-quarter. If the wind is far aft and blows fresh, the greatest attention is required; as ships, riding in this situation, often break their sheer and come again to windward of their anchors; to prevent which, the after-yards must be braced forward, and the fore-yards aft: thus she will be safe, so long as the buoy can be kept on the lee-quarter; or, suppose the helm to port, so long as the buoy is on the larboard-quarter. With the helm thus, and the wind right aft or nearly so, the starboard main and fore braces should be hauled aft if led aft, and forward if they lead forward.

HOW TO MANAGE A SHIP WHEN HER SHEER IS BROKEN.

If the ship tends to leeward, and the buoy comes on the weather-quarter, and she breaks her sheer, brace about the main-yard quickly; if she recovers and brings the buoy on the lee or larboard quarter, let the main-yard be again braced about; but, if she comes to her sheer the other way, by bringing the buoy on her starboard-quarter, change the helm and brace the fore-yard to

OF TENDING TO LEEWARD WHEN THE SHIP MUST BE SET A-HEAD.

When the ſhip begins to tend to leeward, and the buoy comes on the weather-quarter; firſt brace about the fore-yard; and, when the wind comes near the beam, ſet the fore-ſtayſail, and keep it ſtanding until it ſhivers; then brace all the yards ſharp forward, eſpecially if it is likely to blow hard.

It ſometimes happens that, when the fore-ſtayſail is ſet too ſoon, the ſhip's head will pay round off, and ſhe will break her ſhear: to prevent this, and to keep the wind broad upon the beam, it will often be neceſſary to ſet the mizen-ſtayſail alſo; which ſhould be hauled down as ſoon as the wind comes before the beam, otherwiſe the ſhip's head will be thrown in the wind too ſoon.

WHEN THE SHIP IS LIKELY TO GO TO WINDWARD WITH A LONG SERVICE OUT.

Riding leeward-tide with more cable than the windward-ſervice, and expecting the ſhip will go to windward of her anchor, begin, as ſoon as the tide eaſes, to ſhorten in the cable. This work is ſometimes hard, but very neceſſary; otherwiſe the anchor may be fouled by the great length of cable the ſhip has to draw round, or the cable would be damaged by the bows and cutwater.

When a ſhip rides windward-tide, the cable ſhould be *keckled* from the ſhort ſervice towards the anchor, as far as will prevent its touching the cutwater.

When the ſhip tends to windward, and muſt be ſet a-head, hoiſt the fore-ſtayſail as ſoon as it will ſtand; and, in moderate weather, the

the jib alſo; and, when the buoy comes on the lee-quarter, haul down the fore-ſtayſail, and jib, if ſet; brace-to the fore-yard, and put the helm a-lee; for, till then, the helm muſt be kept a-weather, and all the yards full.

TO MANAGE IN A STORM.

When the ſhip rides leeward-tide, and the wind increaſes, give her more cable, otherwiſe the anchor may ſtart by not doing ſo in time, and the ſhip will not eaſily be brought up again: this is the more neceſſary when riding in the hawſe of another ſhip. Previouſly to giving a long ſervice, it is uſual to take a weather-bit, or a turn of the cable round the windlaſs-end, that, in veering away, the ſhip may not overpower you. Greaſe the ſervice, to prevent its chafing in the hawſe.

If the gale increaſes, the topmaſts ſhould be timely ſtruck, but the fore-yard ſeldom, if ever, ſhould be lowered down, that, in caſe of parting, the foreſail may be always ready. At theſe times, let there be more people on deck than the uſual anchor-watch, that no accident may happen from inattention.

TO TEND A SHIP FOR A WEATHER-TIDE.

A ſhip riding at anchor upon a lee-tide, with the wind in the direction of the tide, requires, upon the tide's ſetting to windward, to tend clear of her anchor: for this purpoſe, when the weather-tide ſets, and brings the wind broad upon either bow, hoiſt the jib and fore-ſtayſail, and brace full the yards to ſhoot the ſhip a tight cable

cable from her anchor: then put the helm a-lee, and wait until the buoy comes upon the lee-ſide: this done, brace-to the head-yard, and keep the after-yards full to aſſiſt the helm. If the buoy bears nearly a-beam, the jib and fore-ſtayſail may be hauled down; but, if the wind is freſh, and ſhoots the ſhip nearly end-on with the cable, bringing the buoy upon the quarter, keep up the fore-ſtayſail; as, in this ſituation, the ſhip will be in danger of breaking her ſheer againſt the helm; and the fore-ſtayſail will be ready to catch her before ſhe can fall to windward of her anchor. As the weather-tide ſlacks, the ſhip will gradually fall wind-road; then haul down the fore-ſtayſail and right the helm: ſhould it blow freſh, let the yards be braced forward, and give the ſhip ſufficient cable.

TO TEND A SHIP WITH THE WIND A FEW POINTS ACROSS THE TIDE.

If a ſhip riding at anchor upon a lee-tide, with the wind two or three points upon the bow, is to be caſt for a weather-tide; when the tide is done, the ſhip will become wind-road, and of courſe muſt caſt with her head to the weather-ſhore. As the lee-tide makes and brings the wind on either ſide, put the helm a-lee, hoiſt the jib and fore-ſtayſail with the ſheets to windward, brace a-back the head-yards, and fill the after-yards. When the ſhip has ſheered tight to windward of her anchor, haul down the jib and fore-ſtayſail; and, as the wind is broad upon the quarter, ſhe will lie quiet the remainder of the tide. As the weather-tide ſlacks, the ſhip will ſhoot end-on with the cable, bringing the buoy upon the weather-quarter. When the wind is a-beam, if it is thought neceſſary, the jib and fore-ſtayſail ſhould be hoiſted to force the ſhip a tight cable from her anchor; and hauled down when they ſhiver. Should it blow freſh, give the ſhip ſufficient cable before the lee-tide makes, and point the yards to the wind.

TO

TO TEND A SHIP WITH THE WIND ACROSS THE TIDE.

The ſimpleſt way of tending a ſhip, is to keep each tide to leeward of her anchor. At each ſlack water the ſhip will become wind-road; and, as ſhe tends, and brings the wind on either ſide, put the helm a-weather, and hoiſt the fore-ſtayſail with the ſheet to windward, to force the ſhip a tight cable from her anchor. When the tide is ſet, and the ſhip upon a proper ſheer to leeward of her anchor, the fore-ſtayſail may be hauled down.

GENERAL OBSERVATIONS UPON SHIPS AT SINGLE ANCHOR.

If at any time the anchor-watch ſhould wind the ſhip, or permit her to break her ſheer, the anchor ſhould be hove in ſight immediately, or on the firſt opportunity.

When lying in a road-ſtead, the anchor ſhould be hove in ſight once a week, though there be no ſuſpicion of its being foul, for ſometimes the cable is damaged by ſweeping wrecks, or loſt anchors, or from rocks or ſtones. It is often needful to trip the anchor, to take a clearer birth, particularly when any ſhip brings up too near; but, if there is the leaſt ſuſpicion of the ſhip's having come near her anchor, it ſhould be ſighted the firſt opportunity.

A good road-ſtead is much better than a bad harbour, and more ſafe: therefore never leave a good road-ſtead for the latter, without real neceſſity, which can only be when you can ride no longer, and have no lee-road to fly to.

There are road-ſteads where an anchor will bury itſelf, ſo that the bight of the cable cannot foul it. In ſuch places, where there is room, it is better to lie at ſingle anchor than to moor.

If

If it is poſſible, always ſhoot a ſhip on the ſame ſide of her anchor each tide, to prevent danger from the anchor's not turning as the ſhip ſwings; for the anchor, by not turning in the ground, endangers fouling the cable round the upper fluke or ſtock, which will either trip the anchor or damage the cable: and it often happens, when an anchor is tripped out of ſtiff ground, that it will not take hold a ſecond time, without the upper fluke ſhould cant down; for the quantity of clay ſticking to the fluke prevents its ſetting into the ground again: ſo the anchor keeps tripping over the ſurface, and another anchor muſt be let go before the ſhip can be brought up. As a ſhip, by being ſheered, preſents one bow to the tide, if the wind is againſt the tide, it muſt blow upon the oppoſite quarter.

It is not always neceſſary to uſe the yards, in tending a ſhip, to ſhoot her a tight cable from her anchor. In general the jib, foreſtayſail, and main-topmaſt ſtayſail, will be ſufficient for the purpoſe. Should the wind ſhift at any time, it will be neceſſary to alter the ſheer of the ſhip accordingly.

ON

ON MOORING.

When a ſhip is come to anchor in a place where ſhe is intended to remain, prudence dictates that ſhe ſhould be well ſecured. For this purpoſe the putting down additional anchors is calculated, and has been denominated MOORING. The various ſituations of places, ſettings of tides, &c. occaſion the neceſſity of the following particular directions.

When the beſt bower is gone, and about two cable's length is run out, the ſmall bower is let go; and, when that has taken the ground, you heave in one cable's length upon the beſt bower, and veer away a cable's length of the ſmall bower; and thus the ſhip is kept at an equal diſtance between both, the one lying to the head, and the other to the ſtern.

In roads where there is much tide, and freſhes are expected, ſhips moor according to the ſet of the current, one anchor riding to the flood, and the beſt anchor and cable to the ebb.

In roads where there is little or no tide, ſhips moor according to the ſet of the moſt prevailing wind on the coaſt.

It may ſo happen, according to circumſtance and ſituation, that the veſſel muſt ride by a greater ſcope on one cable than the other, but ſtill the manner of letting go the anchors is the ſame.

Another method of mooring is, by carrying the laſt anchor out in a boat to the place appointed, and there letting it go. Steadying or mooring with a kedge is uſually done in this manner.

OF MOORING WITH TWO, THREE, OR MORE, ANCHORS A-HEAD.

This is done by letting go the number of anchors neceſſary, and veering away; this being no ordinary practice, but only adopted in caſes of danger and peculiarity of circumſtance; time, place, and ſituation, muſt be the only guide to ſuch an operation: as one inſtance, ſuppoſe a ſhip cannot clear the ſhore under her lee by ſailing, owing to a ſtrong wind and high ſea, the only reſource is to let go all the anchors to the beſt advantage. For this purpoſe, let the cables that are bent be got clear for running. Then furl all the ſquare-ſails as quick as poſſible, and ſhoot the ſhip along the ſhore under the ſtayſails. When the ſquare-ſails are furled, let go the weathermoſt-anchor, and veer away the cable quickly; then let go the next weathermoſt, and ſo on, till all the anchors are gone nearly in a line along the ſhore: thus, when the ſhip becomes wind-road, all the cables may be made to bear an equal ſtrain, and are ſeparated from each other.

TO BACK AN ANCHOR.

To back an anchor is to let go a ſmall anchor a-head of a large one, to which it is faſtened, to partake of the ſtrain, and to ſerve as a check upon it, ſhould it come home.

The backing-anchor is carried out in a long-boat, to the buoy of the one already down, whoſe buoy-rope is caſt off and bent to the cable or hawſer of the backing-anchor; that done, the boat is rowed farther a-head, till the buoy-rope and cable of the backing-anchor become tight, when it is let go, the buoy that was taken from the large one being previouſly bent to it.

In

In this ſituation, ſhould the large anchor come home, the ſcope of cable from it to the anchor a-head, participating of the ſtrain communicated to the innermoſt one, checks its progreſs, and enſures to the veſſel a greater ſecurity.

Where there is more room to drive without danger, and it blows ſo hard, that the ſea runs too high for boats to work, an anchor is backed by clenching, round that part of the cable next the hawſe-hole, the end of a cable bent to another anchor on board. This being done, the ſecond anchor is let go under foot; the ſhip is then ſuffered to drive, and the cable, by the driving of the ſhip, becomes tight from the ring of the anchor laſt down to its own anchor, which, by the driving alſo, is now become a cable's length a-head of the former anchor.

TO MOOR IN A TIDE'S WAY.

To bring a ſhip up at high water, with an intention to moor with the beſt bower to the ebb, let go the beſt bower, and bring her up with the cable ſtoppered, until the ebb makes ſtrong; then veer away two cables; and, if poſſible, aſſiſt her a-ſtern with the mizen-topſail. If, when two cables are out and the ſhip in the ſtream of her anchor, it is thought, when moored, ſhe will ride too near any other veſſel, ſheer her over from that veſſel, and let go the ſmall bower-anchor; then ſhip the capſtern-bars, bring-to the beſt bower, veer away the ſmall bower, and heave in the beſt bower to the whole cable-ſervice; then bit and ſtopper the cables, leaving ſufficient ſervice within board to freſhen the hawſe.

TO MOOR WITH AN OPEN HAWSE TO ANY PARTICULAR QUARTER.

Suppoſe, for example, the road-ſtead or river, intended to moor the ſhip in, to lie north and ſouth, (in which direction the anchors are to be laid,) and that her beſt bower is carried on the larboard-ſide, and it is meant, when moored, the ſhip ſhall ſwing with an open hawſe to the eaſtward. In this caſe the beſt bower muſt be the northern anchor; but, if the hawſe had been required to be open *when her head was ſwung* to the weſtward, the beſt bower muſt have been the ſouthern anchor.

HOW THE WEAKEST MOORINGS MAY BE BEST APPLIED TO HELP A SHIP TO RIDE OUT A STORM.

It may happen that the ſmall bower cable may be too much worn, or the ſmall moorings known to be too weak, to ride a ſhip out a ſtorm, when the anchor at the beſt cable is in danger, or expected to come home. In this caſe, to make the weak moorings ſerve for a backing to the beſt anchor and cable, contrive a traveller, of ſufficient ſized rope to go ſlack round the beſt cable, without the hawſe, and well ſecure it with rolling hitches ſeized to the weak moorings, that may be veered away, or let go, as occaſion may require; if ſhort of rope to make a proper traveller, a large ſtopper may be clapt on without the hawſe, till the end of the ſmall moorings is faſtened round the beſt bower cable, with a bowline-knot open enough to ſlide along the beſt cable, until it comes to the ring, which may prove ſuch a ſure backing, as to prevent its coming home.

OF

OF KEEPING A CLEAR HAWSE.

When a ſhip is moored, ſhe is often thought to be in ſuch a ſtate of ſecurity, that the keeping a clear hawſe is too often neglected.

If the hawſe is clear, the ſhip muſt ever ſwing with her ſtern to the ſide on which the headmoſt cable leads.

If, to keep a clear hawſe, the ſhip ſhould ſwing with her ſtern to windward, it will be impracticable to get her the right way by any ſail that can be ſet; for, as the tide ſlackens, ſhe will fall wind-road; and, when the tide ſets, it will take her upon the wrong ſide. However, if the wind continues, ſhe cannot foul her hawſe any more, as, at the next tide, the ſame wind will undo the croſs it cauſed. When the wind is either a-head or a-ſtern, by the aſſiſtance of the mizen-topſail or jib, the ſhip can moſtly be made to ſwing the right way. For example, ſuppoſe the wind a-head, or even a little upon the ſtarboard-bow, and that the ſhip's ſtern is to ſwing to ſtarboard: in this caſe, ſet the mizen-topſail, with the ſtarboard yard-arms braced forward, haul up the ſtarboard-bowline, and hoiſt the jib with the ſheet to windward; then, before the lee-tide is done, put the helm to ſtarboard, to give the ſhip a ſheer, which will be preſerved by the poſition of the ſails. At ſlack water ſhift the helm: thus, when the tide makes, it will act againſt the larboard-ſide of the rudder and ſtern, and very much aſſiſt to ſwing the ſhip the right way. Again, ſhould the wind be a-ſtern, and a little upon the wrong quarter, if the helm be attended to, and the mizen-topſail braced full the right way, in all probability the ſhip will ſwing as wanted.

If the helm were only properly attended, it would often ſave the labour of clearing the hawſe.

It would be highly neceſſary, at all times, to have a ſmall anchor and rope ready abaft, to run out and haul the ſhip round in calm weather.

EXPLANATION

EXPLANATION OF A FOUL HAWSE.

When a ſhip is moored, attention muſt be paid to her ſwinging at the turn of tide, or ſhift of wind, to prevent the cables overlaying each other, or getting a foul hawſe, which is prejudicial, as the cables chafe each other, and as the veſſel is not in that perfect ſtate of ſecurity enjoyed by riding with an open hawſe. The explanation of this turn will be better comprehended by a reference to the figures.

FIG. 1.

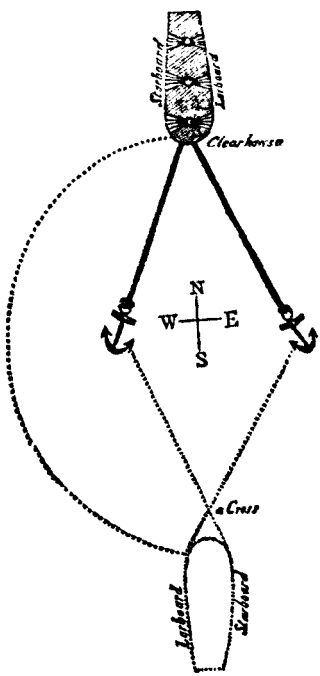


FIG. 2.

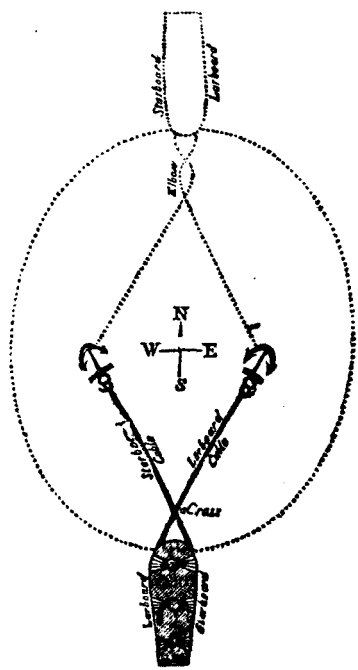
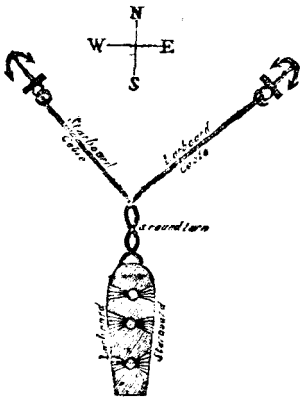


FIG.

FIG. 3.



For example: if a ſhip be moored eaſt and weſt, and ſwings to the northward, the cable of the anchor, lying to the eaſtward, is from the hawſe-hole on the larboard-ſide, and that to the weſtward from the hawſe-hole on the ſtarboard-ſide; ſhould the wind or tide change, ſo as to bring the ſhip to the ſouthward of her anchors, the weſtern anchor will be on the larboard-ſide the veſſel, and the eaſtern anchor on the ſtarboard-ſide. Theſe two cables (the one from out of the larboard hawſe-hole, and leading towards the eaſtward, or ſtarboard of the ſhip, and that from out of the ſtarboard hawſe-hole leading to the weſtward, or larboard-ſide of the ſhip) muſt conſequently croſs each other; that by which ſhe rode, when making the movement of ſwinging, remaining above the other. Suppoſe, in the preſent caſe, the ſhip has ſwung by the eaſtern anchor to the weſtern ſide, it will then be found in the poſition ſhewn in fig. 1.

If, in a ſecond change of ſituation, the ſhip is obſerved to turn round the ſame anchor, and to the weſtward, the croſs will be taken out, and the cables will reſume their firſt diſpoſition, as in fig. 1.

If, on the contrary, the croſs is not taken out, but ſhe ſwings to the eaſtward, the croſs will be doubled, and form an elbow, fig. 2; and,

and, ſhould ſhe continue to turn weſtward to the ſouthward, the cables will be again twiſted, and form a round turn, as fig. 3, which ſhould be carefully avoided.

When two cables are croſſed, to take the croſs out, the ſhip muſt ſwing to the upper cable, drawing it tight, and by that means ſlacking the other cable: when the croſs is doubled, and becomes an elbow, the cable, which at firſt was the uppermoſt, being overlaid by the other, and making a turn, it is always on the firſt that the ſhip ſhould make the evolution to take the turn out.

OF CLEARING THE HAWSE.

This can only be attempted when the ſhip does not ride by the clearing-cable. To execute it, bend a fiſh-hook to the fore-bowline, hook this to the cable the ſhip is riding by, below the turns in the hawſe, and bowſe it well up out of the water: then laſh the cables together at the turns. If the cable, by which the hawſe is cleared, leads on the ſtarboard-ſide, ſend the larboard fore-top bowline into the hawſe-hole under the cable, or under and over, according as the cable to be cleared is either below or above the other, which muſt be bent about three fathoms within the hawſe. Then ſend in the ſtarboard-bowline, which ſhould be bent well in towards the end of the cable, and ſtopped along the cable at every fathom, and let a hawſe-rope be bent to the end of the cable. When all the bowlines are faſt, unbit the cable, and haul out upon the ſtarboard-bowline: let the ſtops be cut, as the cable comes out of the hawſe. When a long bight is out, haul upon the larboard bowline, and trice this bight up to the bowſprit. Should this one bight not ſufficiently expend the cable, that its end may be taken round the other, hang it to the bowſprit, and ſend down the larboard-bowline for a ſecond bight. When the end of the cable is round the other, ſhift the hawſe-rope, and haul it in again. The hawſe being clear, bit the cable and unlaſh it.

Should

Should it blow freſh, and the tide run to windward, it will be imprudent to truſt only to the laſhings, leſt the cable ſhould run out end for end. In this caſe, bend the hawſer, with a rolling-hitch, to the clearing-cable, below the turns of the hawſe, and let it be hove tight, as a double ſecurity.

If it is moderate weather and an eaſy tide, the hawſe may be readily cleared, by bowſing the headmoſt cable well up out of the water, and bending to it a hawſer from the hawſe below the turns. Then unbit the cable, veer away upon the hawſer, and paſs the headmoſt cable round the other until its end is clear; then heave in upon the hawſer, take in the cable, and bit it. Should it come on to blow a gale of wind, when a ſhip is moored, from that quarter which will oblige her to ride equally by each cable, and the hawſe is clear, it will be neceſſary to ſplice a ſecond cable to the ſmall bower, and to veer away equally upon both cables: but, ſhould the hawſe be foul, and it is expected that the cables will damage each other, bend a hawſer below the turns in the hawſe to the ſmall bower, which ſlip, and let the ſhip ſwing to the beſt bower. When the weather moderates, heave in the end of the ſmall bower, and the ſhip will be moored as before with a clear hawſe.

OF GETTING UP OR WEIGHING ANCHOR.

Previouſly to entering upon directions for UNMOORING and GETTING UNDER SAIL, it is neceſſary to ſhew the various modes of GETTING UP AN ANCHOR, as this operation is often requiſite where it is not deſigned to unmoor, and as it is neceſſary to know how to overcome the difficulties of getting up an anchor in all caſes whatever.

TO GET UP AN ANCHOR, IN SHIPS WHICH HAVE A MAIN AND JEER CAPSTERN.

In large ſhips which have a main and jeer capſtern, and the ſtrain is thought too great for the meſſenger alone, the viol is uſed thus: Three or four turns are taken round the jeer-capſtern with one end, ſo as to leave that ſide clear on which the cable is coming in; and paſs the other end through the viol-block, which is laſhed round the main-maſt on the lower deck. It is then carried forward, and paſſed round the rollers in the manger near the hawſe-holes; then brought aft, and ſpliced to the other end with a ſhort ſplice, and the ends marled down tight. That ſide of the viol on which

which the cable is coming in is faſtened to the cable by nippers; and thus the continued efforts of the capſtern are conveyed to the cable, until it is hove in. The nippers are clapt on in the manger, from one to two fathoms aſunder; and the viol is applied to the midſhips, or inſide of the cable. Nippers are clapt on by taking three or four turns round the viol, four turns round the cable and viol, and then three or four turns round the cable. This method is an exceeding good one, and very ſuitable to quick heaving; but, when the ſtrain is great, and the cable muddy, the nippers clapt on after this method will not nip ſufficiently; and ſometimes recourſe is had to the following method: Throw ſand or aſhes upon the cable, and take a long dry nipper; which middle, and paſs one-half aft, racking it in and out round the cable and viol; then worm its end round the viol only. After this, paſs the other half in the ſame manner forward, but worm its end round the cable only, and let each end of the nipper be held on. The advantages of this method are, that, as the ſtrain of the cable lies forward and that of the viol aft, the nipper will be drawn ſo tight as effectually to hold the cable till ſomething gives way: alſo they can never jamb, for both ends are clear for taking off. Another method, when the ſtrain is great, is, to have nippers with an overhand-knot made at one end; and with that end a round turn taken round the cable and viol, leaving three or four feet of the end; then, with the other end, take three or four racking turns, and expend nearly the remainder with turns round the cable and viol, laying the knotted end under and over each of the laſt turns: the end is then held faſt. The men who clap on the nippers are attended by boys, who hold the ends of them; and follow the progreſſion of the cable as it is hove in: and, as the nippers arrive near the main-hatchway, they are taken off and carried forward, where they are again clapt on: and ſo in ſucceſſion, until the cable is hove in ſufficiently to raiſe the anchor above the water. It is then ſtoppered round all before the bits: that is, round the cable and viol. The anchor is then catted, and afterwards fiſhed. To ſhift the viol for heaving in a ſecond anchor, it muſt be unſpliced, and the turns round the capſtern reverſed. When the ſtrain is ſo great as to require other purchaſes, the top tackles may be uſed

thus: The double block is lashed to the main-mast or topsail-sheet bits, the treble block is lashed on the cable, and the fall brought to the capstern. If the top-tackle falls are thought insufficient, any hawser may be used that will reeve through the blocks.

TO GET UP AN ANCHOR IN SHIPS WHICH HAVE NOT A JEER-CAPSTERN.

Ships without a jeer-capstern have no viol, but heave in their cables by the messenger, which has an eye spliced in each end; one of which ends is passed with three or four turns round the capstern on the upper deck, and the other end passed forwards round the rollers, at the fore-part of the manger; then brought aft to the other end, and lashed thus: Several turns are passed through the eyes crossing each other in the middle, then a half-hitch is taken round the parts, and the end stopped with spunyarn. The remainder of the operation is performed as by the viol, with this exception; the messenger is applied to the outside of the cable; and, when the nippers are insufficient, the messenger may be hitched thus: The bight of the messenger is fastened round the cable at the manger with a rolling hitch, and the bight seized round the cable before the hitch. This practice is by no means so good as the others.

When getting under way in a sea-gale, the viol is better than a messenger, as the sending of the ship carries all the strain to the main-capstern, and endangers the men at the bars; whereas, with a viol, the strain is taken to the viol-block, and the men at the fore-jeer capstern heave in security.

TO

TO GET UP A SECOND ANCHOR.

Suppoſe, by the former methods, that the ſtarboard-anchor is gotten up, and that the cable of the ſecond anchor enters the larboard hawſe-hole, the operation of getting up the ſecond anchor is the ſame, obſerving only, that the meſſenger muſt be ſhifted, and the turns on the capſtern reverſed, to change the diſpoſition and ſide: and the men, who before held on the larboard-ſide in the firſt operation, will hold on the ſtarboard-ſide now: the motion of the capſtern is performed the contrary way, and the cable on the larboard-ſide is fixed and hove in.

TO GET UP AN ANCHOR IN MERCHANT-SHIPS.

Moſt merchant-ſhips and ſmall veſſels heave up their anchors by a windlaſs; round which are taken three turns of the cable, and held on by hand, or by a jigger, thus: The end of the rope which has the ſheave is paſſed round the cable, with a round turn, cloſe to the windlaſs, the leading part of the rope coming over the ſheave, and ſtretched aft, by means of the fall paſſing through the jigger-block; the ſtanding part of the fall is made faſt round a ſtantion, at the fore-part of the quarter-deck, and the leading part is bowſed upon, which jambs the turns taken round the cable; and, when the jigger arrives abreaſt of the hatchway, it is removed forward, and the cable is jambed by a handſpeck at the windlaſs, until the jigger is refixed.

TO WEIGH AN ANCHOR WITH THE LONG-BOAT.

This is done, by taking the long-boat to the buoy of the anchor, and putting the buoy-rope over the davit of the long-boat, and a tackle on the buoy-rope; by which, with the assistance of men on the fall, the anchor is weighed out of the ground. This being accomplished, the cable is hove in on board; the buoy rope and tackle being secured in the boat, they approach the ship as the cable is hove in, and the anchor catted and stowed. Small anchors and grapnels are got up by the davit, hauling upon the cable or grapnel-rope by hand.

TO WEIGH AN ANCHOR BY UNDER-RUNNING.

This is by placing the cable over the davit-head, and under-running it, till it is nearly a-peek, when it is tripped by means of tackles as before by the buoy-rope. This method is troublesome, and is only adopted when the buoy is gone, and a ship cannot get near her anchor for want of water.

OF CUTTING OR SLIPPING THE CABLE TO MAKE SAIL.

This is a quick but very expensive method, and practised but in cases of the greatest necessity; such as when the anchor is hooked to rocks, and cannot be purchased; in bad weather; when at anchor on a lee-shore and in danger of being embayed; or when compelled

compelled to fly from or purſue an enemy. The cable is cut by an axe at the hawſe-holes or at the bits. Slipping the cable, if time will permit, (which prevents loſing the anchor and cable, and is more prudent than cutting,) is by letting the cable run out end for end. Obſerving however before it is either cut or ſlipped to paſs a ſpare buoy-rope in the hawſe-hole, and faſten it near the end with a rolling hitch; worm the end in the cuntline and ſtop it, that it may be eaſily regained.

TO SWEEP AN ANCHOR.

To ſweep an anchor is ſeeking at the bottom for one loſt, by means of a rope called a ſweep. This rope has its two ends made faſt to two boats abreaſt of each other, at a ſmall diſtance aſunder. On the bight of the ſweep is fixed a weight of ſhot, ballaſt, &c. to keep it at the bottom. The two boats row on toward the place where the anchor is ſuppoſed to be, and conſequently draw along the ſweep; which, taking the bottom, hooks or entangles itſelf with the object of their ſearch. The boats then row acroſs each other twice, ſo as to take a round turn with the ſweep, which being a hawſer, both parts are brought into the hawſe-hole and to the capſtern, (or if ſmall to the long-boat,) and hove in upon as before.

TO UNMOOR.

Should the ſhip to be unmoored have her beſt bower to the ebb, let her be unmoored upon the ebb-tide: but, if there were a neceſſity to unmoor upon the flood, the ſtream-cable muſt be ſpliced to the ſmall bower, ſuppoſing the ſmall bower has but one cable. To unmoor upon the ebb, when it has made ſtrong, veer away the beſt bower, bring-to and heave in the ſmall bower, and keep veering away the beſt, till the ſmall bower is up-and-down; then ſtopper the beſt bower.

The ſmall bower being up, cat the anchor, ſhift the meſſenger, bring-to the beſt bower, and heave in to the whole or half-cable ſervice, as may be thought neceſſary; then bit the cable, and fiſh the ſmall bower anchor.

Should a ſhip be under the neceſſity of unmooring upon a windward-tide with a ſtrong wind, it will be very difficult and dangerous to take up the ſternmoſt anchor. In this caſe, if there be no ſhips in the way, the headmoſt anchor may be the firſt taken up with ſafety, and the ſternmoſt cable be hove in towards ſlack water.

OF

OF GETTING UNDER SAIL.

GENERAL OBSERVATIONS RELATIVE TO GETTING UNDER SAIL.

Whenever a ſhip is preparing to get under ſail, the topſail-yards ought to be at the maſt-head, and her ſails ſtopped with rope-yarns. And indeed all perſons that pique themſelves on rapid execution ought to obſerve this precaution when the wind is not too powerful.

When the tide takes a ſhip on the beam, and ſhe is to caſt the other way, it is evident that the tiller in the firſt inſtant muſt be put on the ſide the current runs from, becauſe the rudder will be in ſuch a ſituation as to receive very obliquely the impulſe of the fluid, and conſequently will but little oppoſe the ſhip's falling off, provided the ſhip's velocity does not exceed that of the current.

When in a ſituation where it is indifferent whether the ſhip be caſt one way or the other, always let it be to leeward of the anchor, that there may be no riſk of its getting foul of the cutwater.

It happens ſometimes, in getting under ſail, that you are obliged to heave the anchor up to leeward; which often requires a dangerous ſtrain to the capſtern; becauſe the ſhip, driving to leeward as ſoon as the anchor is a-weigh, cauſes the cable to girt againſt the lee-bow, and the ſtock of the anchor is very apt to catch the

cutwater. To avoid this, let the ſhip, (if you are near the land,) get offing enough to wear and bring the anchor on the weather-bow: then the ſhip, lying to leeward of the anchor, or ſtanding-on under an eaſy ſail, drifts, and conſequently leaves the anchor diſengaged to windward; in which ſituation it may be hove with facility.

TO GET UNDER SAIL WHEN THE SHIP IS SWINGING HEAD TO WIND, AND YOU WANT TO CAST EITHER TO STARBOARD OR LARBOARD, IN A PLACE WHERE THERE IS NO CURRENT.

TO CAST TO STARBOARD.

Heave ſhort on your anchor till it is a-peek: then haul in quite home the larboard-braces forward and ſtarboard-braces abaft: looſen, ſheet-home, and hoiſt, the topſails, ſhould they not be ſo already: put the helm a-ſtarboard, and heave till the anchor is a-weigh. The moment the anchor quits the ground, the ſhip will begin to fall off to ſtarboard. As ſoon as this movement is perceived, hoiſt the jib and fore-topmaſt ſtay-ſail, if neceſſary, to help her: and, when ſhe has ſufficiently fallen off, her ſails abaft (which are trimmed ſharp for the larboard-tack) will fill. But, unleſs for very ſuperior reaſons, you had better continue lying-to till the anchor is catted, taking care to haul the mizen-ſheets cloſe aft, if the ſhip be inclined to fall off too much.

TO CAST TO LARBOARD.

Haul in the ſtarboard-braces forward and the larboard aft, and put the helm a-port. The reſt of the operation is the ſame as the preceding; and will be equally proved in the following demonſtration, by only changing ſtarboard for port.

DEMON-

DEMONSTRATION.

You heave ſhort before the top-ſails are looſened, in order to facilitate the working of the capſtern, which would require dangerous efforts if they were ſet; ſince they would be a-back, and conſequently in a ſituation to ſend the ſhip a-ſtern; whereas ſhe ſhould go a-head when you are heaving on your cable. The larboard-braces are hauled in forwards, becauſe, in that ſituation, the ſails are ſo braced as to caſt the ſhip's head to ſtarboard, ſince they make with the keel the moſt acute angle poſſible a-ſtarboard forward, and are at the ſame time a-back. Beſides, the after-ſails, being braced ſharp up to ſtarboard, are alſo taken a-back like the others, and receive the wind in ſuch a manner as to turn the after-part to port. So that there are always two powers acting in contrary directions, one before and the other abaft the centre of gravity of the ſhip; the one forcing the fore-part to ſtarboard, and the other impelling the after-part to larboard. As theſe two effects cannot happen without the ſhip's going a-ſtern the moment the anchor quits the ground, ſince ſhe is no longer with-held by any thing, and is moved by an exterior power, the fluid, which carries her in this direction, part of the effect of her ſails giving her ſternway; (§. 21;) it follows, that the helm muſt be put to ſtarboard, that the rudder may help her after-part round to larboard. (§. 58.) Thus every thing is diſpoſed to make the ſhip fall off to ſtarboard. The jib and foretopmaſt ſtay-ſail are not added, unleſs there be reaſons to fear the ſhip will not fall off faſt enough; and, when you find ſhe has ſufficiently done ſo, the mizen is to be hauled out, to procure the contrary effect, and thereby to counter-balance the jib and ſtay-ſail, which it is very often neceſſary to keep ſet.

TO GET UNDER SAIL, WHEN THE SHIP IS RIDING HEAD TO WIND AND TIDE.

If a ſhip, riding head to wind and tide, wanted to get under ſail, after having decided on which ſide it is beſt to have her caſt, it muſt be performed according to one of the foregoing methods, except with regard to the helm, which muſt be put to ſtarboard, either before the anchor looſens, or while it does, if you wiſh to caſt to port; becauſe the water, coming from forward, acts with the ſame force on the rudder as if the ſhip went with the current, impelling the rudder to ſtarboard and the head to port. Therefore it is evident, in this caſe, the helm ought to be put to ſtarboard; which, on the contrary, would be put to larboard, was the ſhip to be caſt to port.

If the ſhip, after the anchor is out of the ground, goes a-ſtern faſter than the current runs, the helm muſt then be uſed as if there was no current, becauſe the exceſs of velocity, whereby the ſhip exceeds that of the water, acts upon the rudder.

If it blows freſh, ſo that you cannot ſet your topſails without reefing them, let that be done before they are ſheeted home; and if it blew ſo hard as to be obliged to go only under a fore-ſail, it would be then ſufficient to looſen the fore-topſail, without ſheeting it home, after having braced it quite cloſe on the ſide oppoſite to that you want the ſhip to caſt, not forgetting however to put the helm the ſame way as you caſt, as ſoon as you perceive the ſhip going a-ſtern: and when the ſhip has fallen off ſufficiently, then is the time to fill and trim the fore-ſail.

TO GET UNDER SAIL WHEN THE SHIP IS SWINGING WITH HER HEAD TO THE CURRENT, AND WITH THE WIND A POINT ABAFT THE BEAM.

The topſails being ſtopped with rope-yarns, let them and the mizen-topſail be hoiſted, and properly trimmed, as if they were ſet; and, when every thing is properly diſpoſed, heave ſhort on your anchor till it is a-peek; next to this, looſen, ſheet home the fore-ſail and mizen-topſail, keeping the wind in, and heave vigorouſly at the capſtern till the anchor is a-weigh. At the ſame time hoiſt the jib and fore-topmaſt ſtay-ſail, or haul out the mizen, according as circumſtances may require. Whether you wiſh to come to windward, or fall off more quickly, you muſt ſtill continue to heave round the capſtern briſkly to get the anchor up, till you find yourſelf ſufficiently offward to bring to, in order to ſtow it with eaſe, or to ſtand on under an eaſy ſail with the anchor hanging out to windward, if the ſituation of things will admit of it. You may ſometimes alſo hoiſt up both the main and fore topſails, as ſoon as you get ready; but, in certain caſes, as when obliged to make the beſt of your way from an enemy, every ſail poſſible muſt be ſet at once which the weather will admit of; eſpecially when obliged to haul by the wind; in which caſe, the anchor muſt be got up and catted as well as it can: there are caſes even when, without loſing your time in weighing it, you crowd as many ſails as you poſſibly can, and depart in cutting or ſlipping the cable.

DEMONSTRATION.

The topſails and mizen-topſail are hoiſted up, becauſe the ſails in that ſituation are more eaſily ſheeted home and trimmed; and becauſe, as ſoon as the rope-yarns are cut, the ſails fill, and give the ſhip head-way, the moment the anchor quits the ground. The mizen-

mizen-topſail is uſed to make the ſhip ſteer well, by keeping it either filled or looſe to the wind, according as the ſhip is griping or the contrary.

TO GET UNDER SAIL WITH A SPRING.

If a ſhip be in a place too confined to caſt under her ſails only, or being obliged to put to ſea in a gale of wind, without hoiſting the anchors; you muſt, for greater ſafety, in caſting the right way, get a ſpring out, to be clapped on the cable by which the ſhip ſwings, by paſſing a hawſer or a ſtream-cable through the aftermoſt port, on the oppoſite ſide to that you mean to caſt; and, after that ſpring is well hove tight at the capſtern, hoiſt the jib and fore-topmaſt ſtay-ſails, looſe and ſheet home the fore-topſail; when that is done, and if the weather permits, brace quite cloſe the head-ſails on the ſame ſide with the ſpring. When this is executed, ſlip or cut the cable, heaving briſkly at the ſame time on the ſpring, till the ſhip has paid off ſufficiently. Then fill the ſails, by ſetting the mizen-topſail and every other ſail you mean to employ, and ſlip or cut the ſpring, as circumſtances may require. Care muſt be taken, not to let the ſhip fall off too much before the ſpring is cut; becauſe, having no way through the water, ſhe will not come to the wind ſo ſoon as might be wiſhed; and, for the ſame reaſon, the ſpring muſt not be cut, till ſhe has fallen off as much as is neceſſary; becauſe, although ſhe has no other motion but that of falling off, the veſſel might perhaps not wear enough to anſwer the purpoſe.

DEMONSTRATION.

As the reaſons have been ſhewn before why the head-ſails are braced up on the oppoſite ſide to that on which the ſhip caſts, they need

need not be repeated here. Although we ſuppoſe the wind ſo ſtrong as to keep the ſhip wind-road, it may be proved that the ſhip turns almoſt on the middle of her length; ſince the moment the fore-part begins its movement of falling off on one ſide, the after-part makes another to approach the point from which the head is receding. Now ſhe turns ſo much the more ſurely on her centre, and her evolution is ſo much the more rapid, as the force uſed in heaving at the capſtern is ſtronger: becauſe the more powerful the heaving is, the more of the hawſer comes in, and conſequently the more eaſily and with the greateſt rapidity will the after-part approach the point the head of the ſhip has left.

When ſhe has fallen off enough, ſlip the ſpring, becauſe ſhe gathers head-way in proportion as the ſails are filling, and in that caſe the hawſer would only hinder the ſhip going a-head, or cauſe her to fall off more, which would be equally prejudicial. The hawſer or ſtream-cable is paſſed aft as far as poſſible; becauſe, being at the extremity of the ſhip, the capſtern ſtrains leſs, and the veſſel turns with more celerity.

If this operation is performed when it blows hard, you muſt not ſheet home the fore-topſail: for, if the wind is abſolutely too ſtrong, you muſt only looſen this ſail, and hoiſt the fore-topmaſt ſtayſail: but, if the weather is pretty tolerable, it will be found ſufficient to ſheet home the fore-topſail without hoiſting it.

TO GET UNDER SAIL WITH A LEADING WIND IN A TIDE-WAY.

If the ſhip to be got under ſail has a leading wind, and is in the midſt of veſſels, or in a narrow channel, where it would be difficult to caſt her upon the lee-tide, ſhe ſhould be got under ſail before the weather-tide is done. Thus the caſting of the ſhip would be avoided, and ſhe may be ſteered through the fleet or channel with ſafety.

Should

Should it, however, blow ſo freſh upon the windward-tide, as to force the ſhip end-on with her cable, it will be impoſſible to heave it in, without ſheering the ſhip over from ſide to ſide, and heaving in briſkly, as the ſhip ſlacks the cable; but, as this is attended with much danger, by the ſhip ſuddenly bringing up upon each ſheer, it will be beſt to heave a-peek upon the firſt ſetting of the windward-tide, before the ſhip ſwings, to bring the wind aft.

TO CAST A SHIP UPON THE LARBOARD TACK, AND BACK HER A-STERN OF DANGER.

We ſuppoſe the ſhip to lie at ſingle anchor, with the wind and tide the ſame way, and ſhips or ſhoals right a-ſtern, in the intended courſe, and that, to clear them, you muſt caſt upon the larboard-tack, and make a ſtern-board.

Make every thing as ready as poſſible before weighing: let the three topſails be hoiſted, the yards braced up ſharp with the larboard-braces, and the mizen hauled out. Thus ſituated, when the anchor weighs, put the helm a-port. The tide, running aft, acts againſt the ſtarboard-ſide of the rudder; and, in that direction, it will caſt the ſhip the right way, and bring the wind upon the larboard-bow. The wind may be thus kept, at pleaſure, by the helm, till the ſhip begins to get ſternway through the water, which ſhould be attentively noticed, to put the helm hard a-port. The wind, being on the larboard-bow and the topſails a-back, will ſoon give the ſhip ſternway through the water; then the water will act againſt the larboard-ſide of the rudder, and powerfully prevent the ſhip falling too faſt off from the wind. Thus ſhe will drive till the anchor is got quite up, and may be ſo continued till ſhe has paſt the ſhoals, and has room to veer, and get upon her proper courſe.

It

It is advantageous to make a ſtern-board in getting under way from a ſingle anchor in the above ſituation. The anchor heaves up more eaſily when the ſhip goes a-ſtern; and, while heaving up, it ſerves to keep the ſhip's head to the wind. A ſhip, however, cannot long be ſteered ſtern foremoſt when under ſail, ſo as to keep the wind before the beam; but ſhe will in a little time drive broadſide through the water, till ſhe gets headway, and then it is proper to veer, provided the anchor be quite up.

TO CAST A SHIP ON THE LARBOARD TACK, IN A TIDE-WAY, WITH THE WIND TWO POINTS ON THE STARBOARD-BOW.

A ſhip riding in a tide-way, with the wind two points on the ſtarboard-bow, and ſo near the ſhore, on the larboard-ſide, that ſhe muſt be caſt upon the larboard-tack to clear the ſhore, the *three* topſails muſt be hoiſted, and the yards ſharp braced up, with the larboard-braces forward, and the ſtarboard-braces aft, with the ſtarboard fore-top bowline well hauled, putting the helm hard to port at the anchor's weighing: the tide acting upon the rudder, and the wind upon the ſails *braced in that direction*, brings the ſhip about, with the wind on the larboard-bow, before ſhe gets ſternway, which ſhould be always ſtrictly noticed; for, in all proceedings of this kind, if a ſhip gets ſternway before ſhe brings the wind right a-head, ſhe will not come about the right way. In that caſe, it is beſt to veer away the cable directly, and bring the ſhip up again: and carry out a kedge or ſmall anchor on the larboard-bow, hauling its *cable* or hawſer in tight, on the larboard-quarter, when the bower-anchor is a-peek. If this fail, the ſhip muſt lie till the windward-tide makes, to bring the wind on the larboard-bow, when the ſhip may be got under-way, and clear the ſhore.

TO CAST A SHIP UPON THE LARBOARD TACK, AND SHOOT HER BY THE WIND A-HEAD OF DANGER.

If there is but just room enough close by the wind to clear a danger lying to leeward, much depends on heaving up briskly the anchor after it is out of the ground, and having proper sails ready to set to the best advantage. The three topsails must be hoisted, and the yard sharp braced up with the larboard-braces forward, and the starboard-braces aft, when the anchor is at a long peek. At weighing the anchor, put the helm hard to port, then the action of the tide upon the rudder, and the wind on the fore-topsail, will cast the ship off the right way, so as to fill the after-sails, when the fore-topsail may be soon braced about and filled before she gets sternway. The helm will keep the ship under command sufficiently to steer her by the wind a-head clear of danger; but, if the ship gets sternway in casting, the helm should be kept hard a-weather to prevent her falling off too much from the wind; and, when she gets headway again, be cautious how the weather-helm is eased with the anchor much below the bows, by which the resistance forward is increased, and the ship may be brought up in the wind, so as to prevent her shooting clear of the danger. This must be guarded against by the weather-helm, and head-sails, as jib, fore-topmast, stay-sail, &c. As soon as the ship has shot far enough a-head to clear the danger to leeward, and there be but little room a-head, it is best to bring the ship to and drive with the helm a-lee, with the main and mizen topsail a-back, and the fore-topsail shivering till the anchor is up: then take proper time to veer.

TO

TO CAST ON THE LARBOARD TACK, WHEN RIDING WITH THE WIND RIGHT A-HEAD, AND TO VEER HER SHORT ROUND BEFORE THE WIND IN LITTLE ROOM.

The head-ſails ſhould only be looſe, viz. the fore-topſail hoiſted and the fore-ſail looſe: brace ſharp up with the larboard-braces, the jib and fore-topmaſt ſtayſail ſet, with the larboard-ſheets flat aft. When the anchor is a-peck, and a lee-tide running, at weighing the anchor, the helm ſhould be put to port ſo far as to bring the wind two points on the larboard-bow, which ſhould be kept ſo by ſteering the ſhip till the tide ceaſes to run aft. Then put the helm hard to ſtarboard, or a-lee; and, when the ſhip gets ſternway, the water will act powerfully on the ſtarboard, or lee, ſide of the rudder, turning the ſhip's ſtern to windward, whilſt the wind, acting at the ſame time upon the head-ſails a-back, will box her round off upon her heel, ſo as to bring the wind nearly aft by the time ſhe loſes her ſternway. Then the ſhip will ceaſe falling off and ſoon get head-way, which ſhould be attended to, and the head-ſails braced about flat with the ſtarboard-braces, and the helm ſhifted hard to port at the ſame time.

When there is no tide, but ſtill water, at weighing the anchor, the helm muſt be hard to ſtarboard; and, as the ſhip gets ſternway, the water meets with ſo much reſiſtance againſt the ſtarboard-ſide of the rudder in that direction, that the rudder acts with great power to turn the ſhip's ſtern round to port, and the head-ſails being ſet and trimmed as before-mentioned, and the foreſail let fall with the ſtarboard-bowline hauled cloſe forward, will aſſiſt to caſt the ſhip ſo far round the right way, by the ſame time ſhe loſes her ſternway, as then to permit your proceeding as before-directed. To enſure ſucceſs, heave the anchor up briſkly. The ſame methods are adopted in caſting the ſhip on the ſtarboard-tack, only the helm and ſails are managed the contrary way.

ON TACKING.

TO TACK A SHIP IN GETTING TO WINDWARD AS MUCH AS POSSIBLE.

To execute this with propriety, care muſt be taken that the ſhip does not yaw, that ſhe is not too near or too far from the wind; becauſe both ſituations are equally prejudicial.

When this medium is obtained, haul the mizen out, while you put at the ſame time the helm a-lee, and brace the bowline quite to leeward, that the mizen may be as much as poſſible expoſed to the wind. When the ſhip is come to the wind, ſo as to cauſe the ſquare-ſails to ſhiver, let go the jib and all the ſtayſail-ſheets before the main-maſt: at the moment when all the ſails catch a-back, and particularly the mizen-topſail, let it be braced ſharp about the other way; hauling up at the ſame time the weather-clue of the main-ſail; and, when the wind is right a-head, or even a little before, haul the main-ſail, and trim ſharp for the other tack as faſt as poſſible. The jib and ſtayſail ſheets are alſo to be ſhifted over at the ſame time, in righting the helm, whether the ſhip has loſt her way, or even ſtill advances a-head. Then, as ſoon as ſhe has paſſed the direction of the wind about 45°, in continuing her evolution, ſhift the foremaſt's ſails, which are to be trimmed with the ſame celerity as in putting the helm a-lee, if you fear the ſhip (which muſt ſtill go a-ſtern if the operation be ſlowly executed) will

will not fall off ſufficiently: for, if the ſails are braced about briſkly, ſhe will never have ſternway; on the contrary, ſhe will get a great deal to windward.

DEMONSTRATION.

If the ſhip be too near the wind, when the helm is put a-lee, ſhe will moſt probably miſs ſtays; ſince, not having ſufficient way through the water, the rudder will not have a ſufficient power to cauſe the ſhip to double the critical point where all the ſails ſhiver. The power of the rudder to turn the ſhip is in proportion to the force with which the water ſtrikes it. (§. 58.) Hence it follows, that, if the ſhip has not ſufficient velocity, the rudder will not have force enough to cauſe her to double the point, where all that can augment or keep up the rapidity of ſailing (and of conſequence the power of the helm) will ceaſe, the ſails being all ſhivering. The ſhip muſt then neceſſarily fall off, ſince the helm is a-lee, and none of her ſails tend to ſhoot her a-head. On the contrary, her mizen being out, and braced quite to leeward, forces the ſtern of the ſhip athwart; (§. 40;) while, by the wind which ſtrikes her ſails, rigging, and hull, ſhe is but too ready to drive a-ſtern, as a ſhip always finds great difficulty to divide the fluid laterally. Thus it is clear, that, every thing being diſpoſed for driving the ſhip the ſternway, ſhe muſt infallibly both go a-ſtern and to leeward. (§. 58.) This is confirmed by experience; for, whenever a ſhip miſſes ſtays, ſhe is viſibly perceived to fall abaft.

If, previous to tacking, a ſhip is kept too much away, ſhe will be longer in ranging to the wind; which muſt conſequently be diſadvantageous to the evolution. We ſhould not have mentioned this cuſtom, did not many ſeamen, through mere habit, put it in practice, and thereby fail in this operation, which would however have ſucceeded, had they not had the habit of letting go the fore, jib, and ſtayſail, ſheets. When theſe have been kept faſt, the edging away can only prolong the time of the evolution; but, if the fore, jib, and ſtayſail, ſheets be let go, as a great many do at every turn, and as in ſome particular caſes it is really found neceſſary,

care

care must be taken not to suffer the ship to fall off too much: because the velocity of the ship not being sufficiently kept up (§. 46) till the ship comes to the wind, it follows that she has lost a good deal of it, before she arrives at the critical part of the evolution, where all the sails shake. So that, when the ship is at that point, the velocity is so much diminished, the rudder has not power enough to make her double it: on the other hand, the fore-part of the ship is no longer carried to the wind with the same force, since the vessel no longer shocks the fluid (§. 47) with her first velocity.

The mizen is hauled out to help the rudder; because these two forces act together in impelling the after-part of the ship to leeward. (§. 49 and 50.) When the helm is a-lee, the ship of course comes head to wind; and continues that circular motion, first by the effect of the rudder, till the head-way ceases, and then by that of the mizen, till the other sails take the wind from it. Therefore, when the mizen is becalmed by the other sails, the evolution is sure, as this could not happen if those sails were not taken a-back.

You must wait till the square-sails begin to shiver, before letting go the jib and all the stayfail-sheets before the main-mast; because, till that moment, these sails concur to maintain an equilibrium with the others, and keep up the ship's velocity; since it is the disposition of the different sails set on the different parts of the ship, which gives her more or less way through the water. (§. 46.) These however being now the only sails which tend to make the ship fall off, (§. 31,) since they are the only sails full, the others being shivering, it is absolutely necessary at this moment to suppress that effect, since it is contrary to the movement of coming-to; the action of the mizen is, however, to be preserved as long as possible, in order to help the rudder, which, in keeping up the movement of rotation of the ship, will soon make her clear the critical point of the evolution.

Experience teaches that the motion of the ship, in coming to the wind, at the moment the jib and stayfail sheets are let go, is very rapid, provided the other sails shiver; because the velocity of the ship, at that motion, is as great as when all the sails were exposed

posed to the impulsion of the wind. Consequently, the effort of the rudder is likewise very powerful, (§. 56,) since the rapidity of sailing has not diminished.

The mizen sail is to be braced up so far as to join the main-shrouds to windward; because in that situation it is exposed as much as it possibly can to the wind, and receives consequently a stronger and longer impulsion; and, again, because it is trimmed as it will remain even after the evolution has been performed.

The mizen-topsail should be braced about as soon as it is taken a-back, because it will then impel the stern to leeward, jointly with the mizen, (§. 44,) and, by this new disposition, accelerate the evolution: whereas, if it were continued in its first situation, it would retard the circular motion of the ship, by impelling the after-part to windward. (§. 45.) It will also, in this situation become very useful, in moderating the stern and lee way of the ship.

At this same time, the weather clue and sheets of the main-sail are hauled up, in order that all may be ready to brace round for the other tack.

The main-sails are to be hauled about and filled when the wind is right a-head; because, 1st, at this time the sails on that mast are becalmed by those of the fore-mast: 2ly, should they be left longer in this situation, they would counteract the head-sails, (§. 37, 38, 44, and 45,) which are braced up for the same tack, and in the same manner; and, finally, because, were it not for this, the sine of incidence of the wind on them would be continually increasing as the ship were falling off, which would more and more retard her bearing away.

It is, notwithstanding, not untrue, that the evolution would be more rapid, if the sails on the main-mast were filled as soon as they are taken a-back: because (§. 44) they would impel the after-part of the ship to leeward. But this effect of the after-sails ought not to be attended to, except when the ship has lost her velocity, and the rudder its power. Whence it must be concluded, that the ship will always fall off with great celerity as soon as the main-sail is hauled.

The

The jib and ſtayſail ſheets are alſo ſhifted at this time, if they have not been lowered before; becauſe, if ſooner, they would take the wind in again, which muſt not be done before the ſhip has fallen off ſufficiently to clear the direction of the wind.

The helm is to be righted if the ſhip has loſt her way; becauſe, if it were continued a-lee, as in the firſt inſtant, and the ſhip ſhould get ſternway, the rudder (§. 58) would oppoſe the evolution, which muſt now be finiſhed with ſufficient rapidity by the ſole effect of the head-ſails, as theſe are now fully expoſed to the power of the wind. Great care muſt be taken not to ſlack the bow-lines, as is often done by people who act more from cuſtom than reflection.

The head-ſails are to be braced about and filled, when the ſhip has got over the direction of the wind by 45°, or thereabouts; becauſe, if they were left longer a-back, the motion of the ſhip's falling-off would become too rapid and too great. If they are braced about briſkly at the time before-mentioned, they may be made to ſhiver; which, by diminiſhing their effect, will moderate the great velocity of falling off which the ſhip has acquired. (§. 37.)

The helm ought to be put a-lee (§. 58) if the ſhip goes a-ſtern, to aid her falling off, which is now carried on only by the jib and ſtay-ſails before the centre of gravity.. Thus the ſhip falls off moderately, in yielding to the wind by 12° or 20° only, more large than if cloſe-hauled; becauſe the after-ſails, being trimmed ſharp, ſoon bring the ſhip to the wind, and give her head-way. (§. 41.) Let it not be forgotten, that the helm ought not to be put a-lee in hauling off all, unleſs you judge the ſhip not ſufficiently inclined to fall off, which however ſeldom happens when ſhe is come to this point.

THE DEMONSTRATION OF THIS EVOLUTION COMPREHENDS THE WHOLE PLAY OF THE SAILS AND OF THE RUDDER; SO THAT ALL OTHER DEMONSTRATIONS MIGHT BE CONSIDERED AS SO MANY COROLLARIES DEDUCED FROM IT.

TO

TO TACK A SHIP, WITHOUT ENDEAVOURING TO GET TO WINDWARD.

There are circumſtances ſometimes when it is found neceſſary to tack, without caring much whether the ſhip loſes to windward. For example: When a ſhip is found ſuddenly to be cloſe to the land, in the night, or in foggy weather, near a danger, or ſome veſſel, which muſt inſtantly be avoided by ſtaying the ſhip, becauſe you find yourſelf to windward, and too near the object from which you wiſh to recede: in this caſe, when it is neceſſary to deaden the ſhip's way, and tack at the ſame time, you muſt ſuddenly put the helm hard a-lee; and, in the ſame inſtant, let go the jib, fore, and ſtay-ſail, ſheets, without touching the bowlines; and great care muſt be taken that the effect of the mizen is preſerved as much as poſſible. When the ſails begin to ſhiver, the mizen is to be hauled quite in the lee-braces; then, if the ſhip takes well the wind a-head, the remainder of the operation muſt be executed as directed in the preceding caſe; but, if you ſhould miſs ſtays, you muſt proceed according to the ſecond method of veering, called BOXHAULING.

DEMONSTRATION.

It is eaſily conceived, that, in letting go the fore, the jib, and ſtayſail, ſheets, the ſhip's head-way will be diminiſhed, (§. 46,) while, at the ſame time, almoſt all the forces forward are taken away, which might hinder her coming to the wind (§. 31): therefore the ſhip muſt come to it rapidly, by the effect of her after-ſails, (§. 41,) which are trimmed ſharp, and by the power of the helm, (§. 50,) till all the ſails ſhake. It is alſo eaſy to conceive, that, when the mizen is hauled in the lee-braces, it has a greater power to impel the after-part of the ſhip to leeward, and the ſails

 conſequently

conſequently to take a-back. So that the ſhip's head-way will the ſooner be ſtopped; and, the fore-ſheet being gone, the ſail to windward makes a large cavity between the maſts and ſhrouds, which very much contributes to ſend the ſhip a-ſtern. Attention ought therefore to be paid to catch the inſtant, when the head-way ceaſes, to ſhift the helm and aid the ſhip in her evolution; as we hinted already. The reaſon this method is not always practiſed is, becauſe the ſhip would loſe a deal of ground in driving to leeward. It ought, therefore, never to be uſed but when neceſſity obliges, and the veſſel has good way through the water; for, if ſhe has not, ſhe will generally miſs ſtays.

TO TACK A SHIP IN A DANGEROUS ROUGH SEA, WHEN HER STAYING IS DOUBTFUL.

Let every thing be got clear and ready; the hands at their proper ſtations, the ſails trimmed fair, and the ſhip ſteered juſt full, and cloſe by the wind. Take the advantage of the ſmootheſt time when the ſhip has the moſt head-way. The other neceſſary precautions are, to haul down the jib, if ſet, and not to put the helm a-lee all at once, but to luff the ſhip up by degrees, to ſhake the ſails. When they ſhake, give theſe orders: — The helm hard a-lee; let go the lee-ſheets forward, but not the lee-braces and fore-top bowline, as that uſual practice backs the head-ſails too ſoon, and ſtops the ſhip's headway, which ought to continue to give power to the helm till the wind is brought a-head, or the ſhip will not ſtay. Raiſe tacks and ſheets and main-ſail haul, when the wind is a-point on the weather-bow; this ſwings the yards round ſharp, that the main tack may be got cloſe down, whilſt the head-ſails becalm the fore-leech of the main and main-top ſails; while the wind, blowing aſlant on the after-leech of theſe ſails, acts jointly with the rudder to turn the ſhip's ſtern, ſo as to bring her about

about the right way. When ſhe has fallen off five or ſix points, let go and haul.

When a ſhip comes about, ſhe is ſure to have ſternway by the time the head-ſails are hauled; therefore, the helm ſhould not then be ſhifted a-lee, but ſhould be kept hard a-weather, till her ſternway ceaſes. The water, acting upon the weather-ſide of the rudder prevents the ſhip falling round off from the wind, which the helm, when hard a-lee, occaſions, while the ſternway continues. Notice ſhould be made by the compaſs, that the ſhip continues coming about till the wind is on the other bow; for, if ſhe ſtops with the wind a-head, and her headway is perceived to be done, the helm ſhould be directly ſhifted to the other ſide; ſo that, by the ſternway, the water may act upon the rudder and bring her about, and then the helm ſhould not be kept a-lee, but directly ſhifted and kept hard a-weather till her ſternway ceaſes. For the reaſon juſt given, the head-ſails may be hauled as ſoon as poſſible; for, the ſhip will be ſure to fall off the faſter and farther in proportion to her ſternway; ſo that the weather-braces ſhould be tended, to prevent the head-yards flying fore and aft, as they will do when it blows freſh; and to keep the head-ſails ſhivering, that the fore-tack may be got cloſe down eaſily, and the ſhip ſtopt the ſooner from falling off. Shift the helm a-lee when the ſternway ceaſes, and the head-ſails may be trimmed ſharp as the ſhip is perceived to come-to.

ON TURNING TO WINDWARD IN VERY NARROW CHANNELS.

At weighing, if the wind is partly acroſs the tide, it will caſt the ſhip with her head towards the weather-ſhore, which ſhe may be kept clear of, by driving with the ſails a-back till the anchor is up and ſtowed; and, as the tack towards the weather-ſhore is the ſhorteſt, it is prudent to back as near the lee-ſide as poſſible, in order to make the firſt board the longer; to get the three top-ſails,

jib, ſtay-ſail, and mizen, properly ſet; and to get all ready in time for tacking. Make as bold as poſſible with the weather-ſhore, becauſe on that ſide a ſhip is always ſureſt in coming about; and, in caſe of miſſing ſtays, a ſhip may be backed off from the weather-ſhore, till ſhe has room to fill and ſet the ſails, and get ſufficient headway to try her in ſtays again without danger. But, when the ſhip is got about, and ſtanding towards the lee-ſhore, it may be neceſſary to put her in ſtays in good time; becauſe ſhe does not ſo certainly ſtay when going ſlanting with the tide as when going acroſs it.

By ſtaying her thus in good time, if ſhe even miſs ſtays, there may be room enough to fill and try her the ſecond time, or to uſe ſuch means as may prevent her going on ſhore.

But, when the wind is right againſt the tide, which begins to make to windward, be cautious not to weigh the anchor till the ſhip ſwings end-on to the tide, and brings the wind ſo far aft, that ſhe may be ſteered right againſt the tide till the anchor is up and ſtowed, and the ſails, with which the ſhip is to work, are all ready.

Haul the wind and get ready for tacking, when you are cloſe over to one ſide, to gain the whole breadth of the channel for getting underway. For this purpoſe, let the firſt trip be made as ſhort as poſſible, till it is found how the ſhip works upon both tacks; and then make longer or ſhorter boards accordingly, but take care not to ſtand into an eddy tide on either ſide, which has often occaſioned ſhips to miſs ſtays and go on ſhore. If a ſhip will not ſtay, ſhe muſt be veered, box-hauled, or club-hauled.

OF

OF VEERING.

TO VEER A SHIP WITHOUT LOSING THE WIND OUT OF HER SAILS.

To execute this evolution both the main-ſail and mizen muſt be hauled up, the helm put a-weather, and the mizen top-ſail a ſhivering, which will be kept ſo till the wind be right aft, ſuppreſſing for that purpoſe the effect of all the ſtayſails abaft the centre of gravity. As the ſhip falls off, (which ſhe will do very rapidly,) round-in the weather-braces of the ſails on the fore and main maſt, keeping them exactly trimmed to the direction of the wind, and remembering alſo that the bowlines are not to be ſtarted till the ſhip begins to veer. As ſhe falls off, eaſe away the fore-ſheet, raiſe the fore-tack, and get aft the weather-ſheet, as the lee one is eaſed off; ſo that, when the ſhip is right before the wind, the yards will be exactly ſquare. Then ſhift over the jib and ſtayſail ſheets; and, the ſhip continuing her evolution, haul on board the fore and main tacks, and trim all ſharp fore and aft, remembering to haul aft the mizen and mizen-ſtayſail ſheets as ſoon as they will take the right way, or when the ſhip's ſtern has a little paſſed the direction of the wind. When the wind is on the beam, right the helm to moderate the great velocity with which the ſhip comes-to; the ſails being trimmed, ſtand on by the wind.

DEMON-

DEMONSTRATION.

The main-ſail and mizen are hauled up, and the mizen-topſail ſhivered, in order to facilitate the evolution (§. 40 and 41). The main-ſail, however, might be excepted from this rule, by letting go the main-ſheet (§. 49), and working it like the main-topſail. The helm is put a-weather, becauſe, in that ſituation, the rudder (§. 50) cauſes the ſhip to fall off, or yield to the impulſe of the wind, by impelling the after-part of the ſhip to windward with ſo much the more velocity, as the power of the head-ſails exceeds that of thoſe abaft (§. 47); and, as the rapidity of ſailing increaſes, the effect of the helm augments in the ſame proportion. The ſails are trimmed to the direction of the wind, as the ſhip veers, to increaſe her head-way, and of courſe the power of the rudder (§. 58); which, in great evolutions, is the chief mover and principal agent of the movement of the ſhip. So that, its effects being augmented, the ſhip's circular motion is of courſe accelerated in the ſame ratio; and, if the wind be well followed, every ſail will be found properly trimmed when the evolution is finiſhed. Since the ſails muſt be kept in a proper ſituation with reſpect to the wind, except the mizen topſail, (which, from its ſituation on the after-extremity of the ſhip, would retard her veering,) the fore-ſheet muſt be eaſed off to leeward, and gathered aft to windward, but in proportion as the ſhip falls off. It is alſo evident, for the ſame reaſon, that the bowlines muſt not be ſtarted till the ſhip begins to veer. When the ſhip is right aft, the jib and ſtayſail ſheets, which are then becalmed by the ſquare-ſails, are ſhifted; becauſe, the ſhip coming to the wind, they are ready trimmed, and highly ſerviceable in keeping her under command.

The mizen is hauled out as ſoon as the ſhip's ſtern has paſſed the direction of the wind, to accelerate her coming-to (§. 40); and the ſails fore and aft ought to be trimmed ſharp at the ſame moment, in order to keep to the wind without loſing any time. For the above-mentioned reaſons, the main tack is got on board, and the ſheet aft, when the wind is on the quarter.

TO

TO VEER A SHIP THAT HAS LOST HER FORE-MAST.

Run out the end of a cable or hawſer over the lee-quarter, and buoy it up from the ground with empty caſks, &c. in caſe of coming into ſhoal-water with little wind. This will aſſiſt the helm with ſuch power as to make the ſhip veer and ſteer at pleaſure.

A ſpare yard or boom, rigged out abaft the mizen-ſhrouds, may guy the end of the cable or hawſer more or leſs on either quarter, according as the ſhip may have occaſion to ſail. It may be eaſily ſhifted from ſide to ſide, and guyed out to leeward in proportion to the ſhip's griping, to anſwer ſailing upon both tacks; and, when ſailing before the wind, it may be ſecured over the middle of the ſtern, which will prevent the ſhip's broaching-to againſt the helm either way.

This would likewiſe much aſſiſt deep-laded bad-ſteering ſhips, and prevent their broaching-to; to which they are liable in ſpite of the beſt helmſmen, often occaſioning them to lie-to, even with a fair wind. With a little contrivance, by blocks laſhed to the rails on the quarters, to lead the guys fair to the ſteering wheel-barrel, it may be made to ſteer a ſhip that has loſt her rudder. The invention of Capt. Edward Pakenham is, however, far preferable for this purpoſe.

TO VEER WHEN LYING-TO UNDER A MAIN-SAIL.

Advantage muſt be taken of the ſhip's falling off to put the helm a-weather, and eaſe away the main-ſheet roundly; and, when the ſhip has fallen off about 30°, let go the main bowline, and round-in the weather-brace, taking care to keep the ſail full. When the ſhip

ſhip is before the wind, get on board the main tack, and right the helm, to moderate her coming-to.

If, in the beginning, the ſhip is found difficult to veer, the fore ſtayſail may be hoiſted, and the ſheets hauled well aft; but it is to be hauled down as ſoon as the ſhip is before the wind.

DEMONSTRATION.

Opportunity muſt be taken of the ſhip's falling off, becauſe that motion of the ſhip gives her way, and makes her of courſe better diſpoſed to gather way. For that reaſon, alſo, the helm is then put a-weather, (§. 50, 58,) and the main-ſheet eaſed off roundly, (§. 49,) that only that part of the ſail which is before the centre of gravity of the ſhip may be left to act. The main bowline is kept faſt till the ſhip has fallen off 30° at leaſt, and then let go directly, becauſe the wind is then more eaſily kept in the ſail, the velocity of the ſhip increaſed, and conſequently the power of the helm (§. 58) and the movement of rotation is alſo accelerated. (§. 16, 17, 18.) By hauling in the weather-brace, you follow the wind with the ſail; and, when the wind is right aft, that ſail will be found ſquare. To trim it, you have but to eaſe off the brace, and bring the tack on the ſame board as you take the wind; an operation for which you have full time ſufficient, as, by righting the helm, you moderate the velocity with which the ſhip flies to the wind, ſince, by that action, the effect of the rudder is totally ſuppreſſed.

A SECOND METHOD.

Make faſt a four-inch rope to the ſlings of the main-yard; and, when the ſhip comes-to, ſo as to ſhiver the main-ſail, bring it down before the ſail to the topſail-ſheet bitts, and let it be hauled tight and belayed. Then, as ſoon as ſhe falls off, put the helm a-weather, and let go the main ſheet. By theſe means, the lee-part of the ſail no longer has any power to keep the ſhip to the wind, and the

the weather-part acting before the centre of gravity will cause her to veer faster than by the first method; though, in general, the first method will answer the purpose.

TO VEER UNDER BARE POLES.

The fore-stayfail must, if circumstances will allow it, be hoisted. (§. 31.) But, if that cannot be done, the head-yards are to be braced up as sharp as possible, and those abaft pointed to the wind. Then, if the ship veers, she will steer under the masts and ropes only. A number of seamen, sent up and placed close to each other in the weather fore-shrouds, will be found also of very great service.

TO BOXHAUL A SHIP, OR THE SECOND METHOD OF VEERING.

In this evolution, the most rapid execution is necessary. Briskly, and at the same instant, haul up both the main-sail and the mizen; shiver the main and mizen topsails; put the helm hard alee; raise the fore-tack; let go the head-bowlines, and brace about the head-yards sharp the other way; and let the jib and stayfail sheets go in the same instant. When the ship has fallen off 90°, brace the after-yards square, in order to give the ship a little way, and to help her (with the rudder, the situation of which must be changed) to double the point where all the sails shiver; and, when the wind is aft, you will proceed as in the method of "*Veering without losing the wind out of the sails.*"

If the circular motion of the ship, after she has fallen off 90°, continues pretty rapid, the filling of the after-sails, to give the

 ship

ſhip headway, may be diſpenſed with; becauſe ſhe continues to turn by the effect of her helm, which muſt not be ſhifted, (§. 58,) ſince the veſſel ſtill continues her ſternway. Therefore, after having veered a few degrees more, the wind will fill all the ſails, and the ſhip conſequently will have headway. (§. 35 and 43.) Then change the ſituation of the rudder, (§. 50,) to bring her before the wind.

In a caſe of abſolute danger, when it might be neceſſary to go a-ſtern and fall off more rapidly, put the helm a-lee, brace all the ſails a-back, obſerving not to brace the after-ſails more than ſquare, that they may not counteract the head-ſails, which are braced ſharp a-back to pay the ſhip's head off; becauſe the effect of the after-ſails, in this ſituation, is to impel the ſhip abaft in the direction of her keel; (§. 36;) which, with thoſe forward, contribute to give her freſh ſternway, in order to cauſe the ſhip to veer (§. 58) with greater celerity. The jib and fore-topmaſt ſtayſail-ſheets being hauled over to windward, will aſſiſt the ſhip in falling-off and going a-ſtern. (§. 31.)

When a ſhip is taken a-back, by bad ſteerage or a ſhift of wind, ſhe may ſometimes be brought on the ſame tack again, by inſtantly bracing ſharp round the head-ſails, and keeping faſt the jib and ſtayſail ſheets. One muſt recollect, alſo, the after-ſails are not to be touched (§. 45) till the ſhip has ſufficiently fallen off; and, when that ſhall be the caſe, trim the ſails and ſtand on as before. The rudder is to be uſed, as occaſion may require, according to §. 50 and 58, whether the ſhip has head or ſtern way.

DEMONSTRATION.

This operation ſhould be performed with the greateſt alacrity, becauſe it is only practiſed in critical ſituations; ſuch as finding the ſhip unexpectedly too near the land, or becauſe the ſhip miſſes ſtays.

The reaſons for hauling up the main and the mizen ſails, and ſhivering the mizen-topſail, having been given before, we have only

only to add, that the reason why the main-topsail is shivered is, that, if it were kept full, it would bring the ship to the wind, (§. 41,) by shooting her a-head, so that she would almost be laid-to. If this sail were braced a-back, more than perfectly square or perpendicular to the keel, it would still keep the ship to the wind, since it would be braced the same way with the head-sails. Therefore, it would impel the after-part of the ship to leeward, (§. 44,) and act consequently against the power of the head-sails, which ought to cause the ship to veer rapidly, because they receive the wind on their anterior surfaces (§. 37 and 38) with a very great sine of incidence. It is therefore absolutely necessary to keep the after-sails shivering till the ship has fallen off 90°, or thereabouts; because, then, all the sails are trimmed and shivering in the same direction, since the head-sails were suddenly braced sharp a-back, in the beginning, to promote the ship's veering; and the after-sails were also changed at the same time, by bracing them by little and little to the wind, to keep them shivering, as the ship falls off. If the sails are well worked, they will all be found shivering at the same time; and then they no longer act on the ship, which will not double this point by the sole effect of the helm, for the helm was put hard a-lee in the beginning, to heave up in the wind with all possible expedition; but the ship, soon after getting sternway, falls off rapidly, both by the effects of her sails, and by that of her rudder, which is well disposed for this movement, (§. 58,) but has not always sufficient force to cause the ship to double the point where all her sails shiver; because the wind, being then on her quarter, acts on the whole machine to send her a-head; so that, if one ceased working here for a moment, the ship would be motionless for a time, having lost her sternway. To put her again in action, and to prevent her from driving more than is necessary to leeward, fill the after-sails, as mentioned above, to give her headway, in order that, by shifting the helm, (§. 50,) the wind may be quickly brought aft.

The jib and staysail sheets are let go, because they tend to draw the ship a-head. (§. 31.)

Boxhauling is deemed the ſureſt and readieſt way to get a ſhip under command of the helm and ſails, with the leaſt loſs of ground to leeward, when a ſhip refuſes ſtays. The maſters of ſloop-rigged veſſels, turning to windward in narrow channels, when they want but little to weather a certain point, run up in the wind till the headway ceaſes, then they fill again upon the ſame tack: this they call making a *half-board*. Thus a ſhip, in boxhauling, may be ſaid to make two half-boards; firſt running with her head, then with her ſtern, up in the wind; by which two motions a ſhip rather gains to windward.

TO CLUBHAUL A SHIP.

Clubhauling is practiſed when it is expected that a ſhip will refuſe ſtays upon a lee-ſhore. Place the hands to their ſtations for putting the ſhip about, and ſome by the lee-anchor; then put the helm down, and if the ſhip make a ſtand before ſhe brings the wind a-head, let go the anchor and haul the main-ſail. When the wind is a-head, cut the cable, and the ſhip will caſt the way required. The after-ſails being full, let go and haul.

ANOTHER METHOD.

Bend a hawſer to the kedge-anchor on the lee-bow, and bring the end into one of the after-ports, or over the taffarel. Let go the anchor, brace up all ſharp the contrary way, put the helm a-lee, and haul in briſkly on the hawſer. As ſoon as ſhe gets head-way, cut or ſlip the hawſer, and carry a preſs of ſail.

OF

OF LYING-TO, &c.

OF LYING-TO IN FAIR WEATHER.

Lying-to is the art of diſpoſing the ſails in ſuch a manner, that, counteracting each other, they render the ſhip as it were, for a time, immoveable.

This is ſeldom practiſed but under the three topſails; yet it is indifferent whether the fore or main topſails be braced a-back or kept full; becauſe, as theſe two ſails have ſurfaces nearly equal, they have nearly the ſame power either to ſtop the ſhip's way, or to cauſe her to run a-head. When theſe two ſails act together, or one againſt the other, one always tends to pay the ſhip's head off, and the other to keep her to the wind. (§. 32, 37, 41, and 44.) But there are other conſiderations to be attended to, when neceſſity requires this operation to be practiſed.

TO LIE-TO TO WINDWARD OF A SHIP, SO AS NOT TO DRIFT NEAR HER.

The main-topſail muſt be braced ſharp a-back, keeping the fore and mizen topſails full; becauſe the wind acts with a very ſmall ſine of incidence on a ſail when full, in compariſon to what it does when

when braced ſharp a-back: ſo that the fore-topſail, being full, draws the ſhip a-head, and the effect of falling off is oppoſed by the main and mizen topſails. She will of courſe not fall off much; nor will her lee-way be very conſiderable; for the ſhip is well kept to the wind, by the diſpoſition given to her ſails.

TO LIE-TO UNDER THE LEE OF ANOTHER SHIP.

The fore-topſail ought to be braced ſharp a-back, the main and mizen topſails kept full, becauſe theſe two laſt-mentioned ſails tend to give the ſhip headway, and keep her to the wind: they may be aſſiſted by the mizen, which will oppoſe the falling off occaſioned by the fore-topſail. Thus, ſhould the ſhip to windward fall off violently, or drift too much, you are more ready to veer ſhort round, and avoid being boarded; becauſe the fore-topſail being braced ſharp a-back, the impulſe of the wind on it is much greater than if it were full; and it is well diſpoſed to veer ſuddenly, as ſoon as the power of the other ſails is ſuppreſſed.

TO BRING-TO WITH THE FORE OR MAIN TOPSAILS A-BACK TO THE MAST OR FILLED.

Either the fore or main topſail muſt be braced ſharp a-back, and the lee-bowline hauled up a little: the other two topſails trimmed ſharp; with the mizen hauled out, and the helm a-lee.

If you bring-to with the fore-topſail to the maſt, the head-yards may be only laid ſquare. Then the wind will act obliquely on the ſail, and the ſhip will fall off but little, becauſe its effect is in the direction

direction of the keel from forward aft, and the ſails abaft keep the ſhip to. The main-topſail may be worked in the ſame manner, if you wiſh not to expoſe yourſelf much to the wind.

DEMONSTRATION.

It has already been demonſtrated, that if the fore or main topſail be braced ſharp a-back, while the other remains full by the wind, the ſhip ſtands as if it were immoveable, for their actions are abſolutely contrary with reſpect to the centre of gravity, (§. 18,) and very nearly equal; therefore, in this ſituation, the ſhip can but drive to leeward at the rate of about half a league an hour.

TO BRING-TO WITH THE THREE TOPSAILS A-BACK.

The jib and ſtayſails being hauled down, brace ſharp round at once all the ſails you wiſh to lie a-back in hauling up the lee-bowlines, the better to expoſe the ſails to the action of the wind: haul out the mizen, and put the helm hard a-weather.

DEMONSTRATION.

The jib and all the ſtayſails are hauled down, becauſe they are before the centre of gravity (§. 31); and the head-ſails, being braced ſharp a-back, have force enough (§. 37) to balance the effect of thoſe abaft (§. 44); which, being braced in the ſame manner, receive the wind with the ſame ſine of incidence as thoſe forward. But, as in that ſituation the head-ſails, having more power to cauſe the ſhip to fall off (§. 12) than thoſe abaft, being a little becalmed by thoſe forward, have to bring her to the wind, the mizen

is

is hauled out (§. 40), and the helm is put a-weather (§. 58), becauſe the ſhip goes a-ſtern with all the topſails to the maſt. In this ſituation, then, the ſails, aſſiſted by the rudder, act the one againſt the other, and balance reciprocally their effects of ſpringing the luff and falling off; and, though the ſhip goes a-ſtern and drifts a great deal, ſhe is laid-to; becauſe, in that ſituation, ſhe yields but with great difficulty to the impulſe of her ſails, on account of the reſiſtance of the water (§. 5), oppoſed to the very great ſurface of her bottom under the lee.

If there were occaſion to keep the mizen topſail full, it might be done with advantage; becauſe the effect of its acting againſt the other ſails is ſo inconſiderable, that it cannot admit of a compariſon, as its ſurface is hardly half that of the main topſail.

If it be deſired to go a-ſtern without falling off, the head-ſails are to be laid ſquare only.

TO FILL, WHEN LYING-TO WITH THE FORE TOPSAIL TO THE MAST.

Brail up the mizen, hoiſt the jib and fore-topmaſt ſtayſail, ſhiver the main and mizen topſails, and, when the ſhip has fallen off 20° or 30°, fill the fore-topſail, which was a-back before, and ſtand on.

DEMONSTRATION.

The mizen is hauled up, that its effect of keeping the ſhip to the wind may ceaſe (§. 40). The jib and fore-topmaſt ſtayſails are hoiſted, to help the ſhip in falling off (§. 31). The main and mizen topſails are ſhivered, becauſe their effects are contrary (§. 41 and 44) to the movement expected from the ſhip. Every thing, therefore, which cauſes her keeping to the wind, ceaſing to act,

aft, and all that promotes her falling off now operating, it follows that she must fall off with a rapidity so much the greater, as the helm is still a-lee (§. 58). The ship goes a-stern, since her head-sails are braced a-back, and her after-sails so disposed and shivering, that, when she has fallen off sufficiently, the head-sails fill, and you stand on directly.

TO FILL, WHEN LYING-TO WITH THE MAIN-TOPSAIL TO THE MAST.

Brace sharp and briskly the fore-topsail a-back; shiver the main and mizen topsails; hoist the jib and fore-topmast staysails, and brail up the mizen, all at the same time; and, when the ship has fallen off 20° or 30°, fill the fore-topsail, and stand on.

If you are obliged to keep the wind on the same tack as that on which you are lying-to, you have only to right the helm, fill the topsail which is a-back, and trim it sharp, to continue your course.

DEMONSTRATION.

The fore-topsail is braced sharp a-back, in order to cause the vessel to fall off more readily, as then it receives a very strong impulse from the wind (§. 37). The rest of the demonstration will be found in the preceding.

A SECOND METHOD.

Trim the topsail which was to the mast, in order to give the ship way through the water, and be able to tack, or run large, according

cording as may be found neceſſary. But this method is very tedious, unleſs you mean to heave in ſtays; in which caſe it will be moſt expeditious.

A THIRD METHOD.

Shiver the main and mizen topſail, keeping the fore-topſail full, righting the helm, and running up the jib and fore-topmaſt ſtayſail at the ſame time. As ſoon as the ſhip has fallen off enough to get headway, fill the after-ſails, and keep the ſhip in the direction you mean to follow. It is eaſily ſeen that this method, though the moſt common, is not the moſt expeditious, when you have to veer conſiderably.

TO FILL, WHEN LYING-TO WITH ALL THE SAILS TO THE MAST.

Brail up the mizen, lay the after-yards ſquare, and ſhift the helm a-lee. When the ſhip has fallen off ſufficiently to fill the after-ſails, thoſe forward are then to be braced about and trimmed full alſo, in order to ſtand on.

DEMONSTRATION.

The mizen is brailed up, becauſe its effect is to keep the ſhip to the wind (§. 40). The after-yards are laid ſquare, becauſe then they give the ſhip ſternway (§. 36), which cauſes her to fall off, ſince they increaſe her velocity in the laſt-mentioned direction, the helm being a-lee ſo as to turn the ſtern to windward (§. 58). The head-ſails are braced about and filled at the ſame time as the after-

ſails

ſails are, that the ſhip may not be as it were laid-to, and that ſhe may get headway to continue her courſe.

OF LYING-TO IN A GALE OF WIND.

To lie-to when it blows hard, keep as cloſe to the wind as poſſible under ſome one ſail well trimmed, with the helm laſhed a-lee as much as may be requiſite for the ſhip; and, as ſhips commonly bring-to from the ſtreſs of contrary winds, care ſhould be taken to heave-to under ſuch ſail as will leaſt ſtrain the ſhip; becauſe there are ſome ſhips which lie-to better under the fore-ſail than the main-ſail, others are more eaſy under the main-ſail, ſome under a mizen, and many veſſels lie-to beſt under a main-ſtay-ſail.

LYING-TO UNDER A FORESAIL.

This is advantageous for veering (§. 32) when you are well to windward; but it augments the lee-way, and is more ſubject to break the ſea on-board, on account of the ſhip's continual falling off: becauſe, in that movement, ſhe gathers way by yielding to the impulſe of the gale, and is afterwards recalled to the wind by the helm (§. 50); ſo that, in ſpringing the luff, ſhe meets the wave which comes from to windward.

LYING-TO UNDER A MAINSAIL.

The ſhip does not, in this ſituation, fall off ſo eaſily as in the laſt-mentioned mode, becauſe its effect paſſes abaft the centre of gravity of the ſhip (§. 41); but it keeps the ſhip more to the wind, and conſequently occaſions leſs lee-way.

LYING-TO UNDER THE MIZEN.

Under the mizen ſhips keep better to the wind than under any other ſail, becauſe it is farther abaft the centre of gravity (§. 40) than any of the reſt; conſequently ought to keep the veſſel from drifting more than any of the others; but is inconvenient, ſhould you have occaſion to veer ſuddenly.

LYING-TO UNDER THE MAIN-STAYSAIL.

Under the main-ſtayſail a ſhip will not make ſo much lee-way as under a fore-ſail, becauſe its effort paſſes very near the centre of gravity; but it will however cauſe her to drift more (§. 31) than the main-ſail (§. 41): ſo that this mode of lying-to is a mean between the two others, and is preferable when it blows ſtrong enough for that ſail to ſupport the rolling of the ſhip. It ought likewiſe to be preferred, becauſe the ſhip will veer under that ſail, the action of which paſſes at a ſmall diſtance from the centre of gravity

gravity (§. 31), and the power of which overcomes the resistance which all ships meet from the fluid under their lee; a resistance which always gives them a great inclination to fly up in the wind, when it blows hard, or when under a heavy press of sail.

LYING-TO UNDER THE FORE, MAIN, AND MIZEN, STAY-SAILS.

All the preceding modes of lying-to have their peculiar faults; but the preferable way is under the fore-stayfail, the main-stayfail, and mizen-stayfail; because, under these sails, the ship will steer (§. 46), and is in a better situation for veering than under any other sail; for, only haul down the mizen-stayfail, and put the helm a-weather; when the two other sails, being before the centre of gravity, (§. 30 and 31,) will cause her to fall off; she will then soon gather way and steer easily.

Should the gale continue very hard, and one of these stayfails be blown away, the loss is not of much consequence, as the courses, in case of an emergency, are ready to set; whereas the courses are not so readily replaced when lost. This mode, therefore, appears preferable in every respect,* whether you wish to veer or keep your wind: because, if the ship does not sufficiently keep the wind, you may haul out the balanced mizen (§. 40), or take in the fore-stayfail (§. 31), or even the main-stayfail. One of these stayfails, before the centre of gravity of the ship, is sufficient to make her veer as soon as the after-ones are suppressed. There are, besides, these following considerations for so doing: The ship will carry sail better; because, as the centre of effort of those on her is very low, she drifts less, holds a better wind, and goes faster through the water (§. 25 and 46); and these three or four sails are

* Should the sea run too high for the lower stayfails to keep the ship steady, a close-reefed main-topsail (particularly if it has four reefs in it to come close down to the cap) will be found to answer the purpose admirably.

are ſo ſituated as to give the whole body of the ſhip play, which will ſtrain her leſs than when under one ſingle ſail, which cannot by itſelf work it from aft forward.

DEMONSTRATION.

The object of lying-to being to keep to windward as much as poſſible, when foul winds and tempeſtuous weather prevent you from purſuing your courſe, it follows, as much ſail ſhould be carried as is conſiſtent with ſafety; and, as you are often unable to ſet more than one ſail, it is trimmed ſharp, that the ſhip may keep her wind as much as poſſible. It is likewiſe for this reaſon that the helm is at the ſame time put a-lee; becauſe the ſhip, having but very little way, (§. 46,) falls off, by yielding from time to time to the impulſe of the wind, which unceaſingly acts on her; but, as ſoon as ſhe has fallen off, ſhe is brought-to again by the effect of the rudder (§. 50), which muſt act upon her if the water has the ſmalleſt power upon it.

The ſame happens in lying-to under the three ſtayſails, (though the ſhip makes more headway under any other ſail,) becauſe the effect of theſe ſails is better diſtributed (§. 46) than when one only is ſet; notwithſtanding they have not power enough to procure the ſhip much velocity, nor to make her ſteer properly: the helm is therefore put a-lee as in lying-to under any other ſail. It is always more advantageous to keep the ſhip under way and lively, than to let her lie, at the mercy of the wind and waves.

When the wind is ſo violent that no ſail can be carried, you lie-to a-try; that is to ſay, under bare poles and ropes, which ſerve inſtead of ſails, and laſh the helm a-lee as uſual.

OF

OF SOUNDING IN FAIR WEATHER, WHETHER CLOSE-HAULED OR GOING LARGE.

CLOSE-HAULED.

If close-hauled, brail up the mizen and mizen-stayſail, let go the main-ſheet that the ſail may ſhiver, put the helm a-lee, and back the mizen-topſail by bracing it ſquare. The head-ſails, as well as the jib and ſtayſails, are to be kept in their firſt ſituation; recollecting to haul tight and belay the lee-braces. When the ſhip has nearly loſt her headway, though continuing ſtill to come to the wind, you catch that moment to heave the lead, and it is to be hauled in again with all poſſible diſpatch. To fill again, haul aft the main-ſheet, trim the mizen-topſail, and right the helm.

GOING LARGE.

In going large, you have only to put the helm a-lee, to brail up the mizen, and to belay the lee-braces quite tight, to prevent the yards having too much play when the ſails are ſhivering. It is impoſſible to tack in this ſituation, as the jib and head-ſails are always in action (§. 31); and the ſquare-ſails, ſoon coming to ſhake, on account of their ſheets not being tacked, they loſe all their power, and the ſhip is ſoon at a ſtand.

DEMONSTRATION.

The mizen and mizen-ſtayſail are brailed up, becauſe their effect to bring the ſhip to the wind would be too powerful (§. 40). For the ſame reaſon, the main-ſheet is let go (§. 41), though there is another reaſon for it, which is, that it deſtroys the equilibrium that

that exiſted between the ſails forward and the ſails aft (§. 46 and 49); whence the rapidity of ſailing is diminiſhed, as well as the effect of the helm, which acted (§. 50) to bring the ſhip to the wind, while at the ſame time it oppoſes her velocity (§. 59). The mizen-topſail is braced a-back, to impel the ſhip a-ſtern in the direction of her length (§. 36); ſo that her headway, being now much diminiſhed, the ſhip, by the effect of the rudder, ranges to the wind ſo far as to ſhake the main-topſail and the ſails on the foremaſt, which, to that very moment, had acted to keep up the celerity of ſailing (§. 32 and 41). But, as the effect of the rudder is very faint, ſince the velocity of the ſhip is greatly diminiſhed (§. 58) when the ſails have loſt their action, the ſhip muſt ſtop, and is not able to come ſufficiently to the wind, to bring her about, becauſe the jib and ſtayſail ſheets, being hauled aft, oppoſe the effect of the helm; ſo that ſhe reſts, as it were, motionleſs for an inſtant, which muſt be ſeized to throw the lead with the greateſt diſpatch; becauſe, ſhould the ſhip fall off by the effect of her jib and ſtayſail, which are the only ones in action, the other ſails might ſuddenly fill and give her headway, which would prevent you from getting ſoundings, were you too dilatory in throwing the lead. Whether you do or do not find any bottom, haul in your line as faſt as poſſible, and ſeize the opportunity of the ſhip's falling off to fill and ſtand on again.

If the ſhip, in ſpite of the diſpoſition given her, ſhould come head to wind, (which could only happen from her having preſerved ſome velocity,) the helm muſt be kept a-lee, but the head-ſails ſhould quickly be laid ſquare, and the jib and ſtayſails hauled down; then the ſhip will ſoon after be found to veer.

ANOTHER METHOD PREFERABLE TO THE FORMER.

GOING LARGE.

Brace the head-ſails ſquare, haul down the jib and ſtayſails, without ſtirring the after-ſails, and put the helm a-lee. While the ſhip has ſtill a little headway, heave the lead from the place where you

you haul it in; that lead will go firſt a little a-ſtern; but the ſhip, being head to wind, will ſoon herſelf go a-ſtern right upon the line; and, as the helm is a-lee, the ſhip eaſily veers. But, if you wiſh to keep her to longer, right the helm and haul the mizen out, to prevent the ſhip's falling off.

If you have ſtudding-ſails ſet, they muſt be hauled down, particularly the lower ones; becauſe, ſhould the wind take them a-back, their power on the boom might bring the ſhip round entirely; for, they act on a lever without the ſhip, the fulcrum of which is on the outſide of the veſſel before the centre of gravity. If, however, the helm is continued a-lee till the ſhip falls off, ſhe will not come about, becauſe then the veſſel goes a-ſtern with great velocity, and the rudder acts powerfully to make her veer; but the fact is, that the ſhip will go a great deal ſternway, and continue ſo much longer.

CLOSE-HAULED.

If cloſe-hauled, or a very little from the wind, the helm is to be put a-lee; and, the inſtant the ſails are taken a-back, the head-ſails are to be filled by briſkly bracing them ſquare, without waiting for the wind being right a-head; then, a little before the ſhip has loſt her way, heave the lead from the place where you haul it in, and then proceed as before.

ON SHIPS DRIVING.

When it happens that there is not ſufficient room to work in a tide's way, through a crowd of ſhips, or in a narrow channel, but that a ſhip muſt drive by the help of the tide, it may be done, provided the tide be ſtrong enough, in proportion to the wind. This art conſiſts of keeping the ſhip in a fair way, by a management of the rudder and the ſails.

TO DRIVE TO WINDWARD, WHEN THE WIND IS AGAINST THE TIDE.

If the channel is ſufficiently broad, the ſhip ſhould be drifted broad-ſide to the wind, as the tide will then have the greateſt power on her; and, could the ſhip be backed a-ſtern or ſhot a-head at pleaſure, ſhe might be kept drifting upon the ſame tack with ſafety; but ſhips in a tide's way can never be backed ſo far a-ſtern as they will ſhoot a-head. At the firſt of a ſtern-board a ſhip will go briſkly a-ſtern, but will ſoon fall off, and drift with the wind abaft the beam, forging a-head; for this reaſon ſhe muſt be drifted with the helm a-lee. It follows, as a ſhip will ſhoot more a-head than ſhe can be backed a-ſtern, that ſhe will at length arrive at the oppoſite ſhore, when ſhe muſt be ſtayed or veered, and drifted upon the other tack. If ſhe is to be ſtayed, (which is preferable, becauſe

becauſe leſs drift will be loſt by it,) let the ſails be filled in time, to give the ſhip ſufficient headway to bring her about; then put the helm a-lee. Should ſhe come about, the ſails and helm, having now a proper poſition for a ſtern-board upon the other tack, need not be touched till her ſternway ceaſes, when the helm muſt be ſhifted a-lee; but, ſhould the ſhip refuſe ſtays, then brace ſharp round the head-yards, and boxhaul her, by which method ſhe will loſe much leſs drift than by veering.

If the ſhip, now drifting broad-ſide, is approaching a narrow channel, where drifting in this poſition, ſhe muſt be veered and dropped ſtemming the tide, ſtern foremoſt. In this caſe, that the drift may be as much as poſſible, it will be neceſſary to take in ſail, and reduce the ſhip's headway till ſhe has only ſteerage-way left; thus a veſſel may be dropped through a fleet of ſhips at anchor without danger.

TO DRIVE, WHEN THE WIND IS ACROSS THE TIDE.

Should the wind be a little acroſs the tide, a ſhip may be eaſily drifted in the fair way, with her head towards the weather-ſhore; for thus it will be found that ſhe can be backed and filled at pleaſure, and generally be drifted with the ſails ſhivering, in which poſition they oppoſe leaſt power to prevent the drift.

It frequently happens in ſerpentine rivers that the tide ſets acroſs; in this caſe the ſhip muſt be drifted with her head to the ſide from which the tide ſets. Theſe ſets are beſt diſcovered by obſerving the opening or ſhutting of two objects in the direction of the channel.

ON BENDING SAILS.

TO BEND A COURSE IN FAIR WEATHER.

Stretch the ſail a-thwart the deck, the ſtarboard-ſide of the ſail to the ſtarboard-ſide, the larboard to the larboard-ſide; then bend yard-ropes to the ear-ring cringles, and make faſt the head ear-rings a few feet up upon the yard-ropes. The bunt-lines, leech-lines, clue-garnets, and all the geer bent, make faſt a rope-band to each bunt-line and leech-line leg, that the men may be enabled to catch the head of the ſail from the yard. Now man well the yard-ropes, bunt-lines, leech-lines, and clue-garnets, and run the ſail up to the yard. The ſail aloft, ſend the hands up to bring it to, and let them haul out the weather ear-ring firſt, then the lee; and, if it is a new ſail, let them ride the head-rope to ſtretch it. The ſail being hauled ſquare out upon the yard, make faſt the rope-bands, keeping the head of the ſail well upon the yard.

TO BEND A TOPSAIL IN FAIR WEATHER.

Overhaul the leeches of the ſail, put in the ear-rings, bend the bowline-legs, lay out the clues, and open them if neceſſary, and make

make the ſail up ſnug again; then round down upon the lee top-ſail-haliards till the weather fly-block is high enough to bring the ſail up over the guard-iron: then rack the tie over to the weather-rigging. Now pile the ſail upon ſlings, with the lee-ſide uppermoſt; hook on the topſail-haliards, and run the topſail up into the top; then ſtretch the ſail round the fore-part of the top, bend the jeer, and make faſt the head ear-rings a few feet up upon the reef-tackle pendents, with a rope-band or two to each bunt-line leg. The jeer being bent, man the reef-tackles, bunt-lines, and clue-lines, and haul out the ſail. Now let the hands lay out upon the yard, and haul out the weather ear-rings firſt; then haul out to leeward, and eaſe off to windward till the ſail is ſquare, when make faſt the rope-bands, keeping the head of the ſail well up upon the yard.

UPON

UPON SETTING AND TAKING IN SAILS IN BLOWING WEATHER.

TO SET A MAINSAIL.

Before the ſail is looſed, let the double block of a tackle be made faſt to the weather-clue, and the ſingle block be hooked low down upon the cheſs-tree, and the fall led aft. Then man well the main tack and fall at the ſame time; and, when the ſail is looſed, eaſe away the weather clue-garnet, let go the bunt-lines and leech-lines, bowſe down upon the tackle, and take in the main-tack: the main-tack being down, haul aft the ſheet, brace up the yard, and haul the main-bowline.

TO SET A FORESAIL.

A foreſail is ſet after the ſame manner as a mainſail; but, as the fore-tacks generally lead double, they are a ſufficient purchaſe without the aid of a tackle to the weather-clue.

TO SET A TOPSAIL.

Let a tackle be in readineſs to clap on either ſheet, as may be required. Firſt, man the lee-ſheet; and, the ſail being looſed, eaſe down

down the bunt-lines and weather clue-line, and haul home the lee-ſheet; then haul home the weather-ſheet, hoiſt the ſail, and brace up as required.

Should the wind be quartering, the lower and topſail yards ſhould be braced well into the wind, before the ſail is ſheeted home.

TO TAKE IN A COURSE.

Man well the weather clue-garnet, eaſe off the tack and bowline, and run it up; then man the lee clue-garnet, bunt-lines, leech-lines, and weather-brace; and, being all ready, eaſe away the ſheet, haul up the clue-garnet, bunt-lines, and leech-lines, and round-in the weather-brace, till the yard is pointed to the wind. Then haul tight the truſſes, braces, lifts, and rolling tackle, and let the hands furl the ſail.

TO TAKE IN THE FORESAIL IN THE TIME OF VEERING.

When the ſhip begins to veer, the yard being kept braced ſharp up, let go the tack and bowline, and haul up the weather clue-garnet. When the ſhip is nearly before the wind, the bunt and leech lines, and the other clue-garnet, may be hauled up; and, if the ſituation admits of it, and occaſion requires, the ſhip may be ſteered with the wind on the quarter, till the ſail is ſecured.

TO TAKE IN A TOPSAIL.

There are many opinions upon the beſt mode of performing this. Some approve of clueing up to windward firſt, and others to leeward. If the weather-ſide is to be clued up firſt, the weather-brace muſt be rounded well in, and the yard got cloſe down upon the lifts, otherwiſe the lee-rigging will be in danger of being carried away by the great preſſure of the lee yard-arm. If the weather-brace can be rounded well in, and the yard be got cloſe down, it will be beſt to clue up to windward firſt, for thus the ſail may be taken in without a ſhake; but, if the weather-brace cannot be hauled in to eaſe the yard off the lee-rigging, recourſe muſt be had to clueing up to leeward firſt. In this caſe, it will be beſt, if hands can be ſpared, to man both the clue-lines, bunt-lines, and weather-brace, at the ſame time; thus, when the lee-ſheet is eaſed off, the weather-brace may be hauled in with eaſe, and the yard laid to the wind; and, when the lee clue-line is half up, eaſe off the weather-ſheet, and run up the weather clue-line; then haul tight the lee-brace, bowſe tight the rolling-tackle, and furl the ſail.

TO TAKE IN A JIB.

Man well the down-haul, let go the haliards, eaſe off the ſheet, and haul down briſkly; and, when the ſail is cloſe down, eaſe away the out-haul, and haul the ſail in to the bowſprit-cap; then let it be ſtowed away in the fore-ſtayſail netting.

TO

TO HAUL IN A LOWER STUDDING-SAIL.

To haul in a lower ſtudding-ſail, blowing freſh, lead one of the ſheets clear aft, and man it well; then lower away briſkly the outer haliards, to ſpill the ſail; eaſe off the tack, run in upon the ſheet, and lower away the inner haliards as required.

TO HAUL DOWN A TOPMAST STUDDING-SAIL.

Man well the deck-ſheet and down-haul, eaſe off the yard-ſheet, and haul the yard cloſe out to the tack-block; then eaſe away the tack; and haul down both upon the deck-ſheet and down-haul.

TO BRAIL UP AND HAUL DOWN A MAIN-TOPMAST STAY-SAIL.

Man well the lee-brail and down-haul, having a few hands to gather in the ſlack of the weather-brail; then let go the haliards, eaſe off the ſheet, and haul down and brail up as briſkly as poſſible. When the ſail is down, let go the tack, and ſtop the ſail over to the lee fore-rigging.

TO BRAIL UP A MIZEN.

Man well the lee-brails, and in particular the throat-brails, which ſhould have a whip-purchaſe; eaſe off the mizen-ſheet, and brail up briſkly, taking in at the ſame time the ſlack of the weather-brail. After the ſail is hauled up, ſtop its foot by paſſing the gaſket round to leeward, which will ſpill it.

TO TAKE IN A TOPGALLANT-SAIL.

The lee-ſheet muſt be ſtarted firſt; for, if the weather-ſheet is firſt eaſed off, the yard will fly fore-and-aft.

TO UNBEND A COURSE.

Firſt furl the ſail, then caſt off the rope-bands, and make them faſt round the ſail, clear of the gaſkets. When the rope-bands are all off, eaſe off the lee ear-ring, and lower down the ſail; and, when the people upon deck have got hold of the lee-part of the ſail, eaſe away the weather ear-ring.

TO UNBEND A TOPSAIL.

Firſt caſt off the points of the reefs, keeping faſt the ear-rings; then furl the ſail, and caſt off the rope-bands, which make faſt round the ſail, clear of the gaſkets. After this, caſt off the lee ear-rings, and haul the lee-ſide of the ſail into the top; then haul in the weather-ſide. Now unbend the reef-tackle pendents, bunt-lines, and bowlines; bight the ſail ſnugly up together; and ſend it down by the slew-lines to windward or leeward, as moſt convenient.

ON SCUDDING OR BEARING AWAY IN A STORM.

When the waves run high, and ſudden neceſſity requires to bear away, it ſhould be conſidered that the lower ſails forward, which the ſhip may be veered under when ſhe comes before the wind, may be becalmed by the height of the waves breaking violently againſt the ſtern; and that therefore a cloſe-reefed main-topſail ſhould be ſet to catch the wind, becauſe it is a loftier ſail, and may always be kept drawing full above the waves. This increaſes the ſhip's headway ſo much, that the waves will not ſtrike her abaft with ſo great a velocity as when her headway is leſs.

Hence it follows, that, when going to ſcud before high waves, the cloſe-reefed main-topſail ſhould be the laſt ſquare-ſail taken-in in a labourſome ſhip.

OF A SHIP OVERSET ON HER SIDE.

A common but not always a certain method to recover ſhips from this dangerous ſituation, is to cut away the maſts: however, as this expenſive method may fail, ſtopwaters only, on the lee-quarter at ſea, may cauſe the ſhip to veer; or, where there is ground, an anchor or anchors, dropped from the lee-bow, may bring the wind a-head, and take the ſails a-back, ſo as to caſt the ſhip on the other tack, and bring her upright.

ON

ON CHASING.

A veſſel that chaſes another ought to have the advantage of ſailing. We ſhall therefore ſuppoſe this to be the caſe; becauſe, were the ſhip chaſed as good a ſailer as the chaſer, ſhe never could come up with her, if they manœuvred equally and at the ſame time. It is then uſeleſs to chaſe a ſhip over which you have not the ſuperiority in ſailing, unleſs it be found that ſhe does not know how to take the benefit of her equality.

To know if your ſhip ſails quicker than your adverſary, you muſt get on the ſame tack, under the ſame ſails, and keep the ſame courſe with the veſſel you wiſh to chaſe, and ſet her exactly with a compaſs. If you ſail beſt, the chaſe will ſoon be drawn a point more aft; but, if ſhe has the advantage, you will in a ſhort time bring her a point farther forward: if you ſail equally, ſhe will remain on the point you ſet her at firſt.

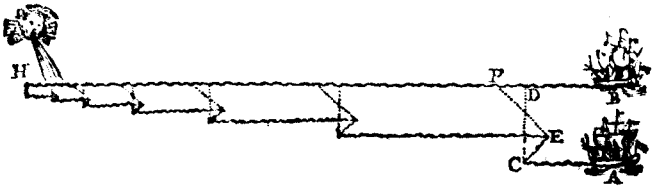
TO CHASE A SHIP WHICH IS TO WINDWARD, AND TO JOIN HER IN THE SHORTEST METHOD.

When the chaſer is to leeward of the veſſel he means to purſue, he ought to run on the ſame tack as the enemy, till he brings her to bear

bear exactly perpendicular to his course, if he has not however already passed that point: then tack and continue the second board till he brings the chase again perpendicular to the direction on which he is standing by the wind, and he must then heave about again; always continuing the same manœuvre, by tacking every time he brings the chase perpendicular to his course on either board. In this manner, the chaser will, by the superiority only of his sailing, join the other by the shortest method.

DEMONSTRATION.

FIGURE 20.



When the ship A (*fig.* 20) chases the ship B, which is three leagues to windward, A having one-fourth of advantage in sailing, the chaser is not to tack till he reeches the point C; because then the ship B will be right on his beam at the point D. He then runs on the tack C E, till he brings the chase again perpendicular to his course at the point F. *The ship* A *is to continue* working thus every time she brings the vessel B right a-breast of her, whether the chase continues on the same tack or not; and thus the chaser will join the other at H, so that she will be able neither to change her course nor fly from him.

You continue on the same tack as the enemy, when first seen, in order to lose no time; because you will always bring the ship you are in chase of right on your beam, when you have a superiority of sailing, whatever may be the track she is on, provided you are careful not to pass that point; but, if perchance you should, you must get on the other tack with all possible dispatch.

The

The chaſer heaves about as *ſoon as the veſſel he is in purſuit of* is on his beam; becauſe ſhe is, at this time, at the ſhorteſt poſſible diſtance, *if he chaſes on the ſame tack* and ſteers the ſame courſe with the veſſel chaſed. If the chaſer runs on a different tack from the veſſel chaſed, he is ſtill to tack when the latter is on his beam, becauſe the diſtance is the leaſt poſſible between them on the different boards they hold.

This mode is preferable to all others, it not only being the ſhorteſt, but becauſe you force the chaſe to fly from you cloſe upon a wind, preſſing her more and more from the leeward, by never paſſing the point at which the diſtance between the two veſſels, in plying to windward, is the ſhorteſt poſſible.

OBSERVATIONS FOR THE SHIP TO WINDWARD, WHICH IS CHASED.

The weather-ſhip, which flies, will always be joined by the chaſer, ſince it is granted that ſhe does not ſail ſo well as the purſuing veſſel. It is therefore her advantage conſtantly to keep one courſe without loſing time to heave about, as tacking cannot be ſo favourable to her as to her adverſary, whoſe ſailing is ſuperior.

If the chaſer ſhould miſtakingly ſtand on a long way, and tack in the wake of the chaſe, the beſt thing ſhe can do is to heave-in ſtays, and paſs to windward of him on the other tack, unleſs you ſuppoſe your veſſel would have a large ſuperiority. If the chaſer perſiſts in tacking in the wake of the other ſhip, the chaſe will be very much prolonged.

TO CHASE A SHIP WHICH IS TO LEEWARD.

When to windward of a veſſel you wiſh to chaſe, keep the ſhip away, to cut her off; and, ſteering continually on that courſe, you come at laſt together at the point where the courſes run by the two veſſels interſecting each other. This will be exactly executed by the chaſing-ſhip, if, in the courſe ſhe has choſen, ſhe conſtantly keeps chaſe on the ſame degree of the compaſs as at the beginning of the purſuit. This principle applies equally to all the courſes which the retreating ſhip ſteers; for over-taking can only be obtained by keeping on a ſtrait line, which is the ſhorteſt poſſible that can be drawn between any two points.

If you take another courſe than that which keeps you in the ſame point of bearing you were in with reſpect to the veſſel purſued, at the beginning of the chaſe, you would fail, by being either too far a-head or too far a-ſtern; that is to ſay, if the chaſer keeps his wind too cloſe, he will be too much a-head, and conſequently prolong the chaſe; and, if he keeps too much away, he will be too far a-ſtern. Theſe are the only two conſiderations to be made for the performance of this manœuvre; conſiderations which are eaſily obſerved, and corrected with an azimuth-compaſs; for, when you ſee that at the end of a certain time you bring the chaſe more aft than her firſt point of bearing, it is evident you keep your wind too much; if, on the contrary, you draw her forward, it is a proof that you keep too much away. Theſe errors are eaſily corrected, by ſteering, for the firſt caſe, ſo as to ſee that the chaſe is always kept exactly on the ſame degree of the compaſs; and, for the ſecond, you keep your wind a little more, till you ſee that you reſt on the ſame point of bearing with reſpect to one another. Then, it is evident, you chaſe by the ſhorteſt and moſt certain method, ſince you reach the chaſe, in running on a ſtrait line.

OBSERVATIONS FOR THE SHIP TO LEEWARD, WHICH IS CHASED.

She ought to run on the courſe that will carry her moſt immediately from the chaſer. Some veſſels have more advantage in going large than others; ſome with the wind right aft; and others, again, are to be found which go beſt cloſe-hauled. So that attention ſhould be paid to the known qualities of a ſhip, in order to take the moſt advantageous and convenient directions capable to effect a retreat. It is, however, nearly certain, that, if the chaſe does not ſail at leaſt at an equal rate with the chaſer, whatever manœuvre ſhe may practiſe, ſhe will at length be overtaken by a ſkilful chaſer adhering to principles.

OF BOARDING.

Boarding is the art of approaching the ſhip of an enemy ſo near, that you can eaſily, and in ſpite of him, throw on board the graplings, which are fixed on the lower yard-arms, at the forecaſtle, gangways, &c. for the purpoſe of being thrown into the enemy's ſhip, as ſoon as along-ſide, in order to confine the veſſels together, and give the people an opportunity of getting on board, to carry the adverſe ſhip ſword in hand.

TO BOARD TO WINDWARD, OR TO AVOID BEING BOARDED.

If it be deſired to board a ſhip which keeps her wind under an eaſy ſail; or that does nor ſhorten ſail, but over which the boarding veſſel has the advantage of ſailing; ſhe muſt get on the weather-quarter of the ſhip ſhe means to board, within half a piſtol-ſhot. She ſhould then begin the action, and continue it with vivacity, to cover her manœuvre by the ſmoke of the cannon and muſquetry of both ſhips; then, under the cover of this cloud, let her make more ſail if ſhe has not way enough, in order to augment the velocity of the ſhip and the rapidity of her movements, that

that ſhe may more readily lay on board her enemy, on the weather-ſide, either exactly a-breaſt or a little abaft. This is very eaſily executed, by edging down ſuddenly upon her; ſo, however, as not to be raked by the enemy's fire. The ſhip boarded by this manœuvre can hardly ſuſpect the deſign but at the moment when, or very little before, the grapnels will be on board of her. In this ſituation the boarded veſſel has but one doubtful expedient to try, and which even will be of no ſervice if the boarder obſerves her well. For, the moment ſhe braces ſharp a-back her head-ſails, to cauſe the ſhip's falling off, (§. 37,) and ſquares thoſe aft (§. 36) to give her ſternway, the boarder has only to perform briſkly the ſame manœuvre, and they will then be both as near for boarding as before, provided the boarding-ſhip feels quickly the impulſe of her ſails and helm, which ought to be put a-weather (§. 50) and kept ſo till the ſhip's headway ceaſes, when it is to be put a-lee (§. 58) to aſſiſt her in falling off, in manœuvring as in boxhauling, in order to board the enemy to leeward; for, the boarder ought to be on the quarter of the other; ſince, at the moment the two ſhips were right before the wind, ſhe who was directly to windward, and wiſhed to board, had only to continue her movement of rotation, and render her velocity equal to that of her adverſary, by ſhortening ſail in order not to paſs her. If, therefore, the circular motion is kept up by the boarder, which at firſt cauſed him to fall off, and now brings him to the wind on the other tack, he will join the enemy to leeward; for, it is evident that, if this motion of turning be more rapid than that of the ſhip which wiſhes to avoid boarding, the boarder will cloſe her before ſhe can range to the wind on the other tack, ſince the boarder comes round with greater celerity. However, if the ſhip which fears boarding was preſſed thus cloſely, ſhe could make no other attempt than to throw once more all her ſails to the maſt, by bracing them only perpendicular to the keel to give her ſternway, (§. 36,) and putting the helm a-weather, to keep her to the wind, as ſoon as her headway ceaſes; (§. 58;) obſerving that, ſhe being to windward, this manœuvre may cauſe her to drive on the boarder, as he is then watching for her under her lee. As there is no other reſource, neceſſity obliges her to this expedient; becauſe, if the ſhip which is attack-

ed could go a-ſtern with ſufficient velocity, ſhe might let the boarder paſs a-head, veer under his ſtern, and rake him, if he is not as quick as the other to foreſee this manœuvre, and as nimble in manœuvring in the ſame manner as the enemy's ſhip: becauſe, the great velocity with which he comes to the wind and goes a-head, (his ſails being ſtill full,) puts him in this bad ſituation, which may prevent his perſiſting in the inclination of boarding. It is however very clear that the boarder will attain his purpoſe, if he takes care to throw all his ſails a-back at the ſame time as the ſhip to windward; becauſe, the attacked ſhip dropping to leeward, and having ſternway firſt, approaches a little the boarder, who has ſtill preſerved his poſition on the quarter, and longer kept his luff, by having gone a-ſtern ſomewhat later than the weather-ſhip. It muſt be farther obſerved, that when the two ſhips are right before the wind, if the veſſel which fears boarding moves quicker to the wind than the one which attacks, ſhe will avoid it, as the retreating ſhip will be cloſe to the wind before the other, and able to get a-head of her by making all ſail to keep her wind, or to heave in ſtays and get upon the other tack. But, it muſt be conſidered that this laſt movement is diſadvantageous; as, by ſo doing, it will preſent the ſtern to a ſhip, which no doubt will take advantage of that ſituation, and rake her; which might be more deſtructive than a well-oppoſed attack by boarding.

There is, however, no doubt that if the ſhip inclined to board ſails better than the other, it will always be in her power to execute that deſign, if ſhe is manœuvred as the ſhip which flies.

TO BOARD TO LEEWARD, WHEN CLOSE TO THE WIND, OR TO AVOID BEING BOARDED.

In order to execute this manœuvre, the boarder is to come within piſtol-ſhot, cloſe in the wake, or, at moſt, to the weather-quarter,

ter, of the ſhip he means to attack; taking care to continue ſteering ſo as not to be raked by any of the guns which belong to the quarter he ſtands on. Then, to come up with his adverſary, he muſt edge away a little, and range round aft, ſo cloſe upon the enemy's lee-quarter, that his cat-head may almoſt touch her quarter-gallery. Now, when you have ſhot ſufficiently a-head, your ſhip being parallel to your adverſary's, ſo as to bring your forecaſtle a-breaſt of your enemy's mainmaſt, the mizen and mizen-ſtayſail ſheets are to be hauled well aft, the helm put hard a-lee, and the head-ſheets let fly; then, your ſhip, coming rapidly to the wind, (§. 40, 50, and 51,) ſhivers her ſails, and cloſes the oppoſing veſſel ſide to ſide. This manœuvre is infallible when you have the advantage of ſailing, provided very great attention is paid to it. But great attention is neceſſary; becauſe, if at this moment the weather-ſhip, which wiſhes to avoid the boarding, either ſets her courſes, or lays all thoſe flat a-back which ſhe had ſet, ſhe may perchance break the grapnels if you have neglected to trim your ſails in the ſame manner as hers: for, by making more ſail, if the wind be a little freſh, ſhe will ſhoot a-head through the water, and drag the boarder with ſuch force as to break the chains or hawſers by which the two ſhips are confined together. By laying all flat to the maſt, the boarded veſſel is ſtill more likely to ſucceed, ſince the ſails of one ſhip will be full, while thoſe of the other are a-back.

This mode of boarding may, as ſhewn before, be anticipated and avoided, if the boarder does not pay the ſtricteſt attention to his own as well as to his adverſary's manœuvres: but it may be ſtill more readily avoided, if the laſt-mentioned veſſel braces her head-ſails ſharp a-back, ſetting only, if neceſſary, the fore-ſail (§. 37), at the ſame inſtant laying to the maſt or ſhivering (according to the neceſſity for more or leſs ſternway) all thoſe which are abaft, (§. 36,) and putting the helm hard a-lee. (§. 58.) All this is to be executed when the boarder is ſtill about a ſhip's length (more or leſs) a-ſtern of the other veſſel. The quickneſs of this evolution, and the rapid veering of the weather-ſhip, may bring the boarding-veſſel, which is a little to leeward or a-ſtern of the other, into the moſt dangerous ſituation, if ſhe does not manœuvre

in

in the ſame manner and with equal celerity; as the boarder's ſails, being full, keep up his velocity, and may, before he can veer, engage his bowſprit in the main-ſhrouds of the enemy, who pays ſhort round on her head.

This terrible and dangerous ſituation is infinitely to be dreaded; and it is of the higheſt importance to pay the ſtricteſt attention to your own manœuvres, and to thoſe of your opponent, which you are to endeavour to foreſee and avoid as much as poſſible.

It is eaſy to conceive, that, if you wiſh to board a ſhip, and to engage your enemy's bowſprit in your main-ſhrouds, you need only get a little to windward of her, and about one or two ſhips' lengths a-head, more or leſs, as (from the knowledge you have of the celerity of your ſhip's movements) may be judged ſufficient; then brace ſharp a-back the head-ſails, ſhiver the after ones, or lay them flat to the maſt, with the helm a-lee. This manœuvre, well executed, and covered by a briſk fire, will commonly ſucceed: but care muſt be taken not to come round too ſoon, but to range very cloſe to your adverſary; becauſe, if you ſhould not be a-head enough of him, you might fail in boarding, by paying too ſhort round, and then you would infallibly get your bowſprit foul of his fore-ſhrouds, which would be highly diſadvantageous.

If you ſhould find yourſelf too far a-head, the deſign will be fruſtrated, by your paſſing under the bowſprit of the enemy, who will however be thereby expoſed to be raked at his head, if he does not manœuvre in the ſame manner and with equal ſwiftneſs as the boarding-veſſel, which has the great advantage of priority.

It is abſolutely neceſſary to range very cloſe to the ſhip, whoſe bowſprit you wiſh to engage in your rigging; becauſe, if you attempted to execute this at only a ſhip's length large and to windward of your opponent, he has only, the inſtant he perceives your deſign, to put the helm hard a-lee and heave-in ſtays, if he does not chooſe to act in the ſame manner as you do. If this laſt method is properly executed, the two ſhips can only range very near each other and exchange their broadſides, and the lee-ſhip will immediately gain the wind of her adverſary. Therefore, to execute this manœuvre well, the veſſels muſt be nearly yard-arm and yard-arm.

If

If the boarder be at a certain diſtance aft on the weather-quarter, the ſhip, wiſhing to avoid boarding, muſt heave-in ſtays, as ſoon as the other veſſel is in the act of veering, in order to cloſe her to leeward. By this manœuvre they will find themſelves head to head, ſo that they may fire reciprocally their broadſides, in paſſing on oppoſite directions, and the lee-ſhip will get to windward.

TO BOARD WITH THE WIND LARGE.

If two ſhips engage with the wind large, the boarding-veſſel ſhould keep as cloſe as poſſible on the lee-quarter of the ſhip ſhe means to attack thus, that ſhe may execute this deſign, as has been ſhewn before, by coming rapidly to the wind, and being careful not to paſs a-head of her opponent.

The weather-ſhip, to avoid being boarded, muſt act on her part as was directed in the preceding article, according to circumſtances.

A ſhip may alſo be boarded on the weather-ſide, by conforming to what has been ſaid of boarding to windward.

When two veſſels are engaged, with the wind right aft, the ſhip, deſirous of boarding, ought to drop a-ſtern of the enemy, in order to run up cloſe along-ſide of him, if the boarder has the advantage of ſailing; for, as ſhe then advances towards her adverſary, her adverſary can only endeavour to range rapidly to the wind on the other tack, as ſoon as the bowſprit of the boarder is a-breaſt of her ſtern, and thus gain the wind, in order to be in a ſituation to extricate herſelf more eaſily by a good manœuvre.

The boarding-veſſel ſhould be permitted to come a-breaſt of the ſtern of her adverſary before ſhe hauls her wind; becauſe, if ſhe were to do this ſooner, the ſhip a-ſtern, at a ſmall diſtance, would board her perfectly well, even if they ſail equally ſwift, ſince the boarder would be to windward, would run large longer than the other,

other, would range more ſlowly to the wind, and continue to ſtem a-head of the flying ſhip. What makes this more evident is, that the boarder, coming from windward, preſerves longer his velocity, trimming his ſails only as the ſhip comes to the wind, and cuts the courſe of his adverſary with a line leſs curved than that deſcribed by the retreating ſhip.

If, by coming too ſoon or too faſt to the wind, the boarder choſe to abandon his deſign, he might do ſo by veering a few points on the other tack and ſhortening ſail; ſo that the retreating ſhip will ſhew her ſtern, and the boarder can then rake her by paſſing under her ſtern.

When you attack a ſhip cloſely to leeward, you may keep away a little, when you are a-breaſt of her, ſeeming to yield under her fire. If this ſhould induce the oppoſing ſhip to veer, in order to keep you more under her guns, you have only to heave rapidly to the wind, by putting the helm a-lee, trimming all ſharp abaft, and ſuppreſſing the effect of the head-ſails; all of which is to be done in the ſame inſtant you perceive the enemy bears down upon you. The quickneſs of this manœuvre, and the priority of the movement you gain thus on your enemy, will ſoon cloſe the two ſhips; and, if proper attention be paid, and the diſtance well meaſured, it may happen that the enemy's bowſprit will be entangled in your fore or main rigging; which would be a moſt advantageous thing in your attempt to board. But much confidence muſt not be placed in this, as you do not frequently meet with perſons ſo eaſily duped: it may even happen that you will no longer be able to attempt the boarding, if the weather-ſhip, inſtead of bearing away, plied to windward more and more; for this feint manœuvre may take you too far off to leeward of your adverſary. If you ſhould happen to be a ſhip's length to leeward, and about the ſame diſtance a-head of the veſſel with which you are engaged, you may, under cover of a heavy fire, heave-in ſtays. By this manœuvre you come right athwart the enemy's hawſe, rake him fore and aft, and board him, his bowſprit being right over your gangway; nor can he poſſibly avoid your broadſide; for, if he heave all a-back and make a-ſtern board, which is his only reſource, he may avoid being boarded, but will always be in a very bad ſituation.

BOARDING

BOARDING AT AN ANCHOR.

If it be intended to board a ſhip which is at an anchor, riding head to wind, it muſt be executed under ſail; for, if you cannot approach the enemy but by towing yourſelf a-head, you will never be able to board her againſt her will; ſince it will always be in her power to annoy the boats which are laying out the tow-lines. It ought not, therefore, to be attempted, unleſs you are under way. To perform this with ſucceſs, you muſt be ſufficiently to windward to approach her by a little falling off, without expoſing your ſtern to her fire, which ſhe could play on you with great advantage in this ſituation. Suppoſing, therefore, the boarder to be thus to windward, ſo as to be able to approach his opponent at anchor, the aſſailant ought to ſtop his headway, by taking a-back his mizen-topſail and fore-ſtayſail, and, when about a ſhip's length a-head of the veſſel he means to board, let go an anchor; then work in ſuch a manner, that, as ſoon as the mizen-topſail is taken a-back, the mizen cloſe aft, the topſails clued up, and the fore-top-maſt-ſtayſail hauled down, he may come head to wind, and veer away cable, till, by falling off, he comes board-and-board with his opponent, who is ſtill riding at her moorings, and who, at that inſtant, ought alſo to be raked by the boarder.

The boarding-ſhip has no other way of manœuvring but this; becauſe, as ſoon as the anchor is gone, the ſhip acquires ſternway; and, when the cable is checked, ſhe comes head to wind, in which ſhe is greatly aſſiſted by the mizen and mizen-topſail, which impel her ſtern to leeward (§. 40 and 44), till the wind is right in the direction of the keel; and, as the cable is veered away till exactly along-ſide the ſhip at anchor, her own anchor being right a-head of the veſſel ſhe means to board, it follows, that, as ſoon as the boarding-ſhip comes head to wind, ſhe is in a proper ſituation to throw her grapnels, and ſend her crew on board of the other, if they are the ſtrongeſt.

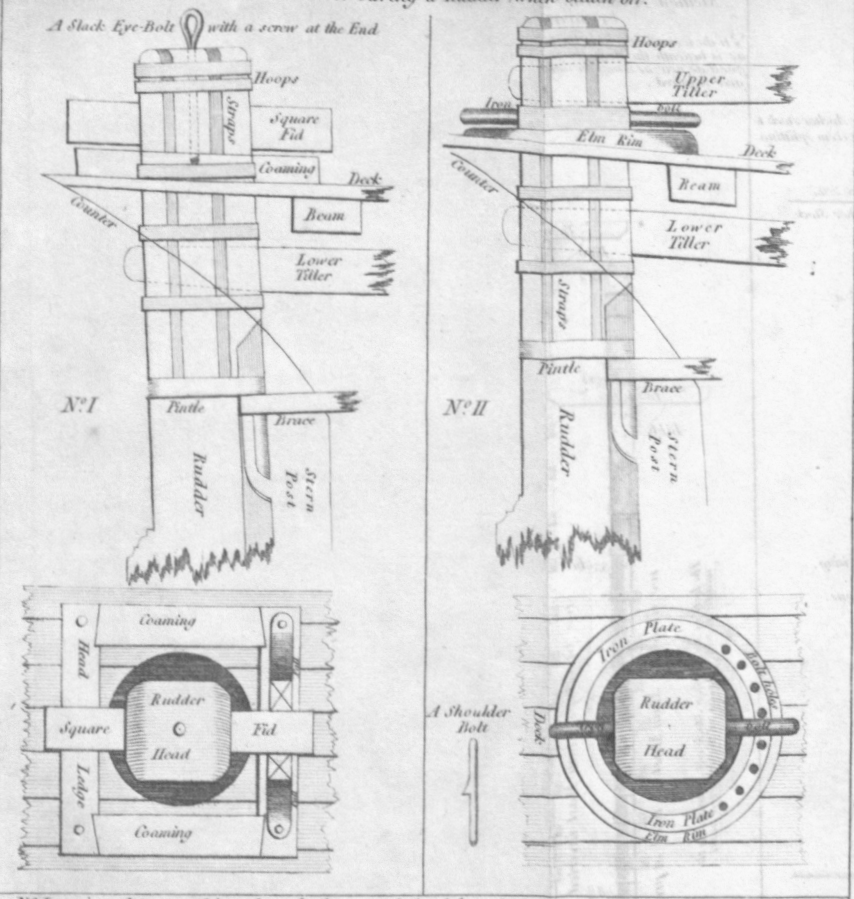
The ſhip at anchor ſhould never wait for the enemy in that ſituation, which is always diſadvantageous, and there is always much greater probability of getting clear when under way. But if, for ſome unforeſeen cauſe, you are obliged to continue at anchor, you are to take advantage of the moment, when the ſhip which attacks lets go her anchor, to cut the cable by which you ride. By this manœuvre you fall athwart, rake your adverſary, avoid being boarded, and bring up with your lee-anchor. Beſides, if time will admit before the attack, you ſhould not neglect to caſt two ſprings out, one on each ſide of the cable by which the veſſel rides, if you have not had time before to lay out two anchors, in order not to be ſurpriſed, in caſe the ſhip which attacks has it in her power to paſs on either ſide of you: and, when you perceive for which ſide ſhe is determined, you heave on the ſpring which is on the ſame ſide ſhe has let go her anchor if ſhe be a-head, and on the oppoſite if ſhe be a-ſtern, veering out at the ſame time the other ſpring and cable, till you bring the aſſailant right a-breaſt of you. Then you may rake him at pleaſure, as he has no way of getting out of this dangerous ſituation. His only courſe would be to prevent this danger by having a ſpring alſo; and, under cover of a briſk fire, veer upon that ſpring and cable to lay his enemy handſomely on board. But, if he has neglected this precaution, he muſt cut his cable, and drop on board of the ſhip to leeward; who, on the other hand, has no way to avoid being boarded, but by cutting, to get under way or to run on ſhore.

It is always eaſy to board a ſhip at anchor, when the wind will allow you to approach her under ſail; and the beſt way to proceed is, to run her along-ſide, or to bring-to to windward of the ſhip you wiſh to attack, keeping her exactly to leeward of you; then drift on board of her, by trimming your ſails in ſuch a manner, as to keep, as near as poſſible, your broadſide oppoſite to that of the adverſe ſhip; annoying her with your guns till you can cloſe her, and your conſtant cannonading may prevent her fire being ſo well ſerved as it might otherwiſe be.

When you are under way, and purpoſe to board a veſſel moored, let go an anchor at the time of boarding; for, if the ſhip attacked ſhould

The Inventions of Captain Edward Pakenham.

Inventions for Saving a Rudder when beaten off.



No. I consists of a square fid made to fit the upper hole of the rudder and bolted through the rudder head. It has likewise a Coaming fitted round the rudder hole and well secured to the Deck, for the fid to work on, acting as an upper gudgeon, in case the pintles are beaten off. Pails are bolted through the fore part of the Coaming, to quiet the Rudder, in the room of Chocks, in case the tiller should be carried away.

No. II consists of a circular rim of Oak or Elm, bolted and clenched round the rudder hole, from 9 to 12 In.s broad and 9 Inches thick at the fore part, decreasing its depth aft, so that its surface may be square with the rudder-head. In the middle of the rim, on the upper surface there is let in, one half of its thickness, & screwed, an Iron Plate, about 4 Inches broad & half an Inch thick. On the fore part of the Plate, on each side of the middle line, are punched holes, that are bored through the Deck, to receive Iron shouldered bolts; by placing one of which on each side of the Iron bolt which goes through the rudder head, the rudder is quieted when the tiller is broken. An Iron bolt at the height of the circular rim is driven through the rudder head & an Iron hoop on the head of the rudder.

The Deck represented in both these drawings is the middle deck in three decked Ships, and the upper Deck in two decked Ships.

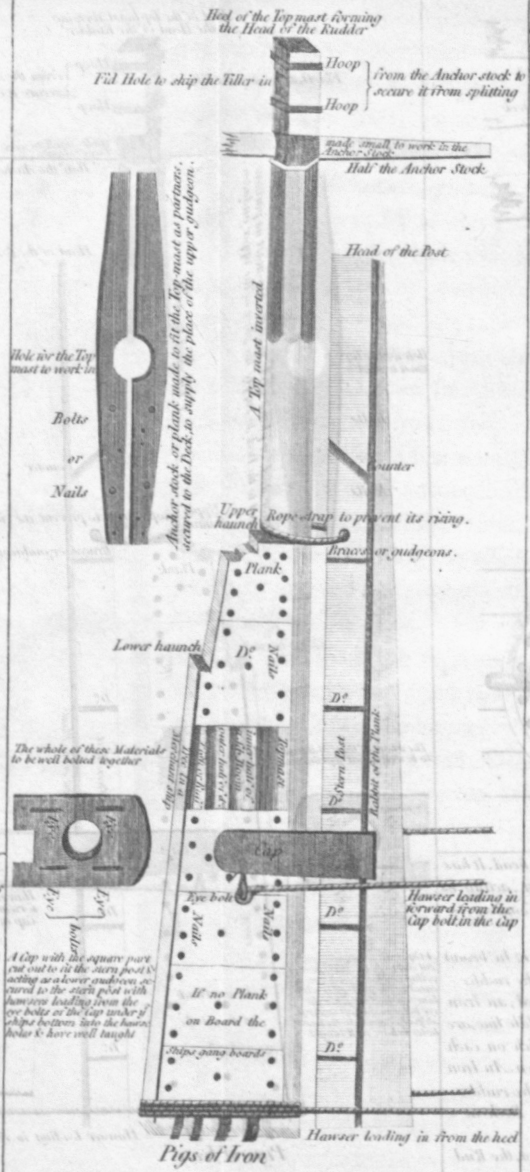
The Sole of Rudders is recommended to be 9 or 12 Inches in depth; by which in case of partially grounding, the Rudder may be saved with the loss of the Sole only.

This second plan is equally applicable to Ships that steer with a tiller on deck, by having the Coaming fixed upon the Deck immediately underneath the tiller; & it is presumed to possess these other advantages: the upper tiller hole is preserved vacant for use, in case the lower tiller be broken; the round bolt through the Rudder will work upon the circular plate, as an upper gudgeon, with less friction; and the shouldered bolts will stop the rudder when in any direction.

METHOD of Steering with the Wheel from the upper tiller, in cases when the lower tiller is broken. Viz. Three-decked Ships are fitted with a block in mid-ships, under the upper deck (the same as is fixed under the middle deck) that the upper tiller may be connected to the Wheel by ropes leading from the Wheel, through the Block under the upper deck, thence through a Block fixed in the side, and thence to the upper Tiller.

All three-decked Ships are, by order of the Admiralty, to be fitted with a Block for this purpose.

Substitute for a Rudder when lost.

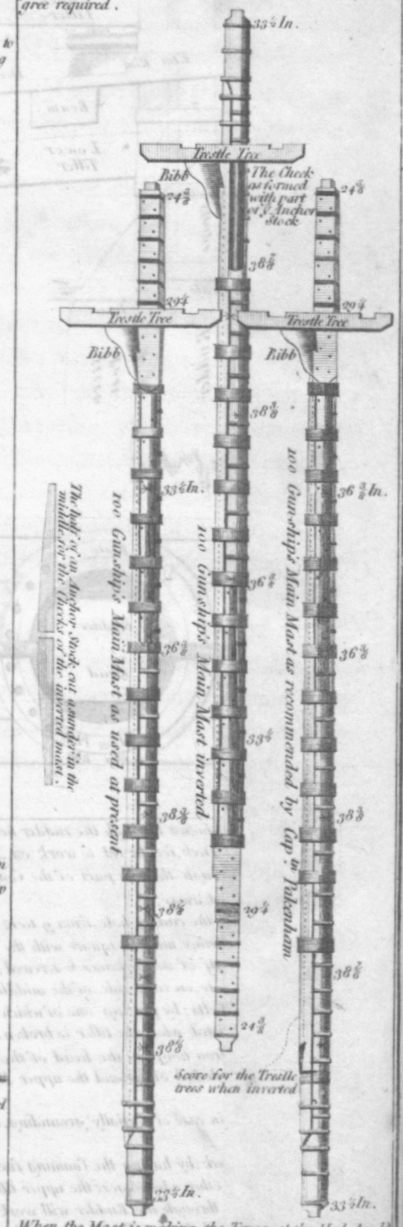


The rudder is made to sink by Pigs of Iron, by Ballast, or by an Anchor at the lower part; which are removed when it is fixed.

Scale of 10 Feet
1 2 3 4 5 10

Method of restoring Masts when wounded by inverting them.

*** If the wound is within such a distance from the head as is beneath the deck, the mast, when inverted, will be as good as new; as it may be fished and secured to any degree required.



When the Mast is making, the Tenon at the Heel should be made to fit the square hole in the Cap. And when inverted, by letting in the Trestle Trees one third of their thickness, a bed is formed for bolting them to the mast, and one of the two pieces of Oak that form the Anchor Stock, if sawed asunder in the middle, will when sqared and bolted on the Thwart-ship-sides of the mast, make Checks & stops to support the Trestle Trees.

Engraved for the Elements & Practice of Rigging & Seamanship

ſhould at this moment cut her cables to drive on ſhore, this would prevent your running a-ground together.

CAPT. PAKENHAM'S INVENTIONS.

On the oppoſite plate will be found an accurate repreſentation and a full deſcription of Capt. Pakenham's very uſeful inventions.

THE END.

BY AUTHORITY.

The following useful Publications, on Navigation and Trade, are printed for D. STEEL.

1. THE ELEMENTS AND PRACTICE OF RIGGING, SEAMANSHIP, and NAVAL TACTICS. Leaving wholly untouched the subject of ship-building, this work embraces every art necessary for the equipment of a ship in a most particular manner. The making of masts, ropes, anchors, sails, and blocks, is discussed with a minute precision, which will be found not only new but serviceable to the naval artist. The British seaman and British officer will find the complex subjects of rigging, seamanship, and naval tactics, more fully and correctly treated of than has ever before appeared in the English language. The whole is elegantly printed on a superfine wove paper, with new types, illustrated with upwards of one hundred beautiful and correct engravings, and ornamented with a frontispiece, designed by *Smirke* and engraved by *Neagle*. In two volumes, quarto, price four guineas, in boards.

2. PRINCIPLES OF LINEAR PERSPECTIVE, particularly adapted to shipping. Containing rules to draw correctly the forms of ships in every possible position. Illustrated with plates, 8vo. 3*s*. sewed.

3. THE SHIP-BUILDER's REPOSITORY; containing the principles of the art, with the theory and practice fully explained. In one volume, 4to. price 1*l*. 6*s*. bound.

4. THE UNIVERSAL DIRECTORY; containing tables which shew, at one view, the solid contents of all kinds of packages. Particularly useful to merchants, captains, mates, &c. long 8vo. price 6*s*. bound.

5. COASTING DIRECTIONS FOR THE NORTHERN NAVIGATION, from London, through all the different channels of the river Thames to the Orkney and Shetland Isles; with the North-Sea, the Cattegat, the Sound, and the Gulph of Finland. To which are added, the ordinance respecting the ceremony of lowering in the Sound, and the regulations and instructions to be observed in the ports and harbours of the Empire of Russia, as published by authority. With a comprehensive tide-table, and correct tables of the latitudes and longitudes. By *J. Chandler*, of Orford, pilot. Price 2*s*. 6*d*.

6. COMPLETE DIRECTIONS FOR THE BRITISH CHANNEL, Bristol Channel, and part of the coast of Wales, to Milford-Haven, including the islands of Guernsey, Jersey, Alderney, &c. and particular directions for Plymouth-Sound, Hamoaze, Catwater, Fowey-Harbour, Falmouth-Harbour, Mount's Bay, &c. Adapted to *Mr. Chandler*'s chart of the British Channel, on three large sheets, price 2*s*. 6*d*.

7. THE SHIP-MASTER's ASSISTANT and OWNER's MANUAL; containing complete information, as well to merchants, masters of ships, and persons employed in the merchant-service, as to officers and others in the royal navy, relative to the mercantile and maritime laws and customs. In the course of which the following subjects are particularly elucidated. — 1. Disbursements and other ship-accounts. 2. Tables useful in maritime affairs. 3. Exchanges. 4. Real and imaginary moneys of the world. 5. Owners. 6. Masters. 7. Seamen and seamen's wages. 8. Impressing. 9. Articles of regulation for the royal navy. 10. Freight. 11. Charter-parties. 12. Demurrage. 13. Insurance. 14. Bottomry. 15. Salvage. 16. Averages. 17. Privateers. 18. Quarantine. 19. Bills of exchange. 20. Navigation-acts. 21. Smuggling-acts. 22. Manifest-acts. 23. Fisheries in the Greenland seas and Davis's Streights. 24. Southern whale-fishery. 25. British fisheries. 26. Newfoundland fisheries. 27. Slave-trade. 28. Act for consolidation of the duties. 29. Duties in the United States of America. — The sixth edition, improved and enlarged. The whole compiled from un[illegible] authority, and the acts of parliament faithfully abridged, by a Gentleman [illegible] Inner Temple. Price 6*s*.