THE THEORY AND PRACTICE

OF

SEAMANSHIP

Since it was first published in 1962, *The Theory and Practice of Seamanship* has been continuously revised, culminating in this 11th edition. This new edition includes an updated section on 'Regulations for Prevention of Collision at Sea' as well as a new Author's Note. It has been widely praised and is the standard work on the subject.

'This book is intended primarily for candidates for Board of Trade certificates of competency but such is the detail that while being equally suitable for the beginner, it is also a reference work for experienced seamen, and the layout and style of text make it suitable for correspondence course work where practical experience can be allied to the theoretical approach. All facets of seamanship from the anchor to damage control are dealt with and the chapters on practical ship handling, stranding and beaching, towing, emergencies and the safety of navigation are particularly noteworthy. This book is an excellent and responsible contribution to the nautical field and must have a tremendous appeal to all grades of seamen.' *Seafarer*

Graham Danton commenced his seafaring career in 1946 on the training ship *HMS Worcester*, afterwards serving with the Port Line to Australia, New Zealand, USA, Canada, Africa, West Indies and the Fiji Islands. He obtained the Extra Master Mariner's Certificate in 1957, gaining the year's highest marks in the examination. For this he was awarded a Royal Society of Arts Silver Medal and also the Griffiths Award by the Merchant Navy and Airline Officers' Association. For many years he was Senior Lecturer in Seamanship, Cargo Carriage and Ship Maintenance at Plymouth Polytechnic, since renamed Plymouth University. Though retired, he is now a newspaper columnist and broadcasts for BBC radio.

THE THEORY AND PRACTICE OF SEAMANSHIP

11TH EDITION

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ROUTLEDGE
London and New York

First published 1962 by Routledge & Kegan Paul
10th edition 1987
11th edition published 1996
by Routledge
11 New Fetter Lane, London EC4P 4EE

Simultaneously published in the USA and Canada
by Routledge
29 West 35th Street, New York, NY 10001

Routledge is an imprint of the Taylor & Francis Group

Reprinted 1998, 1999, 2000, 2001, 2002, 2003, 2005, 2006, 2007

Printed and bound in India by Gopsons Papers Ltd., Noida

British Library Cataloguing in Publication Data
A catalogue record for this book is available form the British Library

Library of Congress Cataloging in Publication Data
Danton, G.L.
The theory and practice of seamanship / Graham Danton. - 11th ed
p. cm.
Includes bibliographical references and index.
ISBN 0-415-14200-8 (hbk). - ISBN 0-415-15372-7 (pbk)
1. Seamanship. 1 Title.
VK541. D3 1996
623.88-dc20

6-14277
CIP

For sale in India only

ISBN 0-415-15372 (pbk)

CONTENTS

	LIST OF FIGURES	*page* vii
	LIST OF PLATES	xi
	AUTHOR'S NOTE	xiii
	ACKNOWLEDGMENTS	xiv
	TABLE OF CONVERSIONS	xv
I.	THE ANCHOR	1
II.	MOORING	35
III.	THE PRINCIPLES OF SHIP HANDLING	51
IV.	PRACTICAL SHIP HANDLING	75
V.	ICE	108
VI.	LIFE-SAVING AND DISTRESS	118
VII.	DAMAGE CONTROL	141
VIII.	STRANDING AND BEACHING	159
IX.	EMERGENCIES	182
X.	TOWING	215
XI.	FIRE	233
XII.	DRYDOCKING AND LOADLINES	258
XIII.	THE OFFICER OF THE WATCH	282
XIV.	THE SAFETY OF NAVIGATION	293
XV.	LIFTING GEAR	373
XVI.	ROPE AND CANVAS	407
XVII.	DECK APPLIANCES	446
XVIII.	THE SHIP'S BOAT	469
XIX.	THE DEPARTMENT OF TRANSPORT (D.O.T) ORAL EXAMINATION—FOREIGN-GOING	495
	INDEX	499

FIGURES

1.1	Hall's patent stockless anchor—common anchor	*page* 3
1.2	Admiralty cast anchor, Type A.C.14	5
1.3	Chain cable and its components	7
1.4	Lugless joining shackle	8
1.5	Markings on anchors and cables	11
1.6	Devil's claws—Blake's stopper—patent slips	15
1.7	Yaw of a ship at single anchor	21
1.8	Anchoring on a shoal	25
1.9	Pointing ship	25
1.10	Anchoring on a steep-to beach	26
1.11	High holding-power anchors	31
1.12	Lifting a bower anchor on deck	34
2.1	Stresses when at open moor	35
2.2	Executing an open moor	36
2.3	Mooring with an anchor each way	37
2.4	Fouling a hawse	38
2.5	Anchoring near a shoal	39
2.6	Executing a standing moor	40
2.7	Executing a running moor	41
2.8	Correcting leeway when mooring	42
2.9	The Baltic moor	43
2.10	Clearing a berth when Baltic-moored	44
2.11–15	Clearing a foul hawse	46–9
3.1	Transverse effect of a propeller	52
3.2	Forces exerted by twin screws	54
3.3	Thruster units	56
3.4	The turning circle	58
3.5	The effect of wind on a vessel	63
3.6	Effect of wind when stopping and reversing a vessel	65
3.7	Turning in a current, ahead and astern	66
3.8	Canal effect	67
3.9	Effect of inequalities of the sea-bed	68
3.10	Sheering effects of a river stream	70

3.11	Entering a dock	*page* 71
3.12	Girding a tug	73
3.13	Effect of passing a moored ship	74
4.1–17	Manœuvring to and from buoys	76–84
4.18	The ship's hawsers	85
4.19–27	Manœuvring to the berth in calms, and currents. Clearing the berth	86–90
4.28–51	Manœuvring to the berth in a wind. Clearing the berth	90–103
4.52	Turning a vessel short round	104
4.53	Turning in a river stream	104
4.54	Turning in a river stream	105
4.55	Entering a dock from a cross-stream	105
4.56	Leaving a dock into a cross-stream	106
4.57–58	Turning a vessel in a wind	106–7
6.1	Rigging the breeches buoy	130
6.2	Firing a rocket in a cross-wind	131
6.3	The R.F.D. Automatic release hook for life-rafts	137
6.4	The Welin-Maclachlan Single-point suspension davit	139
7.1	Patching a hole in ship's side plating	145
7.2	Alternative method of patching	146
7.3	Plan view of the patch	147
7.4	Makeshift fish-bolt	150
7.5	Patent rivet stopper	150
7.6	Shoring a bulkhead	151
7.7–11	Jury rudders	154–7
7.12	Steering by drags	157
8.1	Laying out anchors in tandem	163
8.2	Carrying out a bower anchor between two boats	165
8.3	Securing a purchase to ground-tackle hawser	166
8.4	Anchors in tandem	167
8.5	Ungrounding when broadside on to sea	175
8.6	Ungrounding when stern-on to sea	175
8.7	Beaching a vessel	178
8.8	Securing lines ashore	179
9.1	The drift directions of a wreck	191
9.2	Manœuvres for recovery of a man overboard	197
10.1	Practical towing—layout before towing	227
10.2	Practical towing—layout during towing	228
10.3	Securing the messenger to the hawser	229
10.4	Fairlead chafing sleeve	231

11.1	Kidde Zone detecting system	*page* 249
11.2	Kidde smoke-detector layout	252
11.3	Kidde visual smoke-detector	253
11.4	Kidde audible smoke-detector	254
12.1	Stability of a ship in a floating dock	268
12.2	Loadlines for a steamer	272
12.3	Loadlines for a timber-carrying vessel	272
12.4	Loadlines for a sailing ship	274
12.5	Calculation for the dock allowance	275
14.1	Conventional direction of buoyage in the United Kingdom	295
14.2	Lateral marks, Region 'A'	297
14.3	Cardinal marks, Region 'A'	298
14.4	Isolated danger and safe water marks	299
14.5	Special marks	300
14.6	Light characteristics	302
14.7	Specimen routes, Region 'A'	303
14.8	Action of sailing ships when collision is imminent	320
14.9	Action of powered ships when collision is imminent	322
14.10	Determining the direction of a vessel's heading	329
14.10A	The compass card	332
14.11	The International Code Flags	350
15.1	Reeving a three-fold purchase	374
15.2	Purchases	376
15.3	Hallen derrick	388
15.4	Velle derrick	389
15.5	Stuelcken derricks	391
15.6	Rigging sheers	392
15.7	Rigging a gyn	394
15.8	Deck crane	396
15.9	The union purchase	397
15.10	Doubling gear	398
15.11	Yo-yo gear	398
15.12	The wing-lead derrick	399
15.13	The backweight rig	400
15.14	The Liverpool rig	401
15.15	The heavy derrick	402
15.16	The swinging derrick	404
16.1	The construction of fibre rope	408
16.2	Overhand knot—sheet bend—figure-of-eight knot—clove-hitch—timber hitch	416

FIGURES

16.3 Reef knot—bowline—rolling hitch—half hitch—marline spike hitch 418
16.4 Carrick bend—cow hitch—Blackwall hitch—marling hitch—awning hitch 419
16.5 Clove hitch on the bight—bowline on the bight—sheepshank 421
16.6 Passing rope and chain stoppers 422
16.7 Stage hitches and chair hitches 423
16.8 Whippings 424
16.9 Worming, parcelling, and serving 425
16.10 Flat, round, and racking seizings 427
16.11 Chain, cut, and eye splices 429
16.12 Long splice 430
16.13 Coiling a 'Frenchman'—Eye splice—Bulldog grips 438
16.14 Sewing canvas 444

17.1 Electromagnetic Log Sensor assembly 455
17.2 Chernikeeff Electronic log 457

18.1 Half-section and side elevation of wooden lifeboat 475
18.2 Belaying falls on a staghorn bollard 481
18.3 A lifeboat, fully rigged 488
18.4 The theory of sailing 490

PLATES

Between pages 460 and 461

1. Schermuly line-throwing rocket. Detail and firing operation
2. Schermuly buoyant head. Lifebuoy lights and smokefloats
3. Inflatable rubber liferaft—sectional view
4. Single-point suspension raft
5. Single-sheave cargo blocks
6. Multiple blocks and fittings
7. Commodore Log equipment
8. Commodore Log Rotator
9. Chernikeeff Log—Impeller assembly
10. Chernikeeff Log—Indicator
11. Chernikeeff Log—Tube assembly
12. Desk-mounted 'Synchrostep' telegraphs
13. Single-speed quadrantal davits
14. Overhead-type quadrant davits
15. Welin gravity davits (*Saxonia*)
16. Welin gravity davits (B.T.C. Vessel)
17. Underdeck davits—top picture shows boat stowed, lower picture shows boat swung out
18. Underdeck davits handling glass-fibre lifeboats
19. Clarke Chapman electric windlass—fore side
20. Clarke Chapman steam windlass—aft side
21. Clarke Chapman splash-lubricated steam windlass—aft side
22. Clarke Chapman electric mooring capstan
23. Clarke Chapman splash-lubricated electric cargo winch
24. Kelvin electrically-driven sounding machine

AUTHOR'S NOTE

SEAMANSHIP is a skill as ancient as mankind, defined as 'The exercising of knowledge necessary to navigate, maintain and operate a vessel', to which I add the word 'safely'. As a boy, it was explained to me by a seafarer as 'In a maritime situation, doing the right thing, at the right time, with whatever materials and equipment are available.' The good seaman, whether an officer or a rating, is one who can be trusted by his seniors to take immediate steps to try to bring every potentially dangerous situation under control.

Clearly, with members of the profession likely to serve on ships which may have been built at any time during the last fifty years, a textbook on the subject must blend ancient and modern techniques with equipment that may vary between the revolutionary and the obsolescent. Equally, the book must cope with constantly-changing regulations.

My book is aimed primarily at officers and cadets studying for British Certificates of Competency, but I hope it will be of value to all seafarers as a source of reference.

Since it was first published in 1962, it has been continually revised, metricated, and expanded to include contemporary beliefs regarding stranding, collision, refloating, survival in extreme conditions, oil pollution, and the 'sailing' factor of large disabled tankers.

Colour has been omitted from my diagrams for reasons of cost, but careful colouring, using wax crayons and the colour keys, will enhance the usefulness of those relating to flags and buoys. The book should be studied in conjunction with the latest mandatory regulations, especially those concerning Life-saving and Fire Appliances, Musters, Oil Pollution, Dangerous Goods and Construction Rules.

As the book evolves into its 11th edition, with the latest 'Regulations for Preventing Collision at Sea', I am indebted to my readers for their support and encouragement, and to my publishers for their continued help and guidance.

GRAHAM DANTON

ACKNOWLEDGMENTS

I WISH to extend my gratitude to the following for their assistance in supplying photographs and information:

- Messrs. Brown, Lennox and Company Ltd. (Anchors)
- The Secretary of the Institute of Naval Architects for permission to quote from a paper by Mr. H. Pope
- The Department of Transport
- Pains Wessex Schermuly Ltd.
- The R.F.D. Company Ltd. (Liferafts)
- Beaufort Air-Sea Rescue Ltd.
- Welin Maclachlan Davits Ltd.
- Shell Tankers Ltd.
- The Walter Kidde Company Ltd.
- The Comptroller, Her Majesty's Stationery Office
- The Gourock Ropework Company Ltd.
- Thomas Walker and Sons Ltd.
- Chernikeeff Instruments Ltd.
- Messrs. Chadburns (Telegraphs) Ltd.
- Messrs. Clarke, Chapman Ltd.
- Kelvin Hughes Ltd.

TABLE OF CONVERSIONS
(WITH BS ABBREVIATIONS)

Length	1 inch	=	2·54 centimetres (cm)
	1 foot	=	0·3048 metres (m)
	1 fathom	=	1·83 m
	1 metre	=	3·28 feet (ft)
		=	39·37 inches (in)
Weight	1 pound	=	0·4536 kilogrammes (kg)
	1 ton	=	1 016 kg
	1 kg	=	2·205 lb
	1 000 kg	=	0·985 ton
		=	1 metric ton or tonne (t)
Pressure	1 lb/in^2	=	70·31 g/cm^2
	1 atmosphere (atm)	=	14·7 lb/in^2
		=	76 cm of mercury (cm Hg)
Volume	1 gallon	=	4·546 litres (l)
	1 litre	=	0·22 gallon (gal)
	1 m^3	=	35·314 ft^3
Power	1 horsepower	=	746 watts (W)
	1 000 W	=	1 kilowatt (kW)
		=	1·34 horsepower (hp)
Frequency	1 hertz (Hz)	=	1 cycle per second (c/s)
Various	Diameter of a rope in millimetres (mm) equals circumference in inches (in) multiplied by 8		
	1 tonne of sea water occupies roughly 1 m^3		

As not all readers are familiar with the metric system, imperial equivalents have been put where appropriate in the margin. These imperial quantities are not identical with the metric quantities but are approximately of the same order, and arithmetical calculations with imperial quantities will be self consistent.

CHAPTER I

THE ANCHOR

THE ADMIRALTY PATTERN, STOCKED OR COMMON ANCHOR

This anchor is illustrated in Fig. 1.1 together with the names of the various parts. It is fitted with a stock, which should be of an approved design and weigh one-quarter of the specified weight of the remainder of the anchor. It is renowned for its excellent holding qualities, and even today some designs of patent stockless anchors are no more efficient, so far as holding properties are concerned, than the common anchor of one hundred years ago, assuming anchors equal in weight. It is no longer required to be carried on merchant ships.

When the anchor strikes the sea-bed the stock, being longer and heavier than the arms, assumes the horizontal position as soon as the anchor is stressed, thus causing the lower arm and fluke to become embedded. The stock gives the anchor great stability, i.e. it prevents it from rotating under heavy load or a stress applied other than in line with the shank. The anchor will turn in a horizontal plane quite easily as a ship swings with the tidal stream or wind. There are no moving parts to become choked with sea-bed material, so that should the anchor be accidentally broken out of its holding position it remains efficient for re-anchoring.

The upper fluke, which protrudes from the sea-bed, contributes no holding power and may become fouled by the cable as the ship swings. Further, in very shallow water, or where the sea-bed dries out, small craft may become impaled on this fluke. The common anchor is difficult to stow with the stock in position. In merchant ships it is usually found as a light (non-compulsory) kedge anchor with the stock stowed parallel with the shank, or as a lifeboat anchor. As a kedge anchor it is
likely to weigh up to 2 tonnes, dimensions for this weight being roughly 2 tons
3·9 m overall length; 3·7 m length of stock, and 2·5 m width of arms. 12 ft 6 in

The steel common anchor of today has a holding power of roughly 12 ft
three to four times its weight, depending upon the sea-bed. It is of sur- 8 ft

prising historical interest to note that Admiral Lord Nelson's anchor (H.M.S. *Victory*), with its buoyant oak stock, had a holding power of 2·8 times its weight. Efficiency improvements have therefore been small since then, and are only just developing.

The spheres or enlargements at the stock extremities serve two purposes: they assist rotation of the anchor when biting, and prevent, to a certain extent, sinking of the stock into the sea-bed when it is providing stability under load.

THE PATENT STOCKLESS ANCHOR

This anchor is also illustrated in Fig. 1.1. It has no stock, and can therefore be hove right home into the hawse pipe, quickly secured, and is ready for instant letting go. The entire head, including the arms and flukes, is able to pivot about the end of the shank. Its angle of rotation is limited by stops to 45 degrees from the axis of the shank. In some designs this angle is as low as 30 degrees. The head must weigh at least 60% of the total weight of the anchor.

If it strikes the sea-bed with the flukes vertical, their tripping palms chafe the surface and start rotation of the arms. The anchor has good holding power, in the region of three to four times its weight in efficient holding ground, but has a moving part which can become choked with sea-bed material. This may well cause the flukes to fail to re-trip should the anchor be broken out of its holding position. For this reason, when anchoring for some time, it is a good practice to regularly weigh the anchor and *sight it*. This applies particularly on sandy and muddy sea-beds, and an opportunity is afforded to hose the anchor using a high-pressure water jet. Some shipping companies insist upon this being done.

Having no stock this type of anchor is unstable, and when dragging under heavy load is liable to rotate through 180 degrees. If the flukes fail to re-trip, any holding power remaining is due entirely to weight and, in turn, friction. The size of the flukes is a direct measure of the holding properties.

Disadvantages such as are noted above are generally overlooked in the light of its easy stowage. It is an ideal (non-compulsory) stream anchor for vessels fitted with stern hawse pipes.

Both the stocked and the stockless anchor may have a ring secured to the shank at the anchor's centre of gravity. This is the *gravity band*.

The most common types found in the Merchant Service are the Byer's, Hall's, and Taylor's patent stockless anchors. Two are carried as bower anchors in the hawse pipes and a third is carried as a spare or *sheet anchor*. Typical dimensions of a 5-tonne anchor would be 3·5 m overall length; 2·1 m extreme length of head; 1 m measured in side elevation

5 ton 11·3 ft
7 ft 3 ft

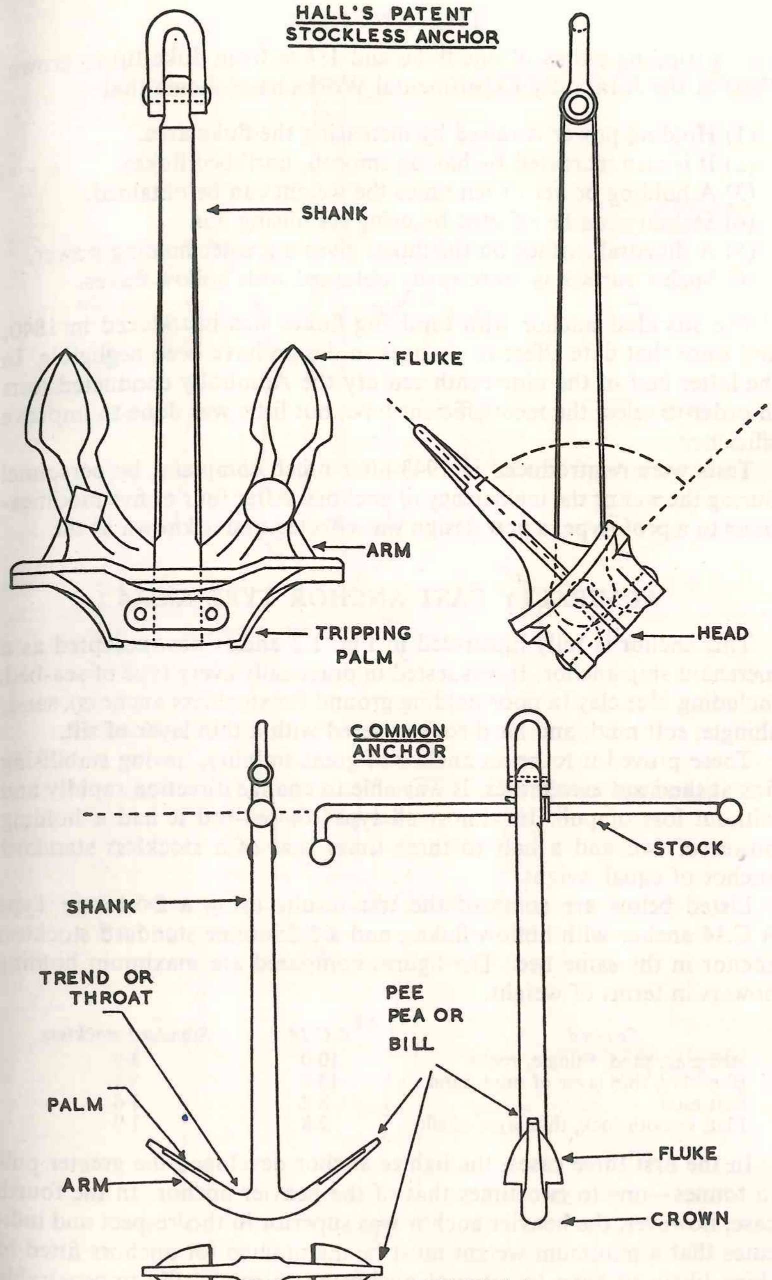


FIGURE 1.1

5 ft 8 in across tripping palms of one fluke and 1·7 m from fluke tip to crown. Tests at the Admiralty Experimental Works have shown that:

(1) Holding power is raised by increasing the fluke area.
(2) It is also increased by having smooth, unribbed flukes.
(3) A holding power of ten times the weight can be obtained.
(4) Stability can be effected by using stabilising fins.
(5) A dihedral surface on the flukes gives a greater holding power.
(6) Such a surface is more easily obtained with hollow flukes.

The stockless anchor with tumbling flukes was introduced in 1840, and since that date effective changes in design have been negligible. In the latter half of the nineteenth century the Admiralty conducted tests in order to select the most efficient type, but little was done to improve efficiency.

Tests were reintroduced in 1943 after much complaint by personnel during the war of the inefficiency of anchors. After four or five modifications to a prototype, a new design was effected and is known as the

ADMIRALTY CAST ANCHOR TYPE A.C.14

This anchor is fully illustrated in Fig. 1.2 and is now accepted as a merchant ship anchor. It was tested in practically every type of sea-bed, including blue clay (a poor holding ground for stockless anchors), sand, shingle, soft mud, and hard rock covered with a thin layer of silt.

These proved it to be an anchor of great stability, having stabilising fins at the head extremities. It was able to change direction rapidly and without loss of pull. In almost all types of sea-bed it had a holding power of two and a half to three times that of a stockless standard anchor of equal weight.

52-cwt Listed below are some of the test results using a 2·5-tonne Type
5¼-ton A.C.14 anchor with hollow flukes, and a 5·25-tonne standard stockless anchor in the same bed. The figures compared are maximum holding powers in terms of weight.

Sea-bed	*A.C.14*	*Standard stockless*
Red clay, sand, shingle, rocks	10·0	3·9
Blue clay, thin layer of mud, sand.	13·6	3·1
Soft mud	8·2	1·6
Flat, smooth rock, thin layer of silt	2·8	1·9

In the first three cases, the lighter anchor developed the greater pull in tonnes—one to two times that of the heavier anchor. In the fourth case, however, the heavier anchor was superior in this respect and indicates that a minimum weight must be maintained for anchors fitted to ships likely to have to attempt anchoring in practically impenetrable sea-beds. Danforth-Jackson have developed the Stokes anchor which

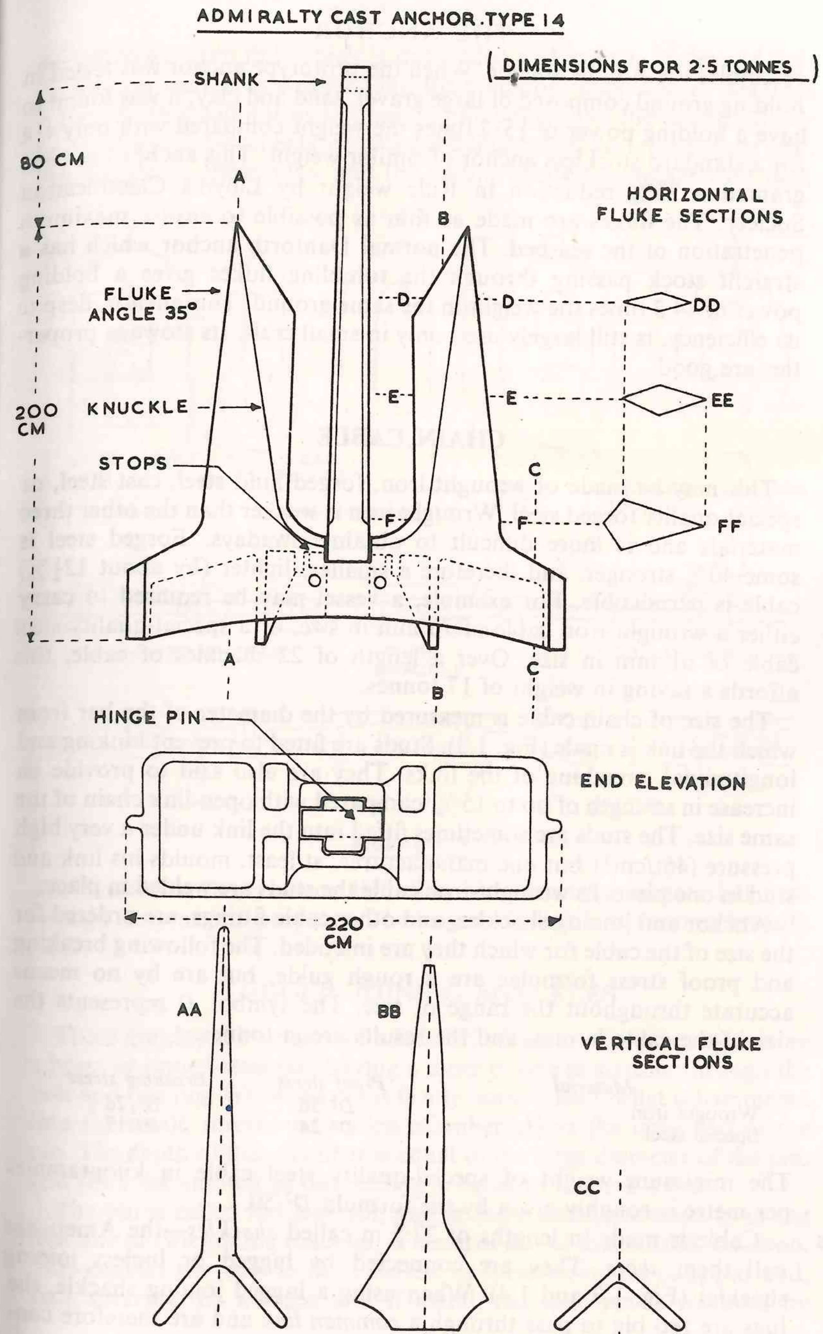


FIGURE 1.2

resembles the A.C.14 anchor. When the prototype anchor was tested in holding ground composed of large gravel, sand and clay, it was found to have a holding power of 15·2 times the weight compared with only 4·4 for a standard stockless anchor of similar weight. This anchor has been granted a 25% reduction in Rule weight by Lloyd's Classification Society. The flukes are made as thin as possible to ensure maximum penetration of the sea-bed. The normal Danforth anchor which has a straight stock passing through the tumbling flukes gives a holding power of 14·2 times the weight in the same ground. This anchor, despite its efficiency, is still largely used only in small craft. Its stowage properties are good.

CHAIN CABLE

This may be made of wrought iron, forged mild steel, cast steel, or special-quality forged steel. Wrought iron is weaker than the other three materials and is more difficult to obtain nowadays. Forged steel is some 40% stronger, and therefore a smaller, lighter (by about 12½%) cable is permissible. For example, a vessel may be required to carry
2 13/16 in either a wrought-iron cable of 70 mm in size, or a special-quality steel
2 7/16 in cable of 61 mm in size. Over a length of 22 shackles of cable, this
tons affords a saving in weight of 17 tonnes.

The size of chain cable is measured by the diameter of the bar from which the link is made (Fig. 1.3). Studs are fitted to prevent kinking and longitudinal stretching of the links. They are also said to provide an increase in strength of up to 15%, compared with open-link chain of the same size. The studs are sometimes fitted into the link under a very high pressure (46t/cm^2), but one manufacturer, at least, moulds his link and stud in one piece. In wrought-iron cable the studs are welded in place.

Anchor and joining shackles, and other cable fittings, are ordered for the size of the cable for which they are intended. The following breaking and proof stress formulae are a rough guide, but are by no means accurate throughout the range of size. The symbol D represents the size of the cable in mm, and the results are in tonnes.

Material	*Proof stress*	*Breaking stress*
Wrought iron	$D^2/36$	$D^2/26$
Special steel	$D^2/24$	$D^2/17$

The minimum weight of special-quality steel cable in kilogrammes per metre is roughly given by the formula $D^2/50$.

15 fathoms Cable is made in lengths of 27·5 m called *shackles*—the Americans call them *shots*. They are connected by lugged or lugless joining shackles (Fig. 1.3 and 1.4). When using a lugged joining shackle, the lugs are too big to pass through a *common link* and are therefore con-

nected to an open link which is unstudded and known as the *end link*. Having no stud, it is weaker than the common links, and is therefore enlarged. This will not fit a common link either, and the two are therefore connected by an enlarged studded link called an *intermediate link*. Fig. 1.3 shows these links, and the joining shackle, together with their

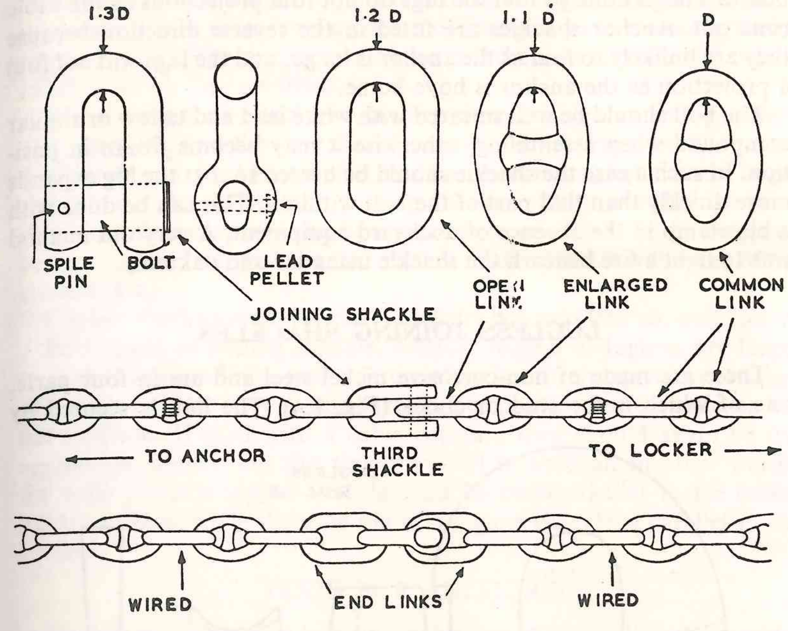


FIGURE 1.3

size relative to the common link. The sizes are approximate but near enough for practical purposes. The length of a link is 6D and its breadth 3·6D.

LUGGED JOINING SHACKLES

These are closed by means of a *bolt*. This is secured in place by driving a brass or tinned-steel pin, having a taper of one in sixteen, through the bolt and one lug. When the pin is firmly home a lead pellet is hammered into the small, reverse-dovetailed chamber above the large end of the pin. The depth of this chamber is equal to the large diameter of the pin, and the total amount of dovetailing is equal to the half-depth.

The pin is called the *spile pin*, and in some cases, particularly in the first one or two joining shackles, is made of ash or male (solid) bamboo. This enables the bolt to be removed by hammering its unlipped end, thus shearing the wooden pin. If metal, the spile pin is removed by punching its smaller end, the lead pellet being knocked out with the pin. Before fitting a new pellet, the remains of the old one must be reamed out of the dovetailing. Anchor shackles have a metal spile pin. Older ones may be found having a forelock.

These shackles are fitted to the cable with the bow end facing outboard. This is done so that the lugs do not foul projections as the cable runs out. Anchor shackles are fitted in the reverse direction because they are unlikely to foul as the anchor is let go, and the lugs will not foul a projection as the anchor is hove home.

The bolt should be well smeared with white lead and tallow or similar compound when assembling, otherwise it may become *frozen* in position. In such a case the shackle should be heated so that the lug expands more quickly than that part of the bolt within it. This can be done with a blowlamp in the absence of dockyard equipment. A very old method was to light a fire beneath the shackle using tar and oakum.

LUGLESS JOINING SHACKLES

These are made of non-corrosive nickel steel and are in four parts, one of which is the stud or chock (Fig. 1.4). The link is secured by

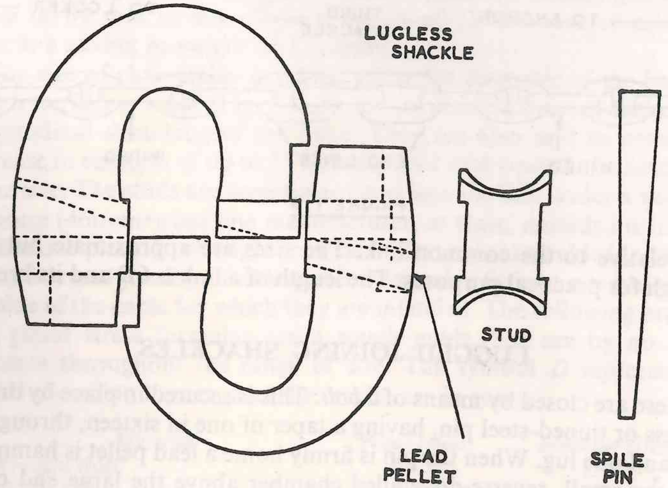


FIGURE 1.4

means of a metal spile pin and lead pellet, the pin being driven diagonally through the two sides of the link and the stud. These pins have a slow taper of about one in thirty-two. To part these shackles, the pin and pellet are driven out, the stud knocked clear, and the two sides of

the shackle separated by means of a top swage available from the manufacturer. The use of this punch avoids damage to the accurately machined surfaces. The manufacturer also supplies a compound for coating these surfaces prior to assembly. Should the shackle be subjected to harsh treatment with a hammer, the machined surfaces may no longer fit together. Being similar to common links, though of larger maximum diameter (1·5*D*), there is no question of fitting them to the cable, facing the wrong way. Their minimum diameter is the same as that of the chain cable to which they are fitted.

When using these shackles with forged-steel cables, no enlarged links are necessary, and they are therefore ideal for joining a broken cable. Anchor or end shackles are also made to this design, but are of a larger size for a given cable than joining shackles. They are slightly pear-shaped, with the tapered end having a size equal to 1·25*D*, the large end being roughly 1·4*D* and the mid-section nearly 2*D*. (*D* is the size of the chain cable.)

Lugless shackles made of nickel steel are not heat treated, only tested.

Both types of joining shackle, whether lugged or lugless, are larger than the common links, and may therefore jam in the sprocket or *snugs* of a cable holder. They should therefore be passed over the latter in the flat position. If used with a cable capstan, they should again lie flat against the holder, but this time they will be vertical. In other words, the spile pin of a lugged shackle must be perpendicular to the cable-holder surface, while the spile pin of a lugless shackle is parallel to the surface.

TESTS FOR ANCHORS

Under the Anchors and Chain Cables Act of 1967, all anchors which are to be used aboard United Kingdom registered ships are to be tested
before being put into service. Anchors of 76 kilogrammes or less are 168 lb
exempted. For the purposes of the Act, the weight of an anchor always includes the shackle, if any, and in the case of a stocked anchor it excludes the stock.

In the first instance, application must be made to a Certifying Authority, which may be the Department of Transport or the Authority appointed by them, such as the Classification Societies.

Anchors are tested to a proof tensile stress which varies from about twenty times the weight for a 1-tonne anchor, to just under five times the weight for a 30-tonne anchor. After the test is completed, the Supervisor must examine the anchor for flaws, weakness and material deformation.

Within one month of the test—if satisfactory—a certificate must be issued which contains a serial number, the name and mark of the testing establishment, the name and mark of the Certifying Authority and the name of the test Supervisor. In addition, it notes the type of anchor, weight in kilogrammes, weight of stock, length of shank in millimetres and length of arm. It must also show the diameter of the trend in millimetres (see Figure 1.1). The proof load is also revealed.

TESTS FOR CABLES

Under the same Act of 1967, chain cables are also required to be
0·5 in tested unless they are less than 12·5 mm diameter. The Testing Establishment considers the cable in lengths of 27·5 m (i.e. shackles of cable). Three links are taken from each length and tested to a tensile breaking stress. If this proves satisfactory, the length of cable is then subjected to a tensile proof stress. It is then inspected for flaws, weakness and material deformation. The manufacturer of the cable will thus provide each length for test with three extra links.

Certain grades of steel cable are then subjected to ultimate-stress, elongation and impact tests.

Shackles and other cable accessories are subject to the same tensile proof loads as the cable with which they are to be used. One sample in every batch of 25 is also subjected to the breaking stress (1 in 50 in the case of lugless shackles).

The chain cable is also awarded a certificate of test. This contains similar general information as in the anchor test certificate. It also shows the type and grade of chain, the diameter in millimetres, the total length in metres, the total weight in kilogrammes, the dimensions of the link in millimetres and the loads used in the tests. The formulae given on page 6 have been assessed from the official load table for cable of size 50 mm.

Some manufacturers like to carry out their own additional tests, such as those of Messrs. Brown, Lennox & Co., who recently achieved the following results:

2-in A 50-mm studded link (breaking stress 141 tonnes) was subjected to an end-compression test and broke at the high stress of 137 tonnes.
0·625 in The stud broke after the link had extended 16 mm.
1·625-in A 41-mm open-link cable (breaking stress roughly 80 tonnes) remained unbroken after a tensile stress of 120 tonnes but was completely rigid.
4-in A 100-mm studded cable (breaking stress 395 tonnes) remained unbroken at 700 tonnes tensile stress.

MARKINGS ON THE ANCHOR AND CABLE

Every anchor which has been officially tested under the Anchor and Chain Cables Rules, 1970 (made under provisions of the 1967 Act) must be marked.

A circle is to be marked in any conspicuous position on the anchor. Within this circle, two items of information appear. In Figure 1.5, the symbol X represents the Serial Number of the Test Certificate. The symbol YYY represents the letters of the Certifying Authority. It must not exceed three initials and one number (or four letters).

The chain cable is marked in a similar manner, as shown in Figure 1.5. The markings are to appear on every shackle, at each end of the cable, and every 30 m along its length.

These markings are much simplified compared with earlier requirements, much of which are now incorporated in the Certificates.

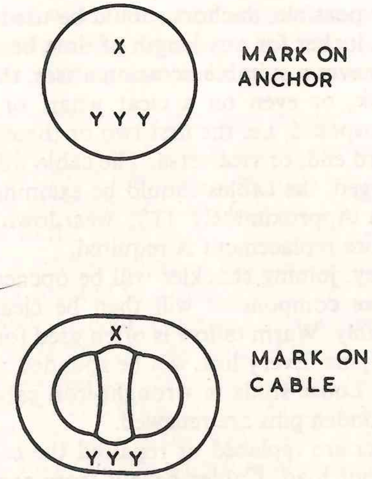


FIGURE 1.5
ANCHOR AND CABLE MARKS

Apart from official markings, the cable is also marked by crew or dockyard staff to show the number of the shackle. The number is reckoned from the anchor towards the chain locker. To indicate the third joining shackle, which will be 82·5 m from the anchor shackle, the third link on each side of the joining shackle is painted white and the stud is bound with seizing wire. When the cable is running out, even quite rapidly, the flashes of white may be seen providing the markings are well maintained.

If D-type shackles are fitted, the open link on each side of the shackle is ignored when arranging the marks. This is illustrated in Figure 1.3. In lugless joining shackles this is not necessary.

It is a common practice to include an extra joining shackle somewhere within the first 27·5 m. (30 yd) This is most useful if it is necessary to trail the cable on the seabed, or to hang off the anchor. This extra shackle may be quite close to the anchor so that when the anchor is stowed in the hawse pipe, it is found just forward of the windlass. In other cases it may be at the 13·75 m mark, dividing the first shackle into halves. Seamen therefore sometimes refer to it as the half-shackle. It is obviously ignored when the cable is being marked for lengths.

If cable is rearranged (see next section) the marks require altering.

CARE OF ANCHORS AND CABLES

Whenever possible, anchors should be used alternately. Cable which lies idle in a locker for any length of time becomes brittle, and for this reason, whenever a suitable occasion arises, the cable should be ranged in a drydock, or even on a clear wharf or jetty, and two or three shackles transposed, i.e. the first two or three lengths should be placed at the inboard end, or vice versa. The cable will then need remarking.

When ranged, the cables should be examined for wear and renewed if necessary. Approximately 11% weardown in bar diameter (D) is allowed before replacement is required.

At a survey, joining shackles will be opened and all parts examined closely. These components will then be cleaned and well lubricated before assembly. Warm tallow is often used for the bolts and white lead for the spile pins. Every link will be sounded with a hammer to test for a clear ring. Loose studs in wrought-iron cable must be re-caulked or replaced. Wooden pins are renewed.

When links are replaced or repaired the cable is again tested to its statutory proof load. Cables benefit from regular heat treatment, but lugless shackles of nickel steel are exempted.

Anchors are not normally re-tested or given further heat treatment after their initial processing unless it is considered desirable. The anchors and cables benefit from a regular coating of Stockholm tar or special chain paint. The pivoting mechanism of a stockless anchor should be regularly lubricated with a thick grease.

When the cables are ranged the cable locker can be thoroughly cleaned out, scaled where necessary, and well coated with anti-corrosive paint. Cable-securing fittings should be thoroughly overhauled. In use,

the lead pellets should be sighted whenever possible—faulty insertion often leads to their dropping out of the recess above the spile pin.

Anchors and cable must be well washed down after use. A thickly encrusted anchor can be trailed awash at slow speed (to avoid damage to hull plating), e.g. while navigating slowly out of an anchorage.

SECURING CABLE WITHIN THE LOCKER

In past times, the inboard part of a ship's cable was belayed on bitts, and the term *bitter end* is still used. Methods by which the bitter end is secured vary greatly from ship to ship. In some cases it has not been secured at all, presumably by accident, and the anchor and eleven shackles of cable have disappeared out through the hawse pipe. In some vessels the two bitter ends are shackled together, often with the intention of being able to use port cable on the starboard anchor and vice versa. It is generally thought to be a malpractice, since it can lead to complications when slipping the bitter end.

The end link is sometimes secured by several turns of wire rope, or small chain, or a cable clench which grips the cable and can be screwed tight, or a chain bridle incorporating a patent slip. The following are three efficient methods not including a patent slip in their components:

(1) The end link is placed between two steel lugs welded to the centre-line bulkhead of the locker and a pin is driven through the lugs and link, being forelocked at one end. The forelock is removed, when the link is to be disconnected, and the pin knocked out.

(2) The end link is taken to the upper part of the chain locker, where it can be reached by a man standing in the lower forepeak store-room, and is similarly secured to a strong bracket.

(3) The end link is placed through a slot cut in a stiffened area of plating so that it projects through the deck of the lower forepeak locker, or into one of the storerooms at the break of the forecastle. A pin secures it as before. This pin should either have a forelock—a flat, small piece of steel passed through a slot in the pin and chained to it to avoid loss—or else a portion of the end of the pin should be able to hinge about the pin axis. Either of these methods prevents the pin from slipping out accidentally.

The latter two methods avoid the necessity for a man having to enter the chain locker when slipping the bitter end. It is obviously an extremely good idea to become quickly acquainted with the method used in a particular ship, since the need to slip cable from the locker may be both unexpected and urgent. A prolonged search for the bitter end, only to find the securing means seized up, is not in keeping with the usual circumstances.

CLASSIFICATION EQUIPMENT

As an example, a cargo-passenger vessel of 165 m in length is required to carry two bower anchors of the stockless type, each weighing 5·4 tonnes, a spare bower stockless anchor weighing 4·5 tonnes and 22 shackles of special-quality steel cable of 61-mm link diameter. The vessel quoted also carries a non-compulsory kedge anchor of the stocked type, weighing 1·5 tonnes. She was originally required to carry wrought-iron cable of 70 mm.

ANCHORING TERMS

The following are a few of the expressions used in anchoring, and officers who may be in charge of the forecastle cable-party will do well to acquaint themselves with all of them, for a misunderstood order from the bridge may give rise to other spontaneous terms.

Windrode: A vessel is so described when she is riding head to wind.

Tiderode: A vessel is so described when she is riding head to tide.

Lee tide: A tidal stream which is setting to leeward or downwind. The water surface has a minimum of *chop* on it, but the combined forces of wind and tide are acting upon the ship.

Weather tide: A tidal stream which is setting to windward or upwind. The water surface is very choppy, but the forces of wind and tide are acting in opposition on the ship.

Shortening-in: The cable is shortened-in when some of it is hove inboard.

Growing: The way the cable is leading from the hawse pipe, e.g. a cable is growing aft when it leads aft.

Short stay: A cable is at short stay when it is taut and leading down to the water close to the vertical.

Long stay: A cable is at long stay when it is taut and leading down to the water close to the horizontal.

Come to, Brought up, Got her cable: These are used when a vessel is riding to her anchor and cable, and the former is holding.

Snub cable: To stop the cable running out by using the brake on the windlass.

Range cable: To lay out the cable on deck, or a wharf, or in a drydock, etc.

Veer cable, Walk back: To pay out cable under power, i.e. using the windlass motor.

Walking back the anchor: To lower the anchor under power.

Surge cable: To allow cable to run out freely, not using the brake or the windlass motor.

A'cockbill: Used to describe the anchor when it has been lowered clear of the hawse pipe and is hanging vertically.

Foul anchor: Used to describe an anchor which is caught in an underwater cable, or which has brought old hawsers to the surface with it, or which is fouled by its own cable.

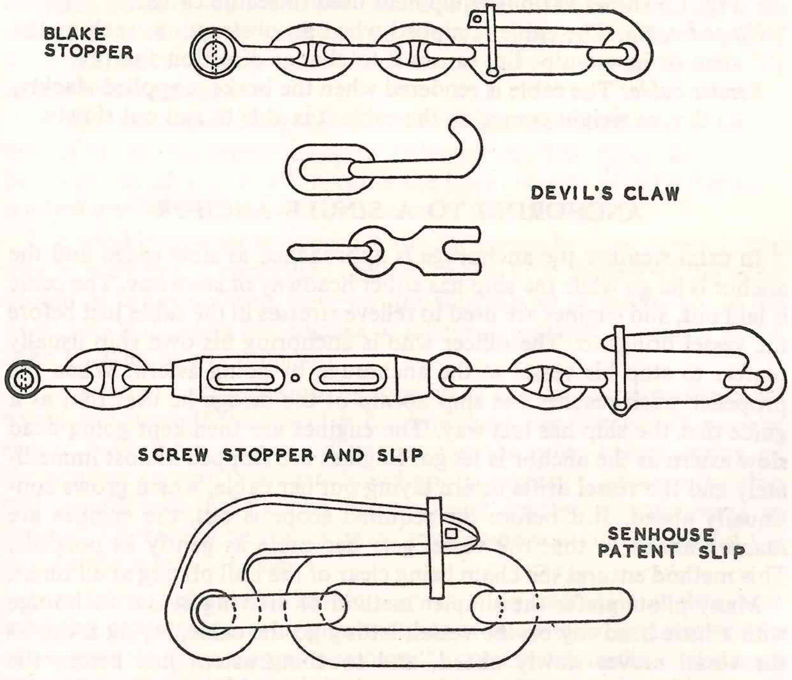


FIGURE 1.6

Up-and-down: The cable is up-and-down when it is leading vertically to the water.

Clear hawse: When both anchors are out and the cables are clear of one another.

Foul hawse: When both anchors are out and the cables are entwined or crossed.

Open hawse: When both anchors are out and the cables lead broad out on their own bows. A vessel lying moored to anchors ahead and astern is at open hawse when she lies across the line of her anchors.

Clearing anchors: Anchors and cables are cleared away when the securing gear on deck is removed. This may include chain bridles passed through cable and shackled to the deck, and *devil's claws,* which are metal bars hooked through the cable and screwed up tight by means of a rigging screw chained and shackled to the deck. Bow stoppers have their guillotines removed from the cable when it is cleared. Cables are cleared when the ship *strikes* soundings (i.e. she enters waters where depths are less than 200 m), when the visibility is poor in anchoring depths, and when nearing harbour. Fig. 1.6 shows various equipment used to secure cables. 100 fathoms

Nipped cable: The cable is nipped when an obstruction, such as the stem or hawse-pipe lip, causes it to change direction sharply.

Render cable: The cable is rendered when the brake is applied slackly, so that as weight comes on the cable it is able to run out slowly.

ANCHORING TO A SINGLE ANCHOR

In calm weather the anchorage is approached at slow speed and the anchor is let go while the ship has either headway or sternway. The cable is laid out, and engines are used to relieve stresses in the cable just before the vessel brings-to. The officer who is anchoring his own ship usually prefers to stop his vessel at the anchorage by going astern. When the propeller wash reaches the ship abeam of the bridge he uses that as a guide that the ship has lost way. The engines are then kept going dead slow astern as the anchor is let go. Engines are stopped almost immediately and the vessel drifts astern laying out her cable, which grows continually ahead. Just before the required scope is out, the engines are *touched* ahead so that the vessel gets her cable as gently as possible. This method ensures the chain being clear of the hull plating at all times.

Many pilots prefer the simpler method of arriving at the anchorage with a little headway on the vessel, letting go the cable, laying it out as the vessel moves slowly ahead, and touching astern just before the required scope is out. With this practice, the cable grows continually astern while it is being rendered and will probably harm the paintwork on the hull. This is rather more serious than it may sound, because often the paint is removed to the bare metal and corrosion sets in rapidly. This is apparent when a vessel drydocks, since there is usually an occasion during a voyage when the cable does grow astern.

10 fathoms In waters up to 20 m deep the anchor and cable should be let go on the run, allowing about double the depth (of cable) to run before checking it on the brake. If the cable is snubbed as soon as the anchor touches the bottom the anchor will be dragged along the sea-bed and will be unable to grip. Further, with the weight of the anchor off the cable, it sometimes happens that when the brake is released the cable will not render itself. This happens when there is a heavy weight of cable abaft the gypsy, leading down into the locker, and when the gypsy is in need of lubrication. By surging the cable initially, the anchor has a

chance to embed itself before the cable tightens. There is little risk of a stockless anchor being fouled in this way.

In water of over 20 m the anchor should first be walked back to 10 fathoms
within say 4 or 5 m from the sea-bed, and let go from there. This 2 or 3 fathoms
ensures that the anchor will not damage itself falling a considerable distance on to a hard bottom, and also that the cable will not *take charge* and run out so rapidly that it becomes extremely difficult to hold it on the brake. This practice therefore considerably lengthens the life of the brake linings.

In very deep anchoring depths, 100 m and over, the entire operation of anchoring should be done under power. 50 fathoms The gypsy should not be taken out of gear at all, because the heavy weight of cable between sea-bed and hawse pipe will undoubtedly take charge.

In a wind it is better to approach the anchorage heading upwind. The ship is more easily controlled and will make little leeway. If the wind cannot be brought ahead, however, the ship can let go the anchor in the usual way and, using her engines to relieve stresses on the cable, swing head to wind as she brings-to.

The weather anchor should be used so as to avoid nipping the cable round the stem. If the vessel is heading dead into the wind's eye she should have her head cast off one way or the other before letting go the weather anchor. The cast should not be excessive, because the ship will rapidly seek to lie across the wind and develop a sharp swing to leeward. Correcting helm and bold use of engines should be used if the cast develops into a swing.

In a tideway the vessel should stem the tide and again anchor with headway or sternway, as in calm weather or in a wind. Her helm will be of use even while making no way over the ground due to the tidal stream running past her. If the tidal stream cannot be stemmed the cable should be rapidly laid out slackly *across* the axis of the stream. As she brings-to in the stream, the bight of the cable dragging across the sea-bed will bring her up to her anchor very gently. When anchoring in a tideway floating objects overside are sometimes used to determine whether the ship still has headway. It should be noted that these objects indicate the ship's speed relative to the water, and a vessel stemming a stream with *stationary* floating objects beside her (i.e. pieces of wood, etc.) will have sternway over the ground equal to the rate of the stream. Only when these objects drift astern will the ship be stopped over the ground or have headway over it.

When anchoring stemming a stream and also having a wind abeam, the lee anchor should be let go first. As she gets her cable, her stem will then swing to the wind, causing the cable to grow clear. If she uses the weather anchor her cable will continually be foul of the bow plating.

DUTIES OF THE CABLE OFFICER

The anchors and cables will have already been cleared away. The selected anchor is now a'cockbilled by putting the appropriate gypsy in gear and walking the anchor back clear of the hawse pipe. We are assuming shallow water—if the water is over 20 m deep, then the anchor must be walked back close to the sea-bed or walked back under power all the way. This latter, of course, is done only when the ship has no headway, otherwise the trailing anchor will damage the forefoot. The brake is now screwed tight and the windlass taken out of gear ready for letting go.

10 fathoms

The anchor buoy will already be attached to the anchor by its wire pendant. The length of this pendant should preferably be equal to one and a half to two times the maximum depth of water at the anchorage so that the buoy is not *swamped* in a strong current and ceases to *watch*. The anchor buoy is streamed just before the anchor is let go. The windlass operator should be wearing goggles. The anchor should not be let go until the Officer has made sure that it is all clear below.

Cable is liable to be stowed in the locker with small stones wedged between the links and studs, and these pebbles are frequently projected at high speed as the cable runs over the windlass. Further, it is not unknown for the cable to part as it runs out. For this reason it is inadvisable to stand forward of the gypsy as the cable surges.

At the order to let go, the brake is released, usually by a blow from the carpenter's maul, and the cable is surged. It should be snubbed when twice the depth has run out. The brake is then slackened and the cable allowed to render. The bell is struck a number of times to indicate (by the number of strokes) the length of cable surged, i.e. three strokes as the third shackle runs out. The officer-in-charge must indicate to the bridge personnel how the cable is growing, particularly if it becomes nipped. If this happens, the brake is tightened and the bows allowed to swing towards the cable so that it grows clear. He indicates by pointing, and at night by swinging a lighted torch.

When the desired amount of cable is laid out the order will be given to *screw up*. The brake is then screwed tight and the handle struck with the carpenter's maul for good measure. The cable is then secured by placing the bow-stopper guillotine across the links, and if necessary, passing the devil's claws. The bow stopper relieves the windlass of much stress while at anchor. Sometimes, when the ship is pitching and the cable is tending to jerk, heavy coir springs (50% stretch) are secured to the cable and led well aft. When the springs have been made fast the cable is veered gradually until the springs share the stresses.

Having secured cable, it must now be carefully watched overside. It will grow to long stay as the ship brings-to her anchor and then slowly

slack down if the anchor is holding. Some officers prefer to watch a little longer before signalling that she has got her cable. It should be noted, however, that a regular cycle of coming to long stay, then slacking, then coming to long stay again, and so on, often indicates that a ship is dragging her anchor. Cross bearings or beam transit-bearings are more reliable. Strictly speaking, the anchor ball should not be hoisted nor anchor lights exchanged for steaming lights until the vessel is anchored, i.e. brought up. Before leaving the forecastle head, the officer should check the bow stopper and windlass brake.

AMOUNT OF CABLE TO USE

A term used here is *scope*. The length of cable laid out, measured from the hawse pipe to the anchor, divided by the distance measured vertically from the hawse pipe to the sea-bed, is called the scope of cable. The scope used depends upon several factors:

(1) The nature of the holding ground. Stiff clay, rock, shells, and stones are considered poor holding ground. Very soft mud can be a poor material in this respect.
(2) The amount of swinging-room available for the ship as the wind or stream changes in direction.
(3) The degree of exposure to bad weather at the anchorage.
(4) The strength of the wind or stream. As this strength increases so the ship moves astern, lifting her cable off the bottom so that it assumes long stay.
(5) The duration of stay at anchor.
(6) The type of anchor and cable.

If the cable leads from the anchor shackle in a direction 5 degrees above the shank axis the holding power of the anchor is reduced by one-quarter. If the angle becomes 15 degrees the loss of holding power is one-half. (This fact is repeated in Chapter VIII in view of the text contained therein.) For this reason, it is most important that a length of cable shall lead from the anchor shackle along the sea-bed before rising gently to the hawse pipe. Only a good scope will ensure this. Very often, when a ship drags her anchor, more cable is veered and the anchor holds. The action is correct, but the oft-resulting belief is a fallacy—that it is the resistance of the extra cable which has held the ship. The anchor was no doubt dragging because the angle between the cable and shank axis, at the shackle, was more than zero. The veering of cable removes this angle and the anchor holds once more.

A rough rule to lay out three to eight times the depth of water in cable length is haphazard. The Admiralty recommend the following lengths, which should be regarded as the minimum for calm weather and a 5-knot stream:

45$\sqrt{D}$ ft For wrought iron cable, lay out 25$\sqrt{D}$ of cable.
50$\sqrt{D}$ ft For forged steel cable, lay out 28$\sqrt{D}$ of cable.
70$\sqrt{D}$ ft For special-steel cable, lay out 39$\sqrt{D}$ of cable.
feet (Where D is the depth of water in metres.)

It should be observed that more cable is laid in the case of the stronger chain. This represents a disadvantage of the special-steel in that it is roughly 12½% lighter than wrought-iron cable, and therefore lifts from the sea-bed more easily. A heavy bight of cable must be used so that the cable partly lies on the sea-bed and its *catenary*, or curve, provides a spring which partially absorbs shocks due to pitching or yawing. The holding power of an anchor, i.e. the types sketched in this chapter can vary from between three and fourteen times its own weight. The resistance offered by cable is only about three-quarters of its weight, and there is thus no point in laying out more cable than is necessary. Further the cable imparts a drag to the anchor, quite apart from the drag of the ship. Recent research has shown that a twin-screw ship, anchored in a 4-knot stream and a 55-knot wind, with locked propellors, imparts the following drag to her anchor:

tons	Screw drag	2 tonnes
tons	Tide drag on hull	4 tonnes
tons	Wind drag on hull	10 tonnes
tons	Cable drag	2 tonnes

DUTIES AT ANCHOR

Cross-bearings are usually taken as the anchor is let go (to get a rough position for the anchor itself) and again when the vessel is brought up. Anchor watches should be set and these bearings frequently checked. A rough circle of swing can be drawn on the chart. Beam transit-bearings, use of the echo sounder, and radar will all help to detect dragging. On a very rocky bottom the noise of the dragging anchor can often be heard quite clearly on deck.

The vessel will normally lie with the anchor and cable fine on its own bow, say a point to a point and a half. This angle is known as the vessel's *natural sheer*, because she lies sheered slightly across the stream or wind. In a strong wind the vessel will tend to yaw about as shown in Fig. 1.7. At the extremity of her yaw she surges ahead and then drops back on her anchor, jerking the cable. If during the yaw the wind catches her on the opposite side to that normally exposed by her natural sheer (i.e. catches her on the port side when using her starboard anchor),

she may, at the extremity of her yaw, surge rapidly across her anchor to the other extremity of yaw, i.e. from position 6 to 8 in the figure, nipping her cable round the stem and breaking the anchor out of its holding position. This is called *breaking sheer*. If the anchor fails to re-trip the other anchor must be let go at once.

When initially bringing to, it is a good idea to arrange for a joining shackle to be situated on deck when the cables are secured. This will facilitate slipping the cable, and clearing a foul hawse should this become necessary.

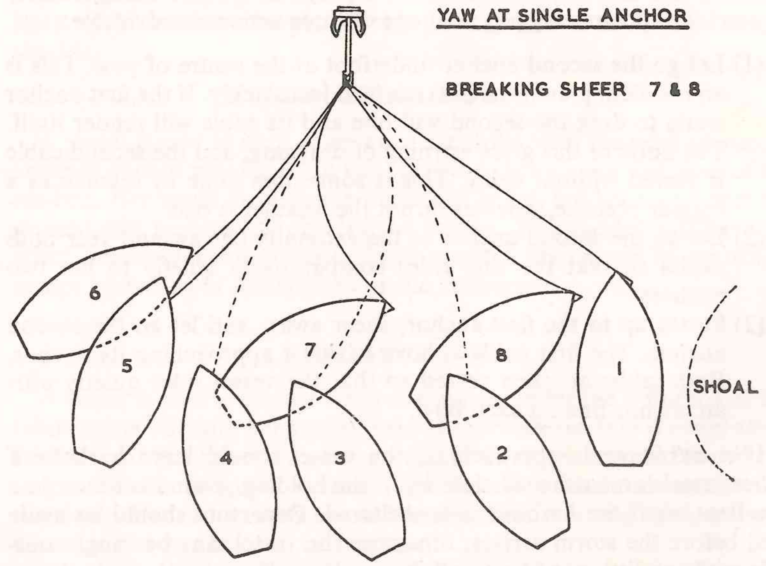


FIGURE 1.7

At anchor it is desirable from the deck officer's point of view to have the main engines and steering-gear ready for immediate use. In a tideway the vessel may be steered by her rudder. It is, however, ineffective when there is no stream. A wind, blowing from one direction for some considerable time, will set up a surface drift current, but this is unlikely to be sufficiently strong for sensitive steering.

The shore signal-station should be watched at all times. Approaching and departing boats need vigilance, as do other vessels navigating in the vicinity. The officer of the watch should at all times have a rough idea of how his cable is lying, so that he can warn off other vessels which try to anchor across it.

DRAGGING ANCHOR

Generally speaking, once an anchor starts to drag, the vessel gathers sternway, and this may become excessive. Prompt action is necessary. However, there are exceptions, and a vessel riding out a gale has been known to drag slowly and steadily for some days at roughly a mile per day.

If the wind rises, extra cable should be laid out to ensure a bight lying on the sea-bed under conditions of yaw and pitch. Pitching can be partially prevented by trimming the ship by the head. Yawing is likely to start the anchor dragging, and one of three actions is advisable:

(1) Let go the second anchor underfoot at the centre of yaw. This is an excellent plan if the brake is held just slackly. If the first anchor starts to drag the second will bite and its cable will render itself. The noise of this gives warning of dragging, and the second cable is veered without delay. This is sometimes done by seamen as a regular practice, whether or not the weather is bad.

(2) Let go the second anchor at the extremity of yaw and veer both cables so that the ship rides comparatively quietly to her two anchors.

(3) Steam up to the first anchor, sheer away, and let go the second anchor. The first cable is hove in while approaching its anchor. Both cables are then veered so that the vessel rides quietly with an anchor fine on each bow.

If a hurricane is approaching, the vessel should leave harbour if other vessels are anchored close by, if the holding ground is other than excellent, or if the harbour is unsheltered. Departure should be made well before the storm arrives, otherwise the vessel may be caught outside with too little sea-room and drive ashore. If remaining in harbour, action (3) above should be taken and cables veered well away.

Once a vessel begins to drag, more cable should be veered. It should not be surged out slackly, otherwise the cable may part as the vessel brings-to. By veering it, the vessel may be brought up gently. The second anchor should be let go in good time, otherwise it may be found that so much cable has been veered on the first anchor (say 8 out of 11 shackles), that very little can be veered on the second (in this case only 2 to 3 shackles). Engines should be used to relieve stresses. If there is room it may be better to heave up and seek better holding ground.

WEIGHING ANCHOR

If, during heaving, the cable is subjected to a bad nip the windlass should be braked and the bows allowed to swing so that the cable grows

clear. The cable should be well washed and stowed. The anchor, if fouled with sea-bed material, can be towed awash for a short distance at slow speed. The bell is again rung to indicate the number of the joining shackle appearing from the water's surface, and vigorously rung when the anchor is aweigh. It should be reported foul or clear as the case may be. The anchor ball, or lights, can now be lowered. The anchors should not be finally secured until deemed no longer necessary for immediate use. Heaving up is a good opportunity for checking spile-pin pellets and cable seizing-wire markings.

A windlass having an electric motor of 48 kilowatts can heave in slack cable at 4 minutes per shackle and tight cable at $5\frac{3}{4}$ minutes per shackle.

DROPPING DOWN

A vessel is said to *drop down* when she drifts with the tidal stream. A vessel at anchor wishing to do this will heave her anchor just clear of the sea-bed. Her speed through the water will be nil, but her speed over the ground will be equal to that of the stream. Her rudder will have no effect, because there is no water flowing past it. She cannot be controlled except by means of the engines or the anchors.

DREDGING DOWN

A vessel is said to *dredge* when she moves under the influence of the tidal stream but with her anchor held at short stay so that it drags along the bottom. Her speed over the ground is therefore retarded and is not so great as the rate of the stream. She therefore has headway through the water. Her rudder may be used to steer her. A strong tidal stream is necessary for her helm to be sensitive.

If a vessel, when dredging, puts her rudder to port, the vessel will remain parallel with the stream direction but will gradually move diagonally across it towards her port hand. She will dredge similarly to starboard. In each case the most efficient movement is achieved by using the anchor on the side opposite to that in which she wishes to dredge, i.e. it is preferable to use the starboard anchor if dredging to port under port helm. A vessel which is dragging, therefore, can, by putting her helm over, avoid other vessels, provided the stream is fast enough to make her steering sensitive. Also, the operation of dredging can be modified somewhat in the case of a ship at anchor which sees another dragging towards her. By surging her cable rapidly and using bold helm, she may be able to sheer away from the line of drag and bring-to on the other anchor. The first one is liable to be fouled, but this is of small moment in the circumstances. In both these latter cases there must, of course, be a stream.

ANCHORING AT HIGH SPEED

The anchors are the narrow-water navigator's stand-by in all cases of emergency. There is an old sea-saying, 'Never go ashore with an anchor in the pipe', and this should apply to most emergencies. A ship may fail to turn, take a sudden sheer, carry too much way, an engine may fail to go astern, a squall may catch the ship, the engine telegraph may jam, a collision may be imminent—in all cases the anchors are waiting to be used. *Both* anchors should be let go and allowed to run out their cable until sufficient is out to enable the anchors to hold. They are then snubbed and perhaps alternately veered and snubbed so that the ship gradually loses her way. Both cables will be growing astern throughout the operation, and both will be subject to bad nips. This means, however, that the hawse-pipe lips are relieving the windlass (although strongly bedded) of much of the stress. Further, both cables are taking an equal share. A ship with quite considerable headway may be brought up quite rapidly with two anchors used in this fashion. Afterwards, the anchors, cables, hawse pipes and windlass should be surveyed. Large tankers may well part their cables when anchoring at speeds above 1 knot.

If a ship uses only one anchor she is likely to part the cable very quickly and then forge ahead into danger. This has happened all too frequently with the second anchor idle in the pipe. If there is insufficient room in which to pay out a good scope as above, the cables must be snubbed after, say, two shackles have run out and the anchors dragged along the bottom to reduce headway. This is highly dangerous, however, in harbours where there are submarine cables.

tons A vessel weighing 27 000 tonnes when stopped in 30 m, travelling
tons initially at 4 knots, incurs a stress of 195 tonnes in a single cable. The
tons figure becomes 435 tonnes if the initial speed is 6 knots. The stresses are halved if two equally tensioned cables are used.

ANCHORING NEAR A DANGER

In Fig. 1.7 the vessel is riding to her starboard anchor. There is a danger to starboard. When she gets to the extremity of her yaw at position 5 and breaks her sheer she virtually sails across her anchor and may break it out. She is also headed towards the danger. For this reason, when anchoring near a danger, the offshore anchor should be used. If sheer is broken the vessel will be heading away from the danger.

ANCHORING ON A SHOAL

If this becomes necessary the vessel should head into the wind, cross the shoal, and take soundings. It is then decided in which depth the

anchor is to be let go. The anchor is walked back to this depth and the vessel moves astern across the shoal. As soon as the cable grows ahead, showing that the anchor has touched bottom, cable is veered and laid out across the shoal, and the vessel will ride to her anchor in deep water beyond the shoal. This is a very good holding position, because it is

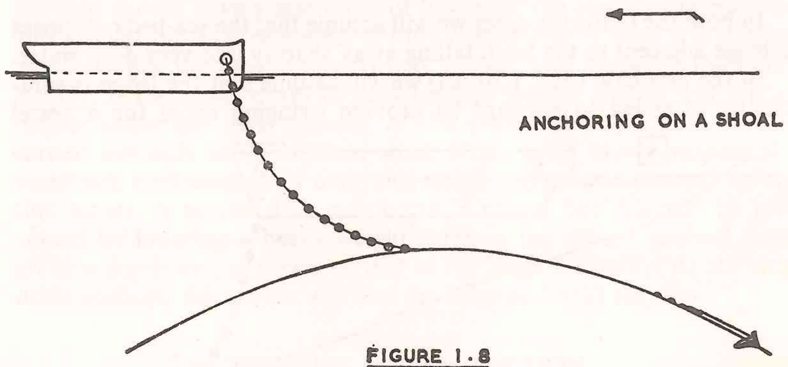


FIGURE 1.8

almost impossible to stress the cable at the anchor shackle in any way other than parallel with the shank (see Fig. 1.8).

POINTING SHIP

A ship riding to single anchor may require to create a lee on one side. An efficient method is to lead a wire, say 24 mm, from the after bitts, 3–3½ in
along the ship's side clear of everything, and secure it to the cable close

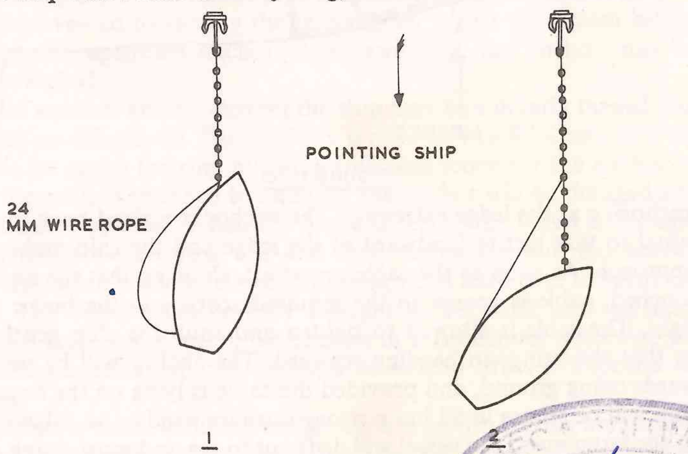


FIGURE 1.9

to the hawse pipe. The wire is then belayed aft and the cable is gently veered. As the wire becomes stressed, the ship is *pointed* off the wind (see Fig. 1.9).

ANCHORING BESIDE A STEEP-TO BEACH

In both the following cases we will assume that the sea-bed comprises a ledge adjacent to the land, falling away sharply into very deep water.

In the first case (Fig. 1.10 (*a*)) we will assume that the ledge is sufficiently extended to seaward to provide swinging room for a vessel

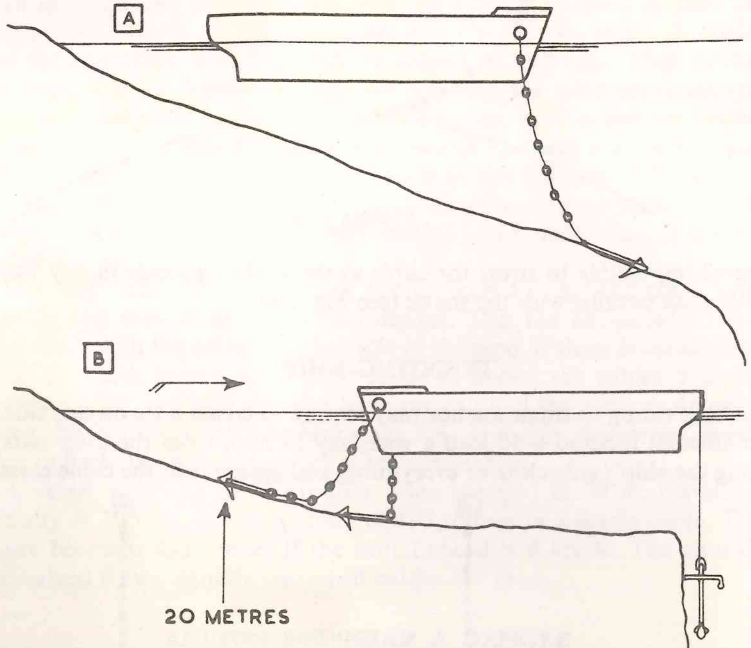


FIGURE 1.10

anchoring at the ledge extremity. The anchor is walked back to a depth equal to that just to landward of the ledge and the ship makes a slow approach. As soon as the cable grows aft, showing that the anchor has touched, cable is veered to the required scope and the brake screwed tight. The cable is allowed to tighten and snub the ship gently round so that she brings-to heading seaward. The anchor will be pulling towards rising ground, and provided the cable is lying on the bottom, the ship will be secure in all but a *strong* onshore wind or an offshore wind. In the latter event the vessel will drift out to sea and must weigh anchor.

In the second case (Fig. 1.10 (*b*)) we will assume an island having a

reef close inshore with typical depths as shown. The vessel must clearly anchor heading towards the land. The anchor should therefore be walked back to roughly 20–30 m and the vessel again headed in slowly. 10–15 fathoms
A sharp lookout must be kept for heads of isolated coral, etc. When the cable grows astern, and this should occur very gradually because the ship should have a minimum of headway, the engines are reversed and a bight of cable rendered. If only one anchor is used it is a good plan to lower the second one so that it bites, and screw up the brake slackly. If the vessel drags to seaward this second anchor will render further cable and give warning of the event. The operation can be carried out only in an offshore wind. If the wind blows onshore the vessel will drift to the reef and must weigh anchor and proceed before this occurs. A similar drift may occur in calms, but this may be prevented by lowering a heavy weight (such as the stream anchor) from aft to a depth well in excess of that at the ledge extremity. As the ship drifts onshore, this weight will foul the ledge and hold the ship.

TURNING ON AN ANCHOR

When heading with the stream astern, the vessel may be quickly turned head to stream with the assistance of an anchor. The anchor, either one will do, should be let go and held at short stay. As the anchor drags it will snub the bows round and upstream. The headway should be simultaneously reduced by an astern movement. This is a simple manœuvre provided the anchor is kept at short stay. By dragging it along the bottom, heavy stresses are completely avoided.

If the sharp nip at the hawse pipe is considered undesirable it may be partially prevented by casting the ship slightly across the stream before letting go the upstream anchor. After swinging, the anchor may be quickly weighed.

In calm weather and no current the ship may be similarly turned, but with some modifications. The headway is reduced to a minimum and the anchor is let go on the run, allowing sufficient scope for the anchor to bite. If the cable is snubbed too quickly the anchor will be dragged and the manœuvre spoiled. When the brake is secure the vessel is brought up with the cable growing aft, and then steamed round the anchor on the taut cable at slow revolutions, with helm hard over towards the anchor. The vessel must be fully brought to her cable and the latter absolutely taut before using the engines in this fashion, otherwise the ship gathers headway and an undesirable sudden stress is imposed on the cable.

Sometimes a vessel is turned on her anchor before leaving an anchorage. Here the anchor cable is hove in until there is sufficient length out to enable the anchor to hold, and the ship moved ahead at slow revolutions until the cable grows astern. Before it tautens, the engines are stopped and the ship allowed to bring-to gently on the cable. When it is taut astern, the engines are moved ahead and the helm put hard over towards the anchor and the ship steamed round to the required direction. Twin-screw ships generally turn more rapidly in this manner than if they weigh anchor and work engines in opposite directions. The anchor is very effective for all turning manœuvres where there is insufficient room for rudder-controlled turns under headway.

CLEARING A FOUL ANCHOR

If the anchor is wedged in an underwater obstruction and cannot be weighed the vessel should be moved very slowly ahead, veering cable until it grows well astern. When the vessel is brought up and the cable is taut the engines are worked ahead very gently to see if the anchor will break out. The vessel can then slowly be steamed round in a circle with the cable taut (turning towards the anchor of course), to try to rotate the anchor and break it out by constant movement. If this fails, together with an attempt under sternway with the cable growing forward, then the cable must be slipped from the deck, buoying the end, and the anchor later recovered by divers.

If the anchor has fouled a cable, wire, or other similar underwater obstruction the anchor and fouling is hove well up to the hawse pipe. A strong fibre rope, such as a manila mooring line in the case of a heavy submarine cable, is passed round the obstruction and both ends are hove taut and made well fast on deck. In the case of an unimportant obstruction a wire rope can be used, but a fibre rope must be used in cases where the obstruction may be a telegraph cable or one carrying high-tension current. When the line is hove taut the anchor is walked back clear of the obstruction and then hove home into the pipe. Provided the *hanger* is secured at the forecastle deck in a region of maximum flare, the fouling will swing clear when the anchor is walked back. The hanger is then slipped from the deck to release the fouling.

If the obstruction is still partially lying on the sea-bed and offering resistance to the hanger, so that it does not swing to the flare of the bow, the ship should be gently sheered away so that the point of suspension of the fouling comes directly under the deck edge. The anchor can then be hove home.

On rare occasions it may happen that when the anchor is weighed it emerges from the water upside-down with the cable half-turned around the shank, close to the head. When this occurs the anchor must be hung off from the forecastle deck by means of a strong wire rope passed round the anchor head. When the wire is secure the cable may be veered until

the half-turn slides down and clear of the shank. The cable is then slowly hove-in until it takes the weight of the anchor, when the wire may be cast off. If an anchor is stuck in its hawse pipe, it might be freed by securing it to the other anchor which is then lowered.

HANGING OFF AN ANCHOR

If it is desired to have a free end of cable available for use, the anchor will have to be detached from the cable. Usually, the first shackle of cable includes a joining shackle 2–4 m from the anchor shackle, 1–2 fathom so that when the anchor is stowed the joining shackle is between the gypsy and the hawse pipe. If the cable can be passed through a forward Panama Canal fairlead, then the anchor can simply be secured in the pipe using wire lashings and the bow stopper. The cable can then be eased off the gypsy and *broken*. It is then passed to the fairlead using chain hooks. The same applies if a third hawse pipe is fitted.

If the cable is to be passed through the hawse pipe the anchor must be removed from its housing and secured at the ship's side. First, the anchor is lowered clear of the pipe and a'cockbilled. With a 5-tonne 5-ton anchor, a 24-mm wire rope is then passed from bitts situated just abaft 3-in the hawse pipe, and preferably at maximum flare, through the anchor shackle and back on deck. Both parts are hove taut and belayed.

Another 24-mm wire rope, which we will call No. 2 wire, is passed 3-in from bitts, through the cable forward of the shackle and then led to the nearest winch warping barrel. The cable is eased to No. 2 wire and then broken. No. 2 wire is then veered slowly so that the anchor swings abaft the pipe. Both wires can be left taut (No. 2 wire will be stoppered off and belayed) so that the anchor is suspended equally by both, or else the whole of the weight can be transferred to the first wire. A man can then be sent overside to cast off No. 2 wire, which is hove inboard. This is advisable, because if this wire is left in the pipe it will be severely chafed by the cable.

Should the spare joining shackle be out of reach when the anchor is lowered clear of the pipe, No. 2 wire will have to be passed while the anchor is stowed. The cable is then eased, broken, and the anchor a'cockbilled by veering the wire. The other 24-mm hawser will then be 3-in passed overside as before.

Vessels which frequently engage in this operation use a specially made strop instead of the overside wire, and with this the anchor can be hung off in about 10 minutes. Other methods include taking the overside wire to a warping barrel and heaving the anchor up to the deck edge. The anchor is then either well clear of the plating due to the flare or else can be easily secured so that it does not swing.

HEAVING UP ANCHOR WITH NO WINDLASS POWER

Two solutions can resolve this unfortunate situation. The first is
tons one whereby a heavy purchase (15 tonnes S.W.L.) is secured to the cable and led well aft so as to get as much *drift* as possible. This avoids frequent overhauling. The purchase is attached to the cable by means of
3–4 in a long pendant of 24–32 mm wire. This avoids fouling the purchase in the many deck fittings adjacent to the windlass. The pendant is doubled so that the stress in each part is halved. A lighter, overhauling tackle is rigged on the main purchase to avoid delay and heavy work. As the cable is hove in, the gypsy should be free to revolve, so that the cable is stowed. The gypsies are fixed to the mainshafts, which revolve either when letting-go or when the main wheels are slid along and engaged with the driving pinions on the intermediate shaft, and also the sides of the gypsies. The intermediate shaft drives the warping barrels, so that in this particular case the main wheel is engaged with the gypsy and able to rotate the mainshaft. A friction drive is now set up by means of a heavy fibre mooring line run from the warping barrel to the drum of a winch. When the winch drum revolves it will drive the intermediate shaft of the windlass; this will drive the main wheel, and this will revolve the gypsy.

The brake must be screwed tight before the purchase is overhauled of course.

The second method is rather more simple. The topping lift from No. 1 derrick is unshackled from the derrick head and led forward. It is secured by a pendant to the cable. One topping lift only is necessary for
tons one cable, provided it has a S.W.L. of at least 10 tonnes. The pendant must be doubled as before. The gypsy is placed in gear, the friction drive is set up, and the topping lift weighs the cable and anchor.

SLIPPING A CABLE

If caution is to be exercised, this work cannot be hurried. Usually the necessity for slipping arises when the anchor cannot be weighed.

(1) Slipping from the Deck

Veer cable, or heave, until a shackle is situated near to the hawse pipe
2½–3 in upper lip. A 20–24-mm wire rope with any eyes frapped shut is passed through the cable forward of the shackle and both ends hove taut and made fast, preferably on separate bitts, i.e. a perfect slip-wire. The cable is eased to the wire hawser and then broken.

The problem now arises as to how to slip the wire. First, the engines should be worked ahead so that the cable is up and down and bearing the minimum of stress, only its own weight in fact. The wire can then

HIGH HOLDING-POWER ANCHORS

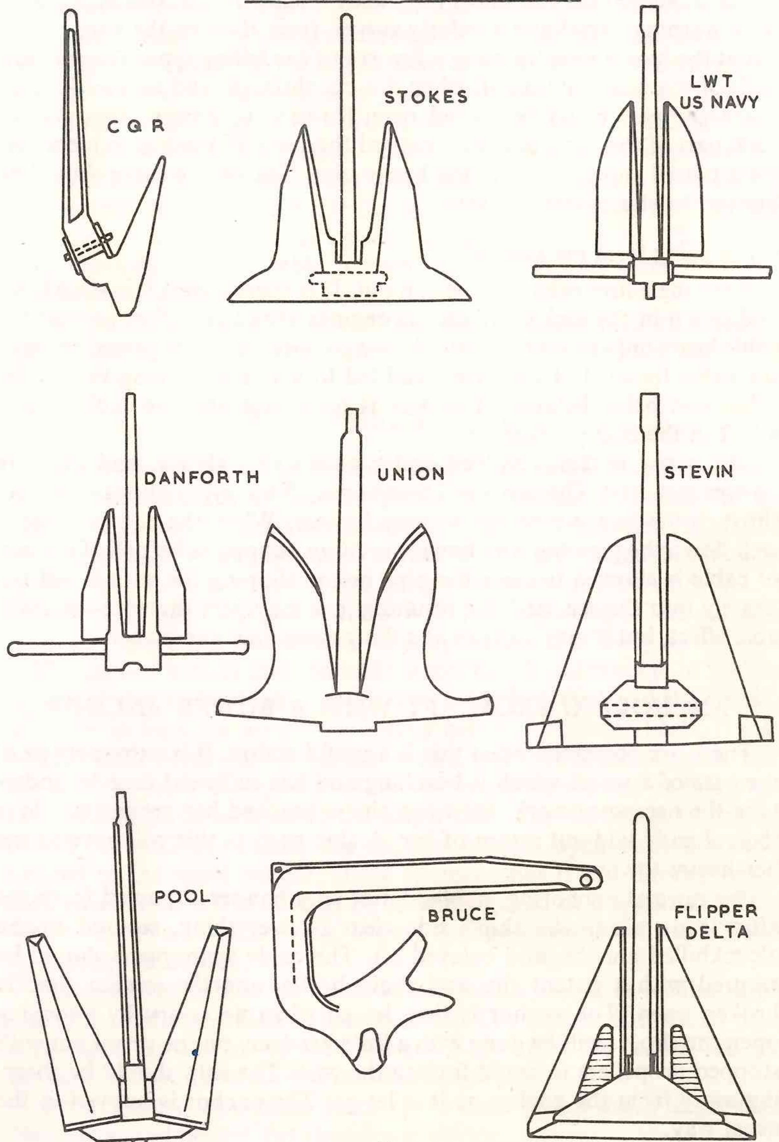


FIGURE 1.11

either be surged off one set of bitts until it runs free, or one end can be on a warping barrel and similarly surged from that, or the wire can be cut at the hawse-pipe lip using a fire axe of the felling type. The inboard ends of the wire will leap aft when it is cut through, and to avoid injury chain stoppers could be passed from forward to prevent this, one to each part of the wire. A better method than any of these is to incorporate a patent slip close up to the hawse pipe. The end of cable should be buoyed to effect later recovery.

(2) Slipping from the Locker

Here the entire cable will be run out. It is veered until it is slackly up and down in the locker. Work the engines ahead as before so that the
3-in cable bears only its own weight. A 24-mm wire hawser is passed through the cable forward of the gypsy and led to a winch warping-barrel, the other end being belayed. The wire is hove taut and the cable is cast adrift in the chain locker.

The gypsy is then revolved under power very slowly, and the wire hawser is veered. The cable will then come off the gypsy and is eased out through the hawse pipe on the wire hawser. When the end of cable is well down the pipe the wire hawser is cut or slipped as before. If the end of cable is allowed to clear the pipe before slipping the wire it will fall heavily into the sea, and the resulting jerk may part the wire—a desirable effect, but it may happen at a dangerous time and place.

ANCHORING FROM AFT WITH A BOWER ANCHOR

There are occasions when this is a useful action. It is extremely so in the case of a vessel which is beaching and has sufficient time to undertake the necessary work, for when she is beached her ground tackle is then already laid out astern of her. A ship such as this will have to use her heavy towline.

3–4-in For normal anchoring, a 24–32-mm wire hawser is passed from the after leads, along the ship's side clear of everything, secured to the a'cockbilled anchor, and belayed aft. The cable spare piece should be secured with a patent slip and chain bridle, and the joining shackle broken open. The anchor is then let go when necessary by knocking open the slip. It will be done with a little headway on the vessel but with stopped propellers to avoid fouling the wire. The ship should be sheering away from the anchor as it is let go. The anchor is buoyed in the usual way.

If it is desired to anchor from aft with the cable, the wire is passed as before and kept ready for shackling to the chain. The anchor is let go and the required amount of cable veered with headway on the vessel. A joining shackle must be positioned near the upper hawse-pipe lip.

The ship is brought up gently on her cable, the latter growing astern. The wire is then rove upwards through the hawse pipe and secured to the cable forward of the joining shackle. A long, curved, specially made shackle is used for this called a *joggle* shackle. A chain stopper and patent slip is then rigged forward of the joining shackle, set tight, and the cable is *eased to the stopper*. The joining shackle is broken and the slip knocked off. The anchor is buoyed in the usual way. The ship is now moved slowly ahead while the wire hawser is hove-in aft. The ship is stopped when the wire is up and down over the stern. The wire is again hove-in and the cable brought aboard aft and secured around several pairs of bitts.

Another method is to ease out the cable from forward on a second wire as it is hove-in aft. This second wire will then have to be slipped.

CHANGING ANCHORS

If a bower anchor is to be unshipped from its cable and the spare bower installed into the hawse pipe the first anchor is lowered to the water's edge and the forecastle derrick swung overside. In Fig. 1.12 a
4-tonne anchor is being changed. In view of the bight of cable which the ton
derrick will have to support, the latter should be at least of S.W.L. 5
tonnes. It is rigged with a 5-tonne S.W.L. lifting purchase. The purchase tons ton
is led to the anchor and secured to it by means of a heavy strop.

The anchor is then lowered underwater to take advantage of the loss in weight due to its displacement. The cable is veered and the derrick fall hove-in until the anchor is directly below the derrick head. It may be kept underwater during this manœuvre. It is then lifted, together with the bight of slack cable, from (1) to (2) in the figure, and at this stage the cable must be secured at the ship's side. The derrick is swung inboard, the anchor landed, the shackle broken open, and the cable secured to the spare anchor. If the spare anchor is not directly below the derrick head it will have to be carefully guyed as it is *floated* off the deck to avoid a sudden swing. It may then be swung to the ship's side by guying the derrick.

The purchase is hove-on until, as before, the weight is off the ship's side cable lashing, which is then cast off. The anchor is lowered until submerged. By heaving on the cable and slacking on the derrick fall, the anchor is shipped and stowed into the hawse pipe.

In the figure the purchase blocks have been drawn much larger than the scale would permit, for the sake of clarity.

Sometimes the spare bower anchor is stowed forward of the forecastle-head breakwater, or washplate. In this case it must have a wire secured to it and led to the nearest forward warping barrel or bitts. This wire then becomes a *bullrope*. The purchase is led to the spare bower anchor, the bullrope set tight, and the purchase fall hove-in. This just floats the anchor clear of the deck and now, by placing heavy, greased planks of timber from the anchor to the top edge of the breakwater, the purchase can be further hove-on, slacking the bullrope, and the anchor will slide up the planks clear of the breakwater. The bullrope can then be used to guy the anchor until it is below the derrick head.

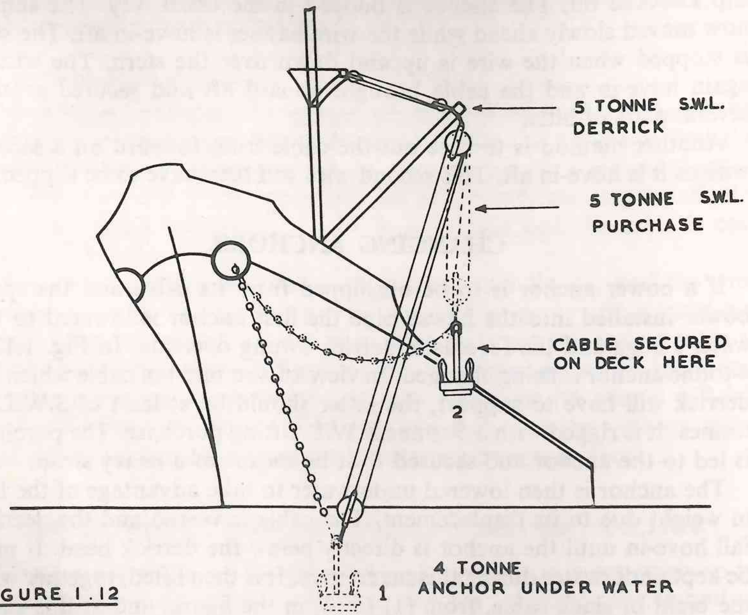


FIGURE 1.12

HIGH HOLDING-POWER ANCHORS

These are defined as being at least twice (some are actually four times) as efficient as a standard stockless anchor of the same weight. Approved types may be permitted a 25% weight reduction by Classification Societies. In most types of sea-bed, *fluke area* is the most important factor in holding-power but weight does play a vital part in poor ground like soft mud or slab rock. Owners may exceed Rule-weight by 7% (with Rule-size chain stached) under Lloyd's Rules. Apart from the A.C.14 in Fig. 1.2 more high holding-power anchors are shown in Fig. 1.11. Most have either stocks or stabilising fins. Because of their efficiency, anchor damage is more frequent nowadays. This occurs at head pins, fluke tips, head stops and in the shank as distortion, which may cause the anchor to jam in the hawse pipe.

CHAPTER II

MOORING

When a vessel is anchored with both anchors leading ahead, she is said to be on *open moor*. Supposing a vessel is lying to a single anchor dead ahead and with a stress in her cable of T tonnes. If she had two anchors leading dead ahead the stress in each tons would be $\frac{1}{2}T$ tonnes. When the angle between the cables becomes 120 tons

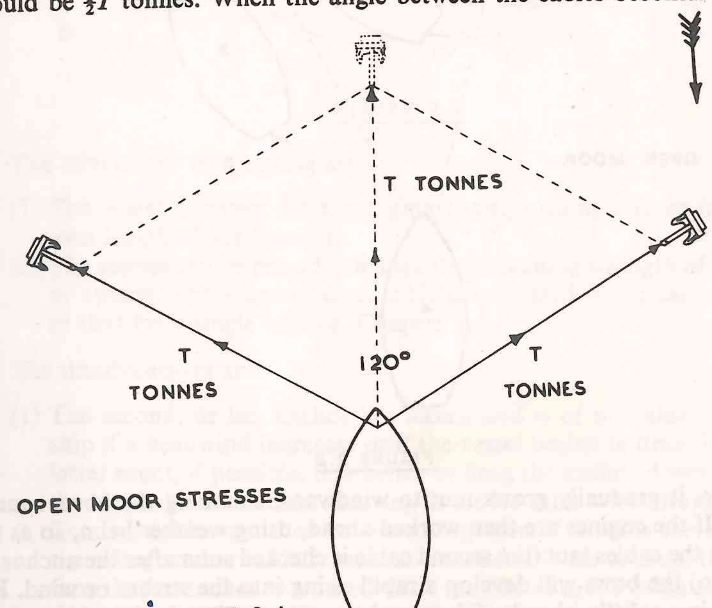


FIGURE 2.1

degrees, i.e. with each anchor about 5½ points on the bow, the stress in each cable becomes T tonnes. This value increases to $2T$ and $3T$ as tons the angle becomes 150 degrees and 160 degrees respectively.

When the angle exceeds the safe limit of 120 degrees she is commencing to ride to a *tight span*. Fig. 2.1 illustrates the parallelogram of forces for an angle of 120 degrees.

COMING TO OPEN MOOR

Fig. 2.2 shows the successive stages of this manœuvre. The vessel is headed into the anchorage with the wind or current on one bow in order to assist counteraction of lee drift. The weather anchor (or upstream anchor) is let go on the run (1), and headway continued for roughly one-third of the final length of cable. The second anchor is let go and the first one snubbed at the gypsy. As the vessel brings-to on her weather

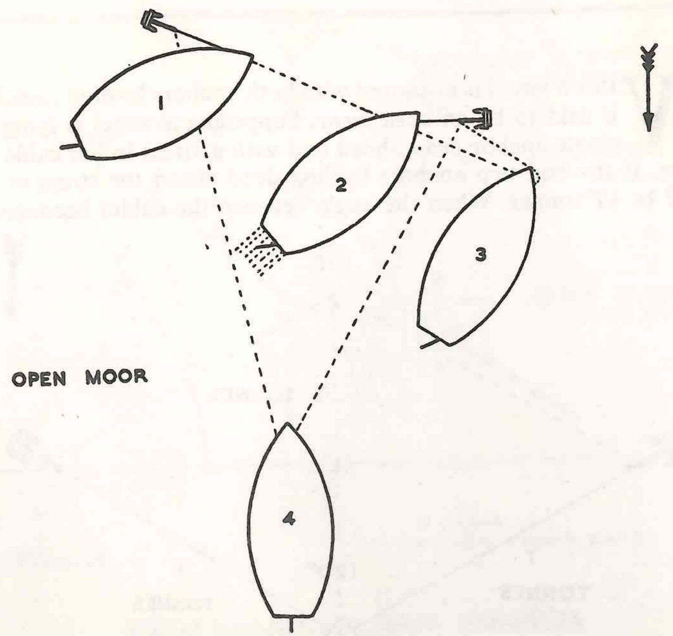


FIGURE 2.2

cable, it gradually grows taut to windward, snubbing the bows round (2). If the engines are then worked ahead, using weather helm, so as to keep the cables taut (the second cable is checked soon after the anchor is let go) the bows will develop a rapid swing into the stream or wind. By keeping a little ahead of her anchors (3), so that both cables grow slightly aft, the manœuvre is hastened. When heading into the wind or stream, both cables are veered (the second one only, for a short while) and the vessel brings-to in position (4). The reason for veering the second one by itself while dropping back initially is to middle the ship between her anchors. By laying out one-third of the length between the anchors, each finally lies a point on the bow.

Mooring is usually taken to mean securing the ship with two anchors, one ahead and one lying astern—a cable each way, as it was once called. The upwind or upstream anchor is known as the *riding anchor* and cable, the other being called the sleeping or *lee anchor* and cable (Fig. 2.3).

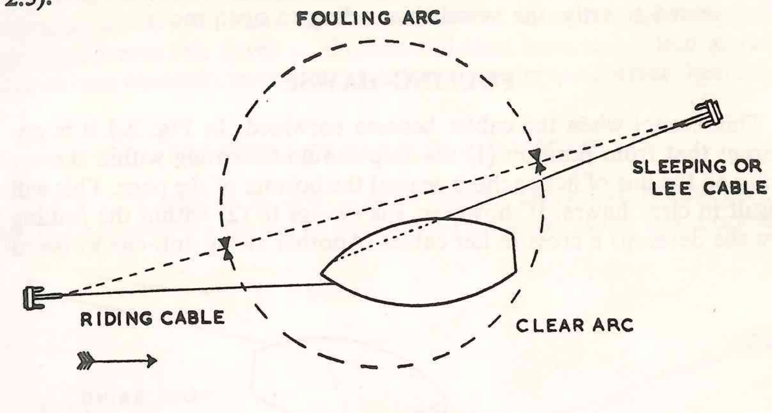


FIGURE 2.3

The advantages of mooring are:

(1) The vessel occupies little swinging room, turning almost in her own length about her stem.

(2) The scopes can be pre-adjusted for the prevailing strength of wind or stream. The scope of each cable is estimated in the same way as that for a single anchor (Chapter I).

The disadvantages are:

(1) The second, or lee, anchor lies astern and is of no value to the ship if a headwind increases or if the vessel begins to drag. In the latter event, if possible, it is better to drag the anchor down until the lee anchor is reached (heaving in the lee cable while dragging). The two cables can then be veered together. If cable is veered on the riding anchor initially and the vessel continues to drag, by the time the lee anchor is reached there may be so much cable out on the riding anchor that the other cable can be veered only a shackle or two.

(2) There is a risk of getting a foul hawse. To avoid this, the vessel must always be swung within the same arc at each consecutive tidal change (Fig. 2.3).

(3) Due to the fact that one cable leads aft, the vessel must be dropped down to it when leaving the anchorage, weigh it, and then heave

herself back to the riding anchor. At 4–5 minutes per shackle, this will take a considerable time. At open moor, provided the anchors are close together, both cables can be hove simultaneously.

(4) In a beam wind the vessel will turn and lie at open hawse across the line of her anchors, creating a tight span. Both cables must be veered smartly, the vessel then riding to open moor.

FOULING HAWSE

This occurs when the cables become entwined. In Fig. 2.4 it is apparent that from position (1) the ship should be swung within the arc lying on the line of her anchors nearest the bottom of the page. This will result in clear hawse. If, however, she swings to (2) within the fouling arc she develops a cross in her cables. Another swing anti-clockwise to

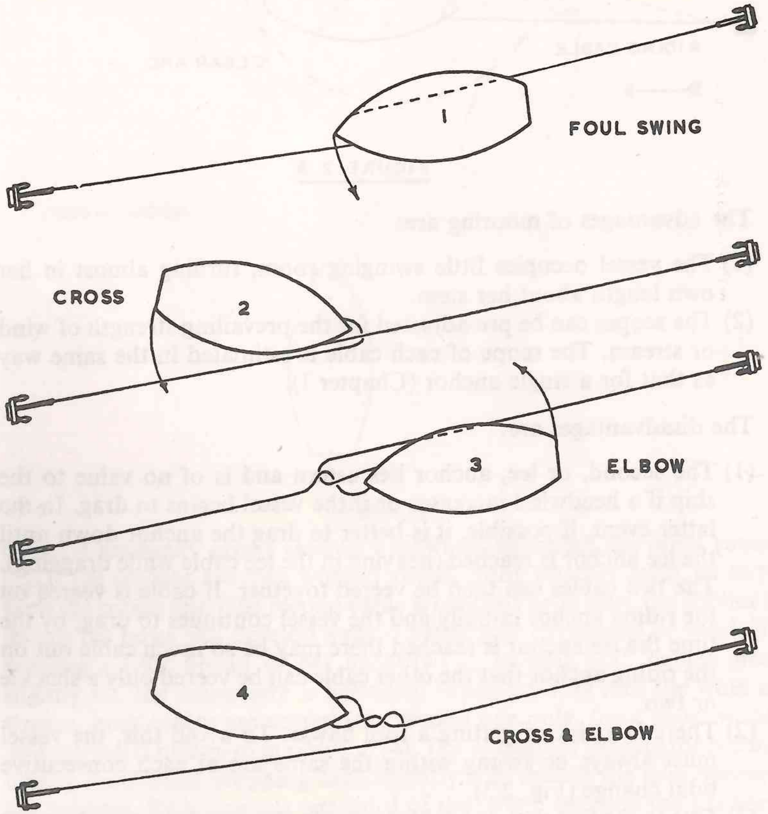


FIGURE 2.4

(3) results in an elbow, and a third similar swing produces a cross and an elbow, (4).

To avoid this, the vessel at (1) should have been given a broad sheer to starboard just before slack water so that the new stream catches her starboard quarter, swinging her within the clear arc. However, during calms or windy conditions at slack water this sheer may be cancelled and an adverse one develop. Engines will then have to be used as the new stream commences to run, in order to restore the correct sheer.

MOORED CLOSE TO A DANGER

In Fig. 2.5 a vessel is moored close to a shoal. This is hardly advisable, but the occasion may arise. In position (1) the vessel is initially moored

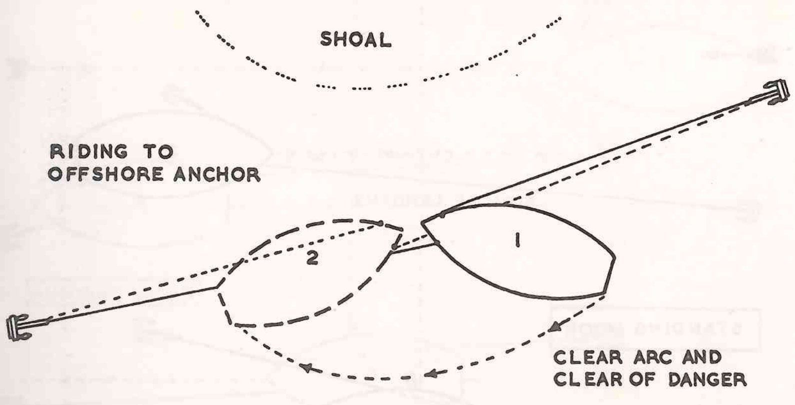


FIGURE 2.5

riding to her off-shore anchor. When she swings with the change of stream to position (2) she must do so to starboard, so avoiding running her stern close to the shoal. Because she is riding to the off-shore anchor, her hawse remains clear. In (2) she again rides to the off-shore anchor—the starboard one.

MOORING

There are two basic methods whereby a vessel may execute the moor.

(1) The Standing, Ordinary, Dropping, or Straight Moor

Let us assume the vessel is required to moor with her bridge along the line *AB* in Fig. 2.6. The stream is running from the left side of the page. Five shackles length is required on the port anchor and four on the starboard anchor. The vessel is headed into the stream (with a wind instead of a stream, the vessel is headed to windward, and when both are present the vessel heads the one which is having the stronger effect), with sufficient headway to take her to (1), which will be roughly five shackles plus a half ship's-length beyond the line *AB* (the vessel is to ride to her port anchor initially, let us say). At position (1) the port anchor is let go and the vessel drifts downstream, rendering her port cable to nine shackles, the sum of the two lengths. She is brought up

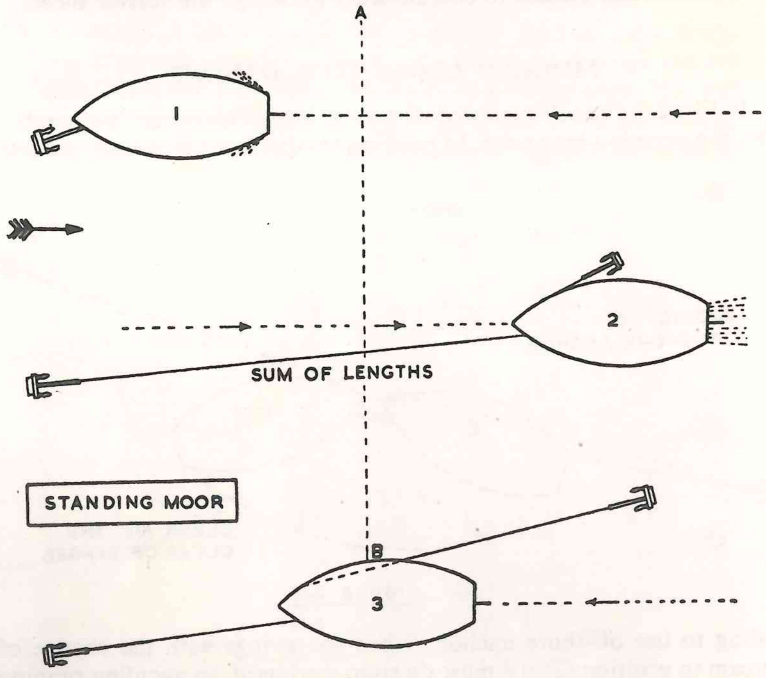


FIGURE 2.6

gently on this cable and the starboard anchor is let go underfoot at (2). The vessel then middles herself between the anchors by veering or rendering four shackles on the starboard (lee) anchor cable and heaving in four shackles on the riding cable until she reaches position (3). During the middling, engines may be used to relieve the windlass of the stress on the taut riding cable.

The figure has been laid out in three sections to show the manœuvre with clarity, though, of course, the mooring is done along the first track of the ship. Notice that the vessel passes the bridge-position line twice during the manœuvre. To move from (2) to (3) will take approximately

16–23 minutes with a 48-kilowatt windlass, depending upon whether the riding cable is slack or taut.

(2) The Running, or Flying, Moor (Fig. 2.7)

Assuming the same conditions and requirements as before, the vessel again heads the tidal stream or wind. The starboard (lee) anchor is let go with headway on the vessel at a position distant from the line *AB* four shackles less a half ship's-length (1). The cable is rendered as the vessel moves upwind or upstream so that the bow is not checked round. The lee cable is laid out to a length of nine shackles, the sum of the two lengths, and the brake is screwed up. The cable is not allowed to tighten,

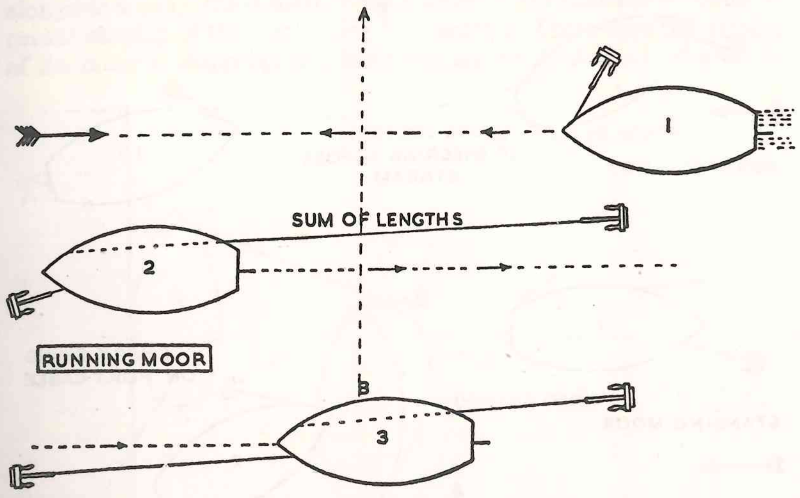


FIGURE 2.7

otherwise the bow will cross the stream and high engine revolutions will be necessary to correct this sheer.

At position (2) while the lee cable is still slack the port anchor is let go underfoot and the vessel moved astern. This riding cable can either be veered to its length or else alternately surged and snubbed. As the vessel moves down wind or stream, five shackles must be weighed on the lee cable (20 minutes) and five shackles veered on the riding cable. The vessel is then brought up on her riding cable at (3).

The figure is again laid out in three sections for the sake of clarity. The vessel passes the line *AB* only once in this manœuvre. Under certain conditions, this moor may take longer to execute, reckoning from the time the first anchor is let go. In the dropping moor, 9 shackles are rendered with the stream. In the running moor 9 shackles are rendered *against* the stream. Again, in the dropping moor, only 4 shackles have to be weighed, against 5 in the running moor. Naturally, if the lengths had been reversed, this latter consideration would also be reversed.

In a cross wind the weather anchor is the first to be let go so that the vessel does not drift across her cable. If the lee anchor is let go the cable will grow under the ship, her bows will be snubbed up into the wind, and she will get across the stream. In the dropping moor slackening the riding cable at some stage between (1) and (2) and working the engines

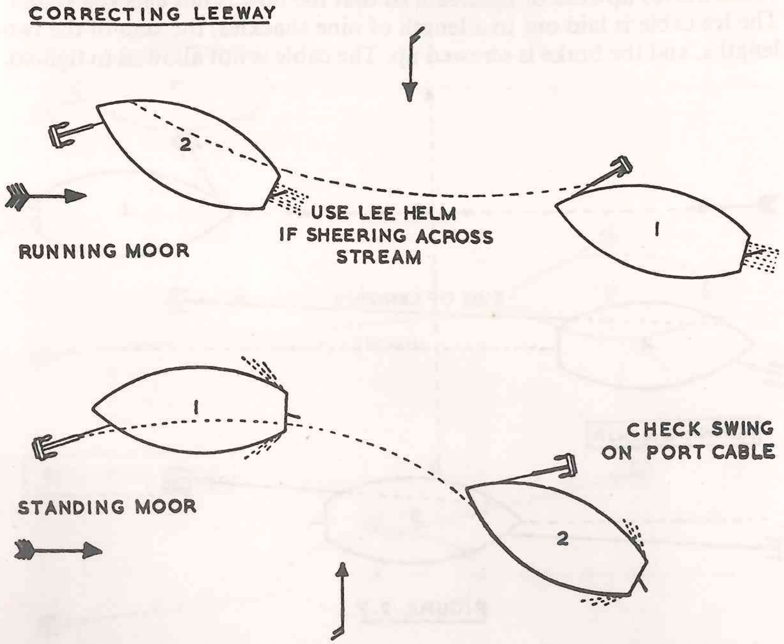


FIGURE 2.8

astern under weather helm will help to counteract leeway, the swing of the bows across the stream being checked as necessary on the cable.

In the running moor leeway is checked by laying out the sleeping cable under engine power and steering upwind. Any sheer across the stream is then corrected with lee helm and also partially corrected by the vessel's tendency to pay off the wind under headway. Notice that in the dropping moor sheer across the stream due to astern movements is aggravated by this tendency. However, the cables provide a good checking action. Too much sternway should not be allowed (see Fig. 2.8).

In calm weather the port anchor is the better one to drop first in the

standing moor, since any astern movements on the engine (right-handed single-screw ship) to reduce any remaining headway will cant the stem away from the anchor underfoot.

For similar reasons, in the running moor the port anchor is the better one dropped at (2). Further, in the event of the lee cable becoming jammed during the run from (1) to (2), an astern movement swings the vessel to starboard, the cable grows clear and avoids a bad nip.

The Baltic Moor

This method of mooring a ship is employed when a vessel is to lie alongside a quay, the construction of which is not sufficiently robust to permit ranging of the ship during bad weather. These days the naming of the moor is inappropriate, but there are no doubt such wharves in

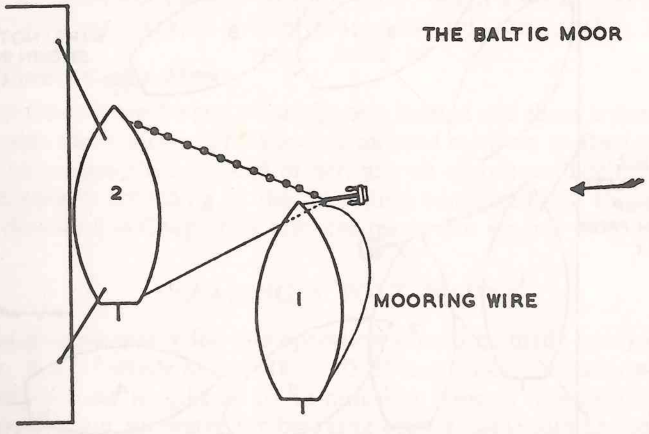


FIGURE 2.9

various other parts of the world. It is a useful method of berthing a vessel in an onshore gale of wind, particularly when the vessel is expected to leave before the weather abates. It is a popular manœuvre in certain small classes of naval vessels.

If the manœuvre is to be executed in an average-sized merchant ship, a 25–30 mm wire is passed from the after leads on the poop, along the offshore side, outside and clear of everything. The offshore anchor is a'cockbilled and a man sent overside on a chair to secure the wire to the anchor, preferably at the shackle. The after end of the wire is sent to a warping barrel, ready for heaving in slack wire. 3–3½-in

When the stem is abreast the position on the quay where the bridge will eventually be the anchor is let go, still with headway on the vessel.

About half a ship's length of cable is surged and then the cable is snubbed. The wire is hove-in aft.

The onshore wind will drift the vessel down on to her berth, and the scope of the cable, and the wire, is adjusted and slowly veered until the ship lands alongside. Fig. 2.9 shows the manœuvre. It is most important to let go the anchor having the best possible judgement of position, for if the anchor be let go too far off the quay the wire will be of insufficient length and the ship will fail to reach her berth. The anchor must then be
120 fathoms weighed and the manœuvre repeated. If the available wire is 240 m

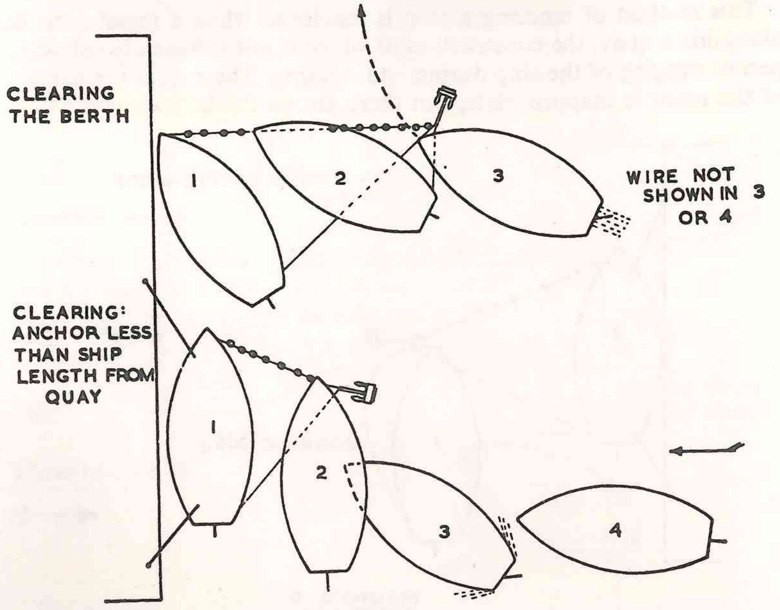


FIGURE 2.10

110 fathoms in length and 220 m are to be veered, then roughly 7½ shackles of
500 ft 60 ft cable will also be veered. If the ship is 150 m long and 18 m in beam the anchor will then lie one-and-a-third ship-lengths off the quay.

If it is discovered, before too much cable is veered, that the anchor has been let go too far from the jetty the cable must be snubbed and the anchor dragged to the desired position.

If there is no wind at the time of berthing the cable and wire are kept slack and the vessel manœuvred to the berth under engine power and helm. Each time the propeller is moved the wire must be hove until it grows farther to long stay.

In the event of the anchor lying more than a ship's length from the berth, clearing is comparatively easy: the vessel is hove out to her anchor by her cable, using the wire to make sure that the stern does not foul the berth. If desired, the reverse may be done and the vessel hove out to her anchor stern first, using the wire alone, picking up the slack cable as she goes. The anchor is weighed and the vessel swung to the desired direction (3). In an onshore wind, the anchor can be left at short stay and the vessel steamed round it, if she desires to head upwind (Fig. 2.10).

If the anchor is lying less than a ship's length from the quay the vessel can heave herself out to it, keeping parallel with the jetty. There is no room to swing head-to an onshore wind, so the anchor is weighed and the vessel bored up to windward stern-first under powerful revolutions. She will execute this swing rapidly. When sufficiently far from the quay, she can then swing to the fairway. If there is no wind it will be preferable to again heave out parallel with the quay, weigh anchor, and proceed to swing (if necessary, of course) under powerful headway (Fig. 2.10).

The Mediterranean Moor

This moor is used when wharf space is limited and there is deep water alongside the wharves. The vessel is moored stern on to the jetty with both her anchors lying ahead of her, fine on each bow. The manœuvre varies greatly according to the prevailing wind, and will therefore be fully discussed in Chapter IV after the reader has studied Chapter III.

CLEARING A FOUL HAWSE

The gear necessary for this operation should be made ready at slack
water. It will include at least three 20–25-mm wires; a smaller wire, say 2½-3-in
10 mm, or some lengths of 10–15-mm fibre rope; a boatswain's chair; 1½ in 1½-2-in
and equipment necessary for breaking open a cable joining-shackle.

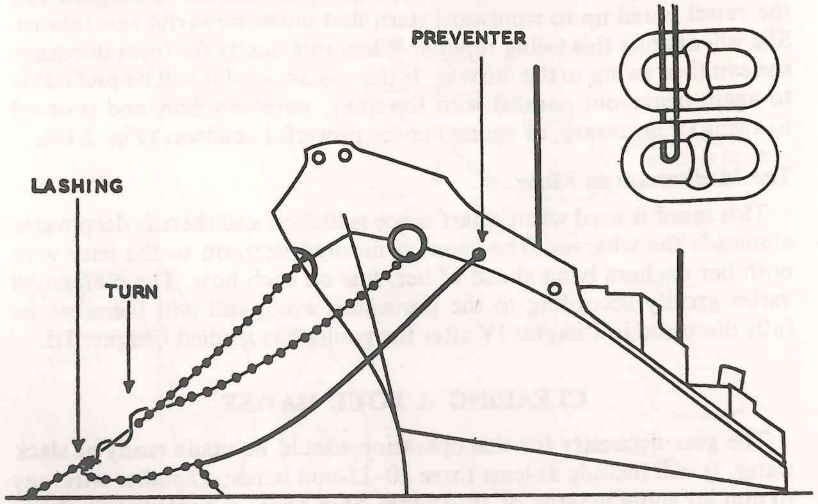
The operation may be started as soon as the ship is swung to a new stream, thus giving about 6 hours freedom. The clearing may take up most of this time if the hawse is badly fouled. Much will depend upon the men employed.

The hawse is cleared by unshackling the sleeping cable and passing the end around the riding cable.

In Fig. 2.11 the turns are hove above water and the cable lashed together below the turns, using the fibre rope. The naval method may be employed, by using the light wire as shown in the figure. The two ends of the wire are then belayed on deck. There should be no difficulty in bringing the cables together, since the sleeping cable will be reasonably slack. One of the bigger wires is then passed around the sleeping cable below the turns, hove tight, and belayed. This wire acts as a preventer in case the unshackled end of the cable is lost, and also relieves the turns of some of the cable weight. A round turn may be used when passing this preventer around the cable. This enables the wire to be slipped later from the deck. The vessel is shown riding to her starboard cable.

In Fig. 2.12 a wire messenger has been passed down through the hawse pipe, dipped around the riding cable, following the run of the port cable, and returned to the forecastle deck. It is dipped only once, and only half a turn will be removed at any one time.

On deck (Fig. 2.13) the port cable has been veered until a joining shackle is forward of the gypsy. The third wire is secured to the cable just forward of the shackle, both parts are led to the bitts, belayed, and



PREPARATIONS

FIGURE 2.11

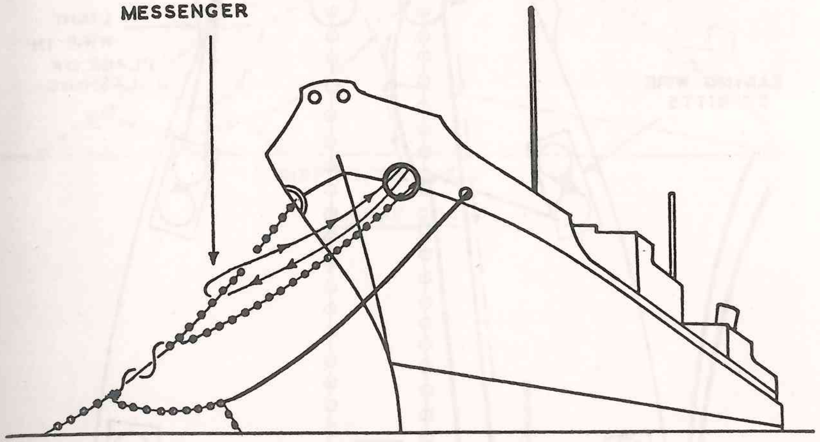
then the cable is eased to this wire. The shackle is broken open. When the cable is parted the shackle may be replaced and assembled. The easing wire should be capable of being slipped from the deck, and for this reason it is advisable to have it passing through the open end-link. Even when the stress of the cable is on the easing wire, the shackle should still be movable. If the shackle is jammed in position by this taut easing wire (through the end-link) it will not matter, because it can still be broken and reassembled in spite of this.

One inboard end of the messenger is now secured to the joining shackle, the other is taken, with as good a lead as possible, to a warping barrel, and set tight. The easing wire is shortly going to be surged on the bitts—if desired, one end of it can also be led to a warping barrel; it can

then be surged without risk of fouling the other end of the wire, or it can be veered under power.

In the case of a lugless joining shackle, where there are no end-links or enlarged common links, the cable is secured by chain stoppers or efficient bow stoppers, the cable shackle broken and then reassembled (when the cable has parted) fast to both the messenger and the easing wire. The easing wire is then hove, the weight taken off the stoppers, the latter cast off, and the situation is as before.

All is now ready for removing the first half-turn. The messenger is hove-in and the easing wire eased. The direction of movement of the messenger is as shown in Fig. 2.12. When the end of cable is about to be



DIPPING THE MESSENGER

FIGURE 2.12

dipped the easing wire is slipped (Fig. 2.14), the messenger hove, and the end of cable dips around the starboard chain. It then continues on up to the hawse pipe and on to the forecastle deck.

On deck the easing wire is again set up, the weight is taken on it, the messenger cast off and re-dipped as before to remove the remaining half-turn.

When this has been achieved the situation is as shown in Fig. 2.15. The cable is re-joined, the preventer is cast off, and the fibre lashings are burned through. This is often done by sending a man overside on a chair. He swings himself along the cable, soaks the fibre rope in paraffin, and returns to the deck. A bucket is then lowered, containing burning paraffin rags, to set the rope alight. Many methods may be devised for this minor job. The cables will then part with very little whip, because the sleeping cable is still slack.

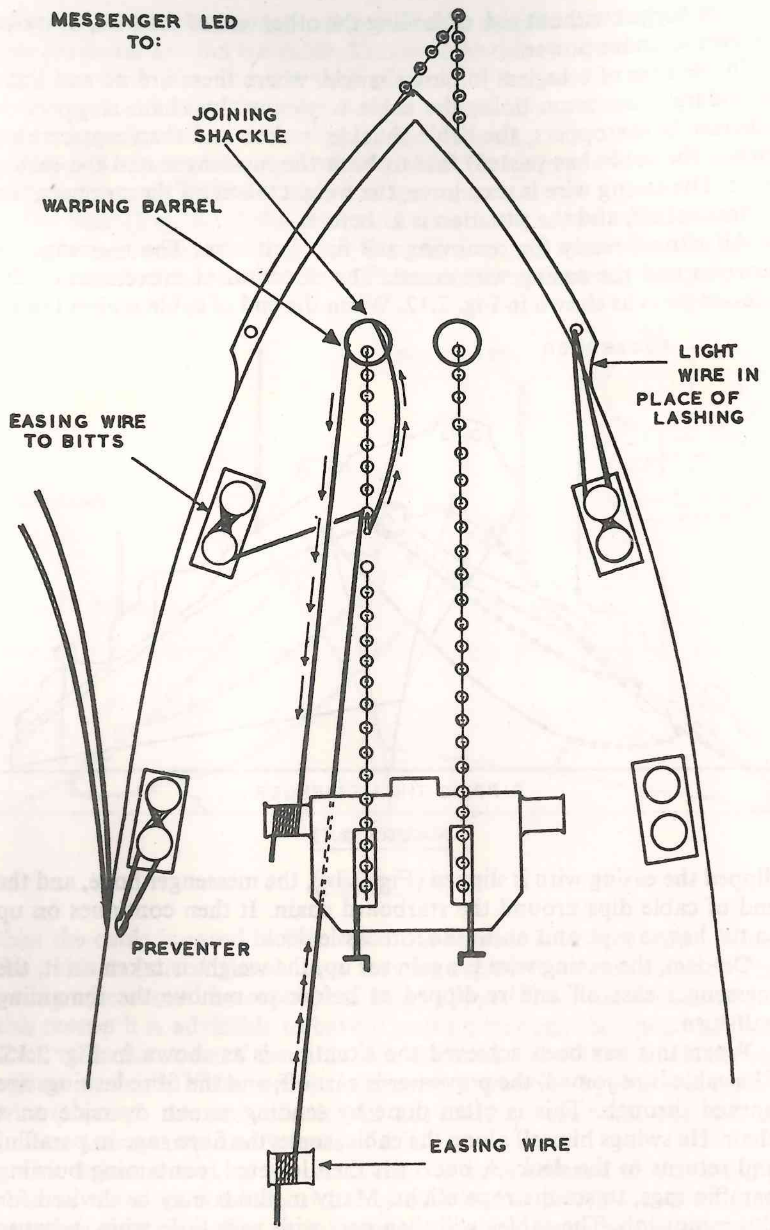
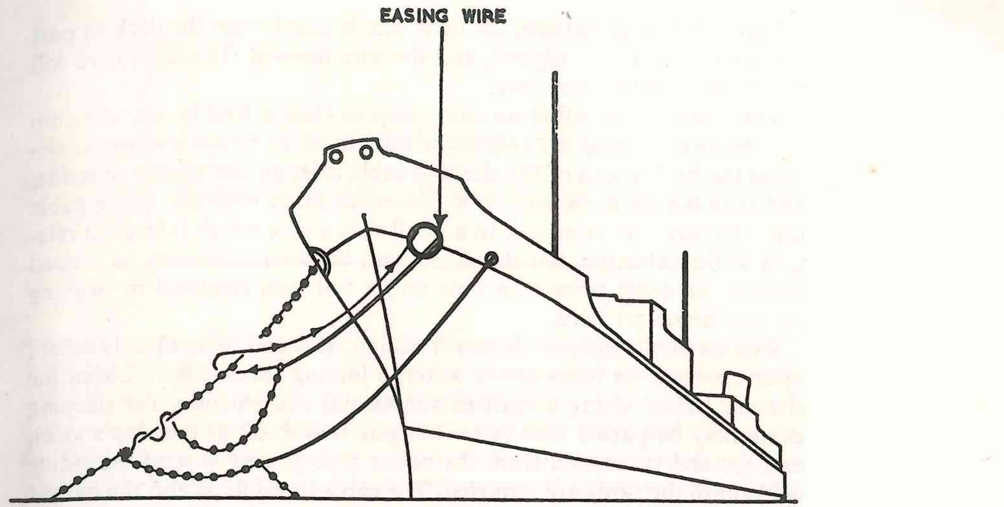
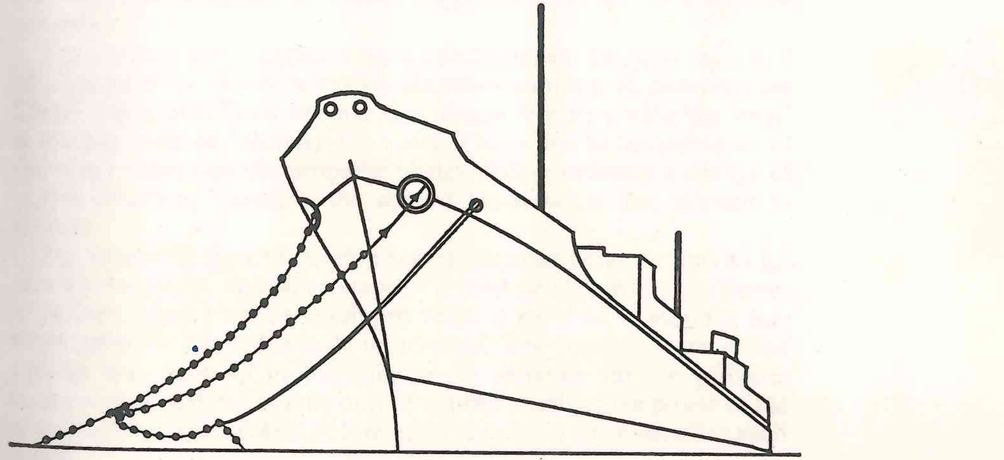


FIGURE 2.13



DIPPING THE CABLE

FIGURE 2.14



CLEAR HAWSE

FIGURE 2.15

Using the naval method, the light wire is eased from the deck to part the cables, one end is slipped, and the wire hove-in. This light wire will pass through a common link.

There are several other methods used to clear a foul hawse: the ship may be turned, using her engines or tugs, until the hawse is clear; sometimes the broken end of the sleeping cable is let go completely overside, and then a wire from each bow is used to lift it over the riding cable until the turns are removed. In a small ship a wire which is large in relation to the cable (so that it will not jam between links) can be dipped around the cable twice at a time and a full turn removed by heaving on this messenger once.

One method employed is worth noting; this can be used only when, upon heaving the turns above water, a joining shackle is visible in the sleeping cable. Using a craft of substantial construction, the sleeping cable may be parted here (after hanging it well off at the ship's side), and the end suspended from the hawse pipe passed around the riding cable until the turns are removed. The cable is re-joined and the hanger removed.

CHAPTER III

THE PRINCIPLES OF SHIP HANDLING

THE successful handling of ships is entirely dependent upon the handler having a wide knowledge of the many factors involved. Some of the factors are controllable by him, others are not, and he must quickly assess their effects so that he may make due allowance for them. Some factors, such as wind and current, may be used to great advantage, providing they are well understood. We shall discuss all the aspects involved, under separate headings, but they are not to be read as being in order of importance.

(1) THE ENGINES

The steam reciprocating engine is generally considered to be the best from the point of view of response. It is rapidly stopped and reversed, and may be relied upon to develop full power either way in a very few seconds.

The modern Diesel engine is started and stopped almost at once, and often develops power more quickly than the steam engine. However, the Diesel engine is difficult to start in a reverse direction while the vessel is making good way through the water. This is due to the resistance of the water stream on the propeller blades. Before ordering a change of engine direction, therefore, the way of the vessel is best allowed to reduce.

The turbine is slow to develop power—it must be given time to increase revolutions, and when stopped it must be allowed to run down. Therefore, when a turbine-equipped vessel is required to stop the turbines must be stopped a little in advance. The running-down of the turbine may take up to five minutes. A separate turbine provides astern power, and has usually only about two-thirds of the power of the ahead turbine. A great deal of foresight is necessary when handling such a ship.

All vessels, particularly Diesel-equipped ships, should be handled with as few starts and stops as possible.

(2) PROPELLERS

By convention, engines are designed to have clockwise-turning shafts when going ahead and when viewed from astern. For this reason, right-handed propellers are nearly universal in single-screw ships. Twin-screw ships invariably have outward-turning screws, i.e. the propeller on the right side of the ship is right-handed, and that on the left side is left-handed. When going astern, both propellers naturally turn inwards.

Triple-screw ships are usually manœuvred on the outer two screws, the central one being used to increase ahead or astern power.

RIGHT-HANDED SCREW, GOING AHEAD

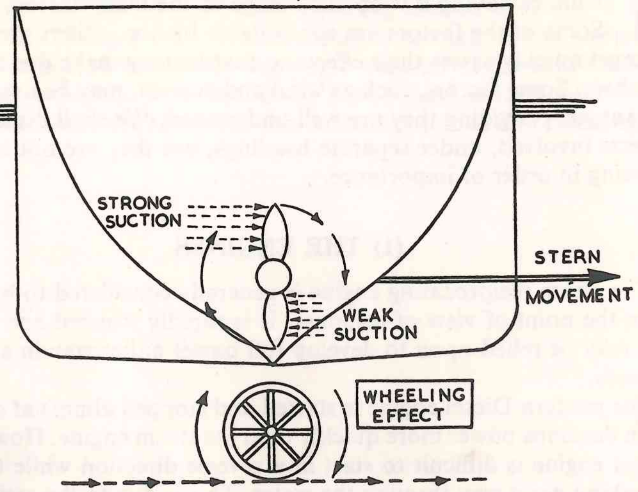


FIGURE 3·1

Quadruple-screw ships have a pair of propellers on each side, a right-handed pair on the starboard side and a left-handed pair on the port side. They are usually manœuvred on the outer screws only. A turbine-equipped ship with four screws generally has the outer pair only capable of going astern.

The thrust of the propeller blade is divided into two components, a fore-and-aft one and a very small athwartships one. The latter is called *transverse thrust*, *screwing effect*, or *starting bias*.

The result of this force may be deduced by considering the propeller to be a wheel, carrying the stern through the water at right angles to the vessel's line of motion. The cause, however, considering an immersed

propeller, is mainly due to the suction exerted upon the hull immediately behind the rotating blades. Since the hull is more full in way of the upper blades, the suction has its greater effect at this position and a bias is caused. This bias is very noticeable in full-sterned vessels, but is almost negligible in fine-lined destroyers. Density and aeration cannot be held responsible, since the specific gravity of salt water changes by only 0·000015 over a depth of 3 m, and the bias still occurs at depths 10 ft where aeration is negligible. It is likely, however, that aeration may affect bias when the propeller is working close to the surface. When the propeller is partially emerged bias is undoubtedly very largely due to the paddling of the lower blades.

In Fig. 3.1 a right-handed propeller is shown working ahead, together with the suction bias and the wheeling effect, swinging the bow to port. A starboard swing occurs when going astern, and the reverse is true when using a left-handed propeller. Readers should note that controllable-pitch screws will always produce the same bias, since they rotate in a constant direction, whether the vessel moves ahead or astern.

When the vessel moves ahead a belt of water called the *frictional wake* is drawn along by the hull. This provides a resistance to the upper blades, which reduces starting bias as the speed increases. In some cases an opposite bias may even develop. Under sternway there is very little wake strength at the propeller, and starting bias is maintained as speed increases. Considerable sternway may be necessary before the rudder will correct the bias, and sometimes stopping the engine provides the only correction.

Starting bias is naturally modified in conditions of wind, current, and when the ship's head is already swinging.

Summarising then, in a single-screw ship with a right-handed propeller:

When going ahead, the bow cants to port, the swing decreasing as way is gathered and possibly changing in the opposite sense.

When going astern, the bow cants strongly to starboard and will continue to do so until correcting helm is used.

In a twin-screw ship the propellers are offset from the centreline and a moment is created about the latter by the fore-and-aft thrust of the screw, turning the vessel to one side. If both engines are going ahead or astern, and at the same revolutions, the two transverse thrusts cancel each other. In any case, the port screw is left-handed, and both its transverse thrust and its *offset-effect* cant the bow to starboard when going ahead. Similarly, the starboard screw when going ahead cants the bow to port, both by its offset and its transverse-thrust effects. From this, it is obvious that a vessel fitted with outward-turning screws is more manœuvrable than one fitted with inward-turning screws. Consider the port propeller of such a ship; it is right-handed, and therefore when going ahead its transverse thrust cants the bow to port, while its offset-effect cants the bow to starboard. The net swing of the ship is the difference between these two effects. With outward-turning screws the swing is controlled by the *sum* of the effects.

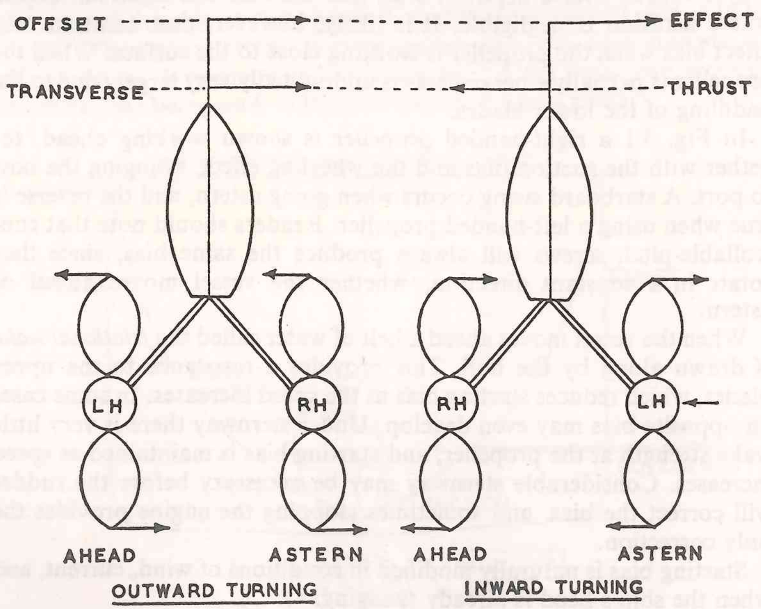


FIGURE 3 . 2

In narrow waters a vessel having inward-turning screws may become unmanageable. As far as handling it is concerned, engine movements are made as for any other twin-screw ship, but the behaviour may be unpredictable. The advantage of inward-turning screws will be discussed later, but it is vastly outweighed by the inferior manœuvring qualities.

To complete this discussion, imagine an outward-turning screw ship having its port engine going ahead, and its starboard engine going astern. This 'push-and-pull' turns the ship smartly to starboard. Both propellers are now turning left-handed. Consider them as one big left-hand propeller. The transverse thrust cants the bow to starboard, assisting the swing of the ship. Think of the inward-turning screw ship under similar conditions. Again the push-and-pull action turns the

ship to starboard, but both propellers are now revolving right-handed and their transverse thrusts oppose the push-and-pull effect. Often the latter is opposed sufficiently to cant the ship in a reverse direction (Fig. 3.2).

When turning a twin-screw ship which is stopped or moving very slowly the transverse thrusts of her propellers is greater than the offset-effect, and the two combined are more effective than helm.

For freedom from vibration the propeller must turn in a smooth flow of water. This flow is restricted when the engines are reversed and also in shallow water, so that vibration occurs under these conditions.

Manœuvring Propellers

A device developed in 1950 is known as the Active Rudder. It consists of a submersible electric motor, water-filled and water-lubricated, installed in the trailing edge of the rudder. It can be supplied with ratings varying between 15 and 1200 kW. The rear end of the motor shaft carries a propeller which is capable of being reversed in the direction of rotation. Power can be supplied immediately to turn the ship in any direction. It is of particular use when the vessel is stopped. A side effect is that, in the event of a main engine failure, the active rudder gives sufficient power to propel the vessel to port.

Bow thruster units are increasingly in use. One of these, fitted to a coastal tanker, saved the initial expense of the unit in one year. These units (about 300 kW for a 9000-tonne deadweight vessel) enable a vessel to turn within her own length. Thruster units may also be fitted at the stern. Hull resistance is not increased if properly faired doors are fitted at each end of the thruster tunnel, the doors and the motor having interlock switching. In berthing or unberthing, the units are invaluable. By steaming ahead on a forward spring and thrusting towards the quay at the same time, a vessel can move sideways off the quay.

(3) THE WAKE CURRENT

If a beamy, rectangular barge is under headway a cavity will be created at its stern. Water will flow down the sides of the barge and swirl in to fill this cavity. Steering will be very adversely affected because the rudder will be working in what might loosely be termed a partial vacuum. Further, the propeller will be working in disturbed water, speed will be lost, and vibrations will be set up. This water, swirling into the cavity, is called the wake current. Both cavitation and wake current increase with speed.

If, however, a finely sterned yacht was under headway the cavitation

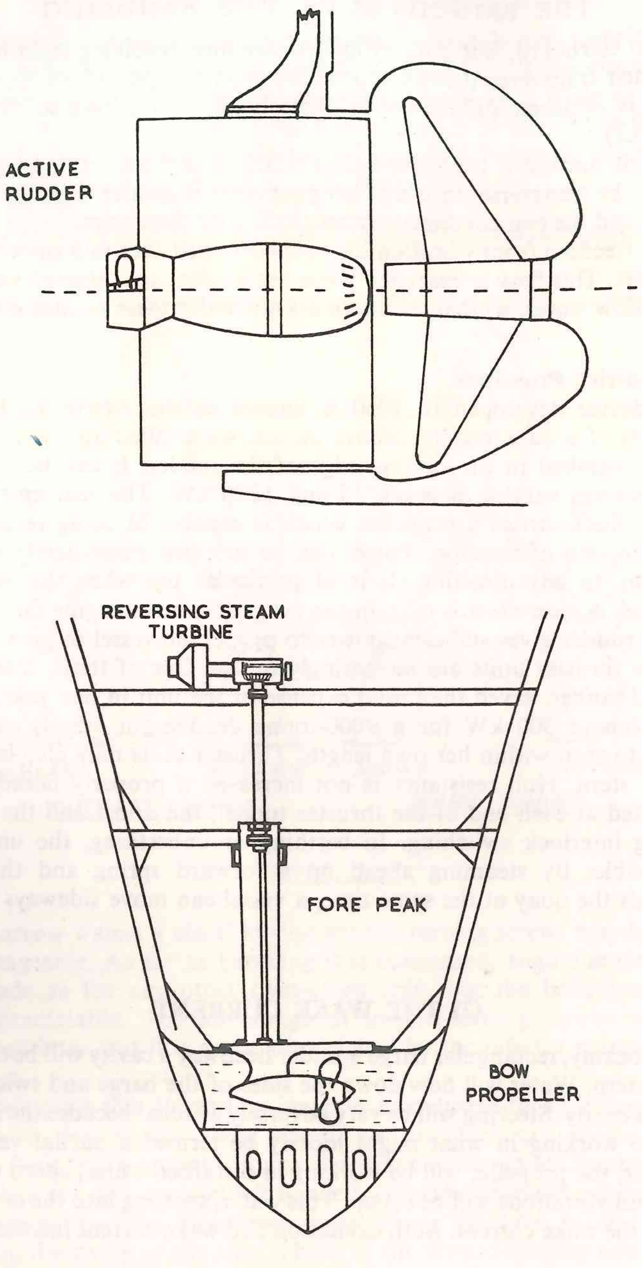


FIGURE 3 · 3

and wake current would be very much smaller. Ships should therefore be constructed with as fine a form aft as possible. When the ship moves astern the cavitation and wake current exist at the stem and will be very small. In any case, it will not affect the propeller or steering.

(4) THE RUDDER

The turning properties of a ship depend largely upon the size, shape, and position of the rudder. Basically, there are two types: the older-fashioned rudder, which has all its area abaft the rudder post, and the balanced rudder, having about a third of its area forward of the post. When this type of rudder is turned water impinges upon the forward area and assists the rotation.

In a single-screw vessel the rudder is directly abaft the propeller and the slipstream strikes directly upon the rudder surface. In a twin-screw ship the rudder is situated midway between the two slipstreams and will have effect only when it is directed into either one, or when the ship has sufficient way upon her to cause a flow of water past the rudder.

It is for this reason that a single-screw ship is the more sensitive of the two types when the rudder is moved during very slow speeds or when the ship is stopped. We have already stated that the helm of a twin-screw ship, stopped or moving very slowly, is not as effective as the offset-effect of the two propellers.

It should be noted that despite the good steering qualities of a single-screw ship, the rudder is almost ineffective when the ship has her head-way reduced by astern engine movements, due to the resulting turbulence.

In some twin-screw vessels twin rudders are fitted, one directly abaft each propeller, the steering qualities then closely approaching that of a single-screw ship. Vessels working upon the Canadian Great Lakes have their engines aft and their bridges right forward. This unusual distribution of weight adversely affects steering, even under full headway, and twin rudders are fitted to compensate for this.

Under sternway considerable way must be gathered in order for the rudder to be effective, and even then steering is likely to be unreliable. The best that can be hoped for is a trend in the right direction.

Vessels fitted with inward-turning twin-screws have a very much narrower screw stream, and hence better steering qualities than are found with outward-turning propellers. They also have a slightly improved speed. These factors are, however, greatly outweighed by their poor manœuvrability at slow speeds. We have already stated how their transverse thrusts oppose the offset effect, and this will persist until the ship has sufficient way upon her for her rudder effect to predominate.

(5) SIDESLIP OR SKID

When a vessel turns under helm her ends skid about her pivoting point. There is also a bodily sideslip due to centrifugal force. When a vessel is light her sideslip, and skid, become more apparent because her reduced underwater volume has a less grip on the water. At high speeds the skidding has a marked effect in reducing headway.

(6) THE TURNING CIRCLE

When a vessel alters her course under helm through 360 degrees she moves on a roughly circular path called a *turning circle*. Throughout the turn her bow will be slightly inside the circle and her stern a little outside it. The circle will be the path traced out by her centre of gravity.

At any instant during the turn a line drawn from the centre of curvature of the path, perpendicular to the ship's fore-and-aft line, meets the latter at a point called the *pivoting point*. This is about one-third of the

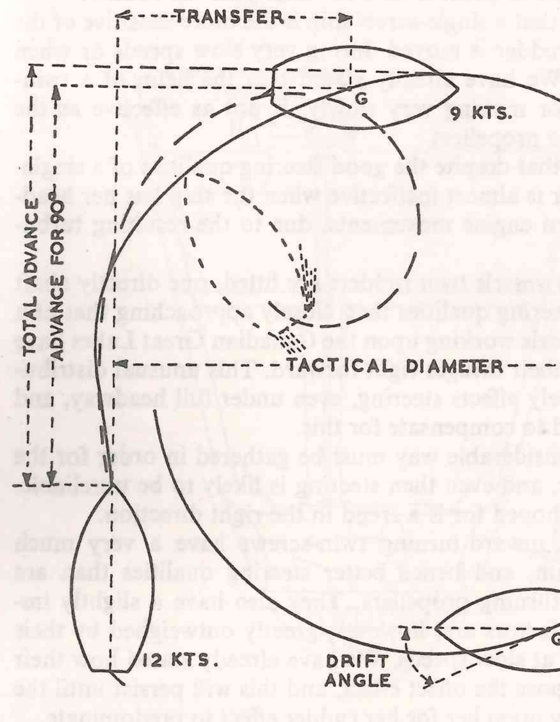


FIGURE 3.4

length from forward. For practical purposes, it may be taken as being just forward of the bridge. When the vessel moves under sternway the pivoting point moves aft, very close to the stern. Fig. 3.4 shows the starboard turning circle for a single-screw ship. The dotted track superimposed on the first circle is the turning circle of a similar vessel, but having twin-screws, one going astern and one going ahead, at equal revolutions.

The circle does not link up with the original course, due to some sideslip when the helm is first used. During the turn the vessel suffers some deceleration; after turning through 90 degrees she has lost about one-quarter of her original speed and after a further 90 degrees she has lost about one-third of her original speed. Thereafter the speed remains roughly constant.

With a right-handed propeller the circle to port will be slightly smaller in radius than the circle to starboard, due to the effect of transverse thrust.

Seamen usually refer to the turning circle as being the path traced out by the pivoting point, the definition given previously being that of naval architects. The two circles will be very close together, and concentric.

The *advance* is the distance travelled by the centre of gravity along the original course.

The *transfer* is the distance travelled by the centre of gravity, measured from the original track to the point where the vessel has altered her course by 90 degrees.

The *tactical diameter* is the transfer for 180 degrees.

The *drift angle* is the angle between the ship's fore-and-aft line and the tangent to the turning circle.

The average advance is about three to four ship-lengths, but may be considerably more at high speeds. The average tactical diameter for an easily turned ship is about four ship-lengths.

The time taken to complete a turning circle can range from 6 to nearly 30 minutes in merchant ships.

(7) EFFECTS OF LOADING

When deeply laden a vessel will carry her way longer, cause greater damage under impact than if she were light, be slow to answer her helm, be sluggish in gathering way, be affected by wind to a minimum, have a turning circle generally unaffected by her speed, and will have a larger turning circle for a given speed than if she were light.

When light she will be lively to engine movements, sensitive to her helm, easily turned on her anchor, be affected by wind to a maximum, easily stopped, be more easily brought up by anchors or mooring lines, be subject to larger amounts of skid and sideslip, have a smaller turning circle for a given speed than if she were deeply laden, cause less damage under impact than if she were deeply laden, and will have a turning circle, the radius of which increases as the speed increases.

However, if the vessel is so light as to only partially immerse her propeller, her acceleration and deceleration will be small, making her slow to stop and start, though not so slow as if she were deeply laden.

A merchant ship handles best when she is a half to two-thirds loaded, and trimmed a little by the stern.

Generally speaking, the most awkward type of vessel to handle is one which is low powered, deeply laden, of large size, having a single screw, and poor steering qualities.

(8) EFFECT OF TRIM

A vessel trimmed by the stern has her pivoting point farther aft than if she were on even keel, has a larger turning circle, will develop maximum power, will steer well, and will turn more readily downwind.

A vessel trimmed by the head has her pivoting point farther forward than if she were on even keel, has a smaller turning circle, does not develop her full power, will be difficult to turn, and once swinging she will be difficult to check, will turn more readily into the wind, will be slow to seek the wind with her stern under sternway, and with the wind on the quarter may become unmanageable.

(9) EFFECT OF LIST

A vessel listed will turn more readily towards her high side, will have a smaller turning circle on that side, and in the case of a twin-screw ship the low-side engine will be more effective than the other. Low-side helm will be necessary to correct this.

(10) CARRYING WAY

A vessel will carry her way farthest when she is large, deeply loaded, smooth-hulled and non-fouled, and of fine form. When deeply laden she may carry her way up to three times as far as if she were light.

A ship usually reduces her headway quite quickly down to a speed where her wave-making is at a minimum, say 7 knots. Thereafter the loss of way occurs at a reduced rate.

720 ft A tanker, 220m long, travelling at 16 knots, was stopped with full
1·75 miles stern power in 2·8km (10 minutes). With the rudder hard over, the
1 mile figures became 1·6km (9 minutes). This tanker had a deadweight of 66000 tonnes.

tons The following figures relate to a twin-screw ship of 23500 tonnes dis-
660 ft placement, 26000 kW, length 200 m, and speed 23·5 knots:

Under trials full speed was reached after $17\frac{1}{2}$ minutes commencing from rest, during which time the vessel covered 9·3km. 5·8 miles

Upon reversing her engines, she came to rest in 4 minutes after carrying her way for $6\frac{1}{2}$ ship lengths.

When handling a ship in narrow waters she should never have too much way upon her. This does not mean that full speed becomes a dangerous order; on the contrary, it is the most efficient when instant response from helm is desired, or for correcting or commencing a swing. It only becomes dangerous when too much way is allowed to be gathered.

(11) THE EFFECT OF SHALLOWS

As the hull moves through shallow water, that which it displaces is not so easily replaced by other water, and the propeller and rudder are working in what might again be loosely termed a partial vacuum. The vessel takes longer to answer her helm, and response to engine movements becomes sluggish.

In these circumstances vibration will be set up, and it will be extremely difficult to correct a yaw or sheer with any degree of rapidity.

At normal speed it is found that steering becomes erratic when the depth of water is equal to, or less than, one and a half times the deepest
draught, i.e. a vessel drawing 8 m maximum draught will develop 24 ft
unsteady steering in water of depth 12 m or under. When a ship is 36 ft
nearing an extremely shallow depth of water, such as a shoal, she is likely to take a sudden sheer, first towards it and then violently away. This is called *smelling the ground*, and the movements of a sluggish ship may suddenly become astonishingly lively.

Due to the fact that the water displaced by a hull moving through shallow water is not easily replaced, the bow wave and stern wave of the vessel increase in height. Further, the trough which normally exists under the quarter becomes deeper and the after part of the ship is drawn downwards towards the bottom. By reducing speed, the wave heights and trough depth will be diminished, and the vessel will not therefore close the bottom, or *squat*.

The speed of a vessel moving in shallow water should always be moderate; if the speed is increased the keel will close with the ground and the ship will sheer about unpredictably. If the bow wave and stern wave are observed to be higher than is prudent speed should be reduced —but not suddenly. If the speed is taken off rapidly the stern wave will overtake the vessel and cause her to take a sheer, which in a narrow channel could be disastrous.

Further effects of shallows will be discussed later.

(12) THE EFFECT OF STERNWAY

A single-screw ship will answer her helm under these conditions provided she has good sternway, the conditions are calm, and her propeller is not revolving. In a wind steering under sternway is possible only, and then rather erratically, when the stern is run right into the wind's eye.

Despite the above, response to the rudder under sternway is generally poor unless it is desired to swing the vessel to starboard, when the rudder assists the transverse thrust. If the vessel is to be swung to port under sternway way must be gathered and the engines stopped before swinging, in order to avoid the adverse transverse thrust.

The twin-screw ship will steer quite well under sternway by varying the revolutions on each engine as appropriate. She will not, however, steer as well as she would under headway, and in a wind she will not steer under sternway.

(13) GENERAL EFFECT OF TWIN-SCREWS

Apart from what has already been discussed about these vessels, it should be noted that headway can be checked and a swing achieved simultaneously by reversing one engine. To achieve the maximum rate of swing in a twin-screw ship, she should be kept under headway. If space is restricted, however, the outside engine should be worked full ahead, the rudder is put hard over to make the turn, the inside engine is reversed full astern, and then the outer engine is slowed. By gathering sternway, and then slowing the inner engine and speeding the outer one, another run ahead can be made and the swing continued. The ship, in other words, swings in the same way as a car turns in a narrow road; the engines are never stopped, but accelerated or decelerated as required.

To turn a merchant ship, having twin-screws, in her own length by running the screws at equal but opposite revolutions is a very slow process.

As has been seen already, the twin-screw ship can make a very small turning circle by reversing the inner engine.

Twin-screws offer the further advantage of being more able to correct a sudden sheer than the single screw.

(14) THE EFFECT OF WIND

When a vessel is light, a gentle breeze can have the same effect upon her as a gale would have on a deeply laden ship.

When a vessel is stopped she adopts a position such that the wind is roughly on the beam.

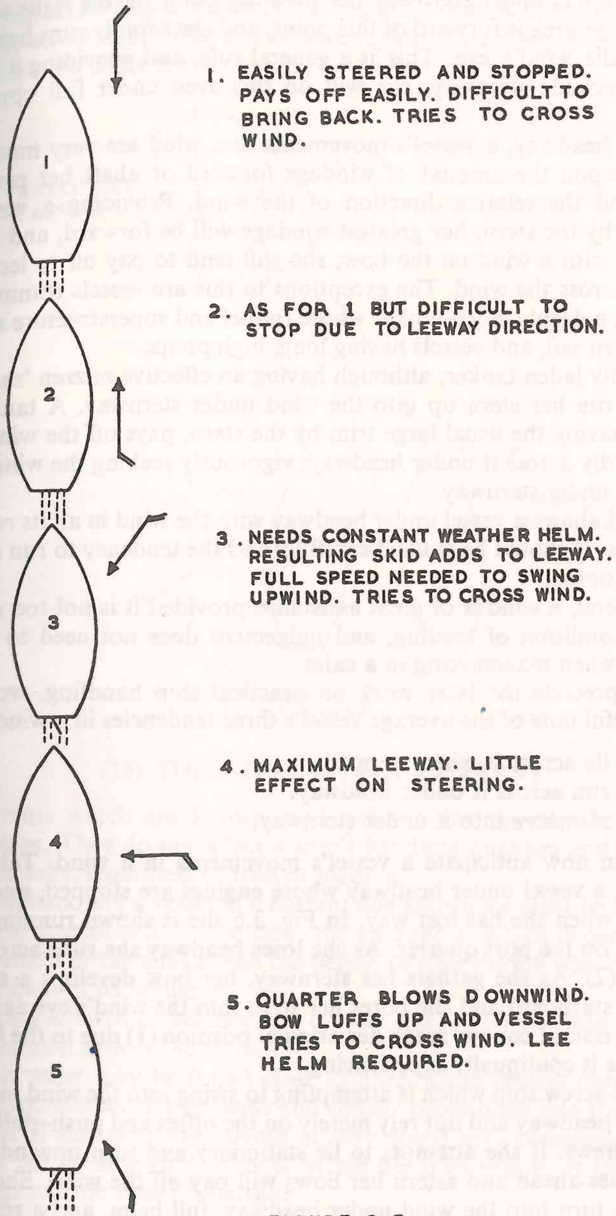


FIGURE 3.5

When she is under sternway her pivoting point moves right aft, all her windage area is forward of this point, and she rapidly runs her stern up into the wind's eye. This is a general rule, and providing a vessel has appreciable sternway, she will do this even under full opposing helm.

Under headway, a vessel's movements in a wind are very much dependent upon the amount of windage forward or abaft her pivoting point, and the relative direction of the wind. Providing a vessel is trimmed by the stern, her greatest windage will be forward, and under headway with a wind on the bow, she will tend to pay off to leeward, i.e. run across the wind. The exceptions to this are vessels trimmed by the head, a deeply laden tanker whose funnel and superstructure aft act as a mizzen sail, and vessels having long, high poops.

A deeply laden tanker, although having an effective mizzen 'sail' aft, will still run her stern up into the wind under sternway. A tanker in ballast, having the usual large trim by the stern, pays off the wind and runs rapidly across it under headway, vigorously seeking the wind with her stern under sternway.

Fig. 3.5 shows a vessel under headway with the wind in all its relative directions. It should be studied carefully and the tendency to run across the wind noted.

In general, a wind is of great assistance provided it is not too strong for the condition of loading, and judgement does not need to be so exact as when manœuvring in a calm.

To appreciate the later work on practical ship handling, we must take careful note of the average vessel's three tendencies in a wind:

(1) To lie across it when stopped.
(2) To run across it under headway.
(3) To *sternbore* into it under sternway.

We can now anticipate a vessel's movements in a wind. Take, for example, a vessel under headway whose engines are stopped, and then reversed when she has lost way. In Fig. 3.6 she is shown running with the wind on the port quarter. As she loses headway she runs across the wind to (2). As she gathers her sternway, her bow develops a reverse swing to starboard and she bores her stern into the wind's eye as in (3). She does not, of course, reach her original position (1) due to the leeway which she is continually experiencing.

A twin-screw ship which is attempting to swing into the wind must do so under headway and not rely merely on the offset and push–pull effect of her screws. If she attempts to lie stationary and turn upwind using her engines ahead and astern her bows will pay off the wind. She must therefore turn into the wind under headway, full helm, and a reversed inside engine.

A twin-screw ship desirous of turning downwind will, as in the case of a single-screw ship, swing much more rapidly if sternway is gathered, so that the stern seeks the wind's eye.

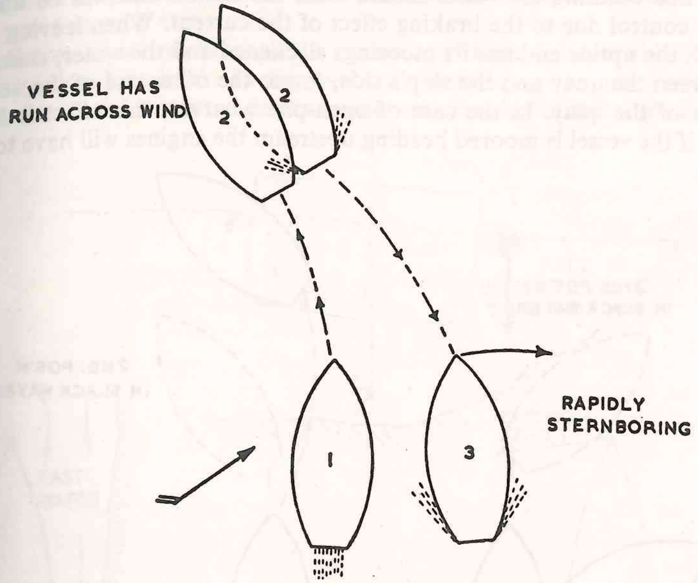


FIGURE 3.6

(15) THE EFFECT OF A CURRENT

Currents which are known, and not too strong, may be used to advantage. They do not affect a ship's handling qualities and affect all ships equally, regardless of trim or loading.

When handling a vessel in a current due allowance must be made for the downstream drift of the ship, the amount of which depends upon the strength of the stream and the period of time during which the ship is subjected to its influence.

When anchored or berthed in a current the rudder is effective due to the continual flow of water past it.

Slack water may be found close inshore, while reverse currents are often experienced off pierheads and similar projections into the stream.

A vessel stemming the stream at slow speed may complete the first part of her turning circle almost within her own length, as the stream runs against the vessel broadside.

A vessel running downstream may well develop double the speed over the ground normally attained in slack water by the existing engine revolutions, and if she is turned the radius of the first 90 degrees of turn is far in excess of her slack-water swing. These swings are shown in Fig. 3.7. Great care is necessary in handling a ship running downstream.

When berthing the vessel should stem the stream and will be under easy control due to the braking effect of the current. When leaving the berth the uptide end has its moorings slackened and the water, running between the quay and the ship's side, forces the other end of the vessel clear of the quay. In the case of open-pile wharves, this effect is lost, and if the vessel is moored heading upstream the engines will have to be

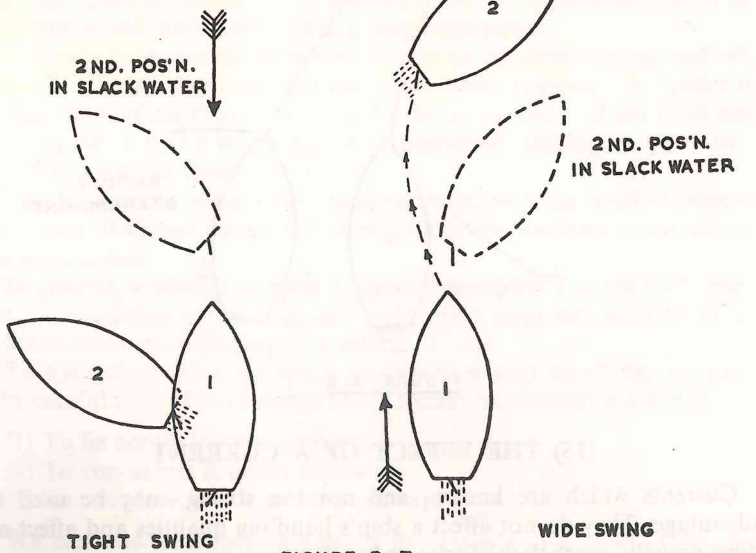


FIGURE 3.7

worked ahead as soon as the bow is cast off across the stream, in order to prevent the stern fouling the piles. Heading downstream, this situation does not arise.

(16) THE EFFECT OF NARROW CANALS, RIVERS, AND RESTRICTED CHANNELS

In these localities all the effects of shallow water are present, together with others. The water displaced by a vessel moving ahead is restricted in movement by the proximity of banks. The general effect is a build-up in the water level ahead of the ship and a lowering in the level astern of her. This produces a surging effect which can part a moored ship's

hawsers up to 3 km ahead of the moving vessel, provided the same 2 miles
restricted conditions prevail all the way.

In addition, the moving vessel's bow wave, stern wave, and trough increase in amplitude, and for this reason a vessel should proceed at slow speed in such areas.

As the vessel moves through the restricted channel it is possible that she may close one bank. In this event a streamlining or venturi effect arises due to the restricted flow of water on one side of the ship. This

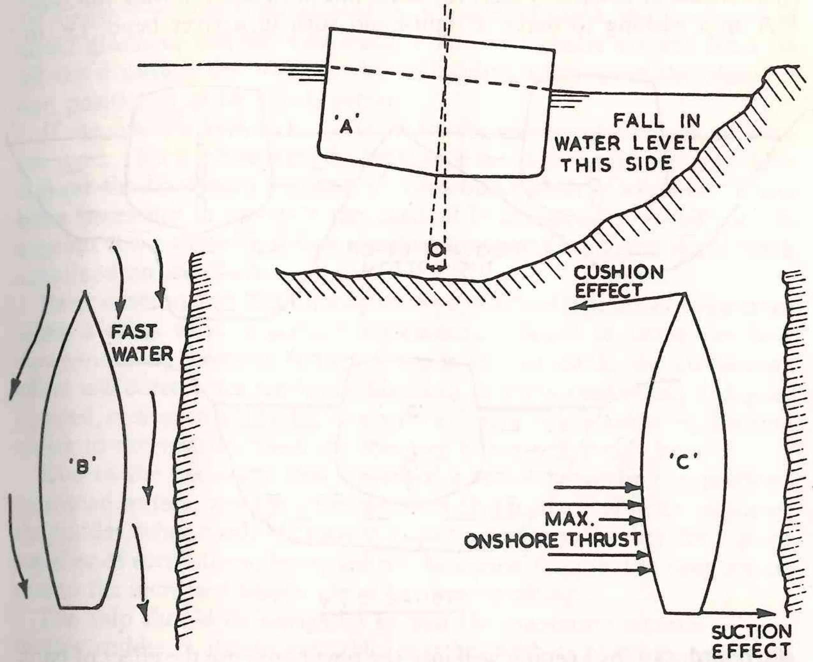


FIGURE 3.8.

causes an increase in the velocity of the water on that side, together with a loss of pressure head. The latter manifests itself as a drop in water level at the nearer bank, and a thrust is set up towards it. The greater fullness over the after body of the ship accentuates the thrust, and it thus appears more strongly at the stern than at the bow. The stern moves towards the bank and the bow away from it. American terms for these sheers are *bank suction* and *bank cushion*, respectively; the terms are useful in describing the effects, though there is no cushioning unless the speed of the vessel is so high as to cause a build-up in water level at the inshore bow. All these effects can be demonstrated easily in a simple glass tank, and a person holding the ship-model can feel the suction at the stern. It should be noted that ships passing close to one another will also experience these venturi effects.

Fig. 3.8 illustrates canal effect, and it will be seen that the vessel heels towards the nearer bank so as to displace constant volume.

The drop in water level, and thus the canal effect, varies as the square of the speed. So a small change in speed will produce a large change in the canal effect. *Navigators using correcting helm when experiencing canal effect should be extremely alert to reduce this helm when slowing the ship.*

A ship wishing to make a right-hand turn in a river bend, i.e. to

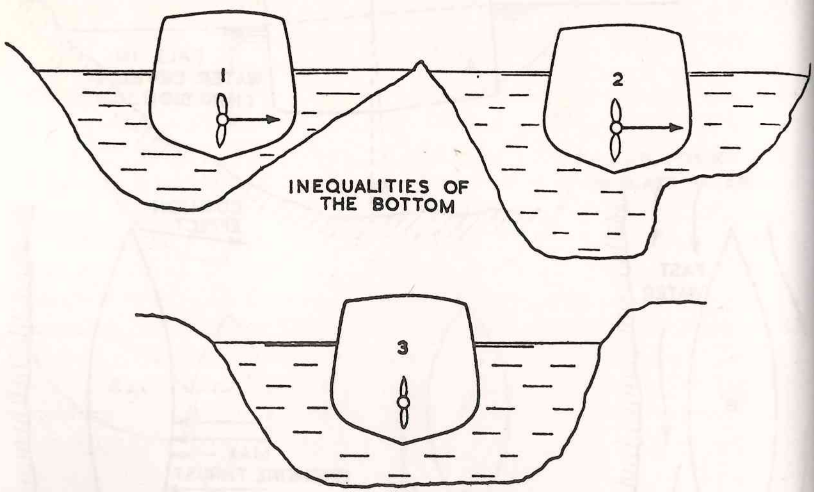


FIGURE 3.9

starboard, can, by keeping well into the port bank, use the effect of bank cushion forward to assist her turn. This is frequently resorted to in narrow channels, such as are present in the Panama Canal. There, a ship turning to starboard around a bend will be kept well into the port bank. She will turn quite easily with the rudder kept amidships. If the cushioning effect becomes excessive port helm may have to be used in spite of the fact that the turn is directed to starboard.

If the ship is kept in the true centre of the channel all these forces are equalised. Inequalities of the bottom can cause these forces to come into play despite the fact that the ship is equidistant from both banks. If the channel is deeper on one side than on the other, if the bank is steeper on one side, or if the vessel passes over a shoal suction and cushion will appear suddenly due to the river bed restricting the flow of water. This

is similar to smelling the ground, and dangerous sheers may suddenly be taken.

For this reason, the ship should at all times be kept in the true centre of the channel, which, as shown in Fig. 3.9, is not necessarily the visual centre. In (1) she is taking a sheer to port because the starboard bank is less steep than the port bank and her stern is sucked towards the former. She should therefore have been kept closer to the port bank. In (2) she is taking a similar sheer because the starboard side of the channel is shallower than the port side. Again, her positioning should have been farther to port. In (3) the channel is of constant depth, the banks are of equal gradient, and the visual centre and true centre are the same. In all the drawings the vessel is shown heading away from the observer and positioned in the visual centre.

If the vessel is kept to the true centre the minimum amounts of helm are used. This is advantageous, because if the ship should suddenly take a sheer the maximum amount of correcting rudder is available. If the helm necessary to navigate the channel is consistently of half or full amount these sheering forces should be suspected and the ship's track examined on the chart.

Bank cushion and suction may be used to advantage under conditions when a cross wind is persistently causing a vessel to swing her bow downwind. By keeping farther towards the lee bank, the cushioning effect will correct this tendency. Similarly, if she is continually swinging upwind, such as might be the case with a deeply laden tanker, by keeping closer to the weather bank the sheering forces will steady her.

Due to the necessary slow speed of a vessel navigating in shallow, restricted waters, and the corresponding sluggishness of helm response, the rudder, when used, will have to be moved boldly. Further, for a given number of revolutions, her speed will be slower than that in deep water, due to the increased amplitude of her wave-making.

The ship should be navigated so that the maximum amount of correcting rudder is always available, together with as much manœuvring room as possible. A sheer should be instantly corrected by ordering full revolutions and full correcting helm, reducing both immediately the swing is checked. In an emergency the anchor on the side towards which the vessel is sheering should be let go and held at short stay.

(17) THE EFFECT OF BENDS

The use of bank cushion and suction in navigating bends has already been mentioned. For reasons which we are about to discuss, it is better, where possible, to avoid passing other vessels within a very narrow bend. Both are subjected to sheering.

In narrow waters the strength of stream varies greatly, and the vessel may well become out of control if her ends are subjected to opposing or differing currents. The water usually runs fastest in the middle of a straight run and in the concave bank of a bend. Off the convex bank, known as the point, slack water or even reverse currents may be found.

In Fig. 3.10 a vessel is shown rounding a bend to port against the stream. As she leaves the straight reach and enters the bend the current is flowing along her side aft, but on to her port bow forward. This, unless bold correcting helm is used, will cause her to take a sheer to starboard. When heading against the stream it is advisable to keep within the bend and as far away from the point as possible. Bank cushion will then assist in correcting the sheer, if any.

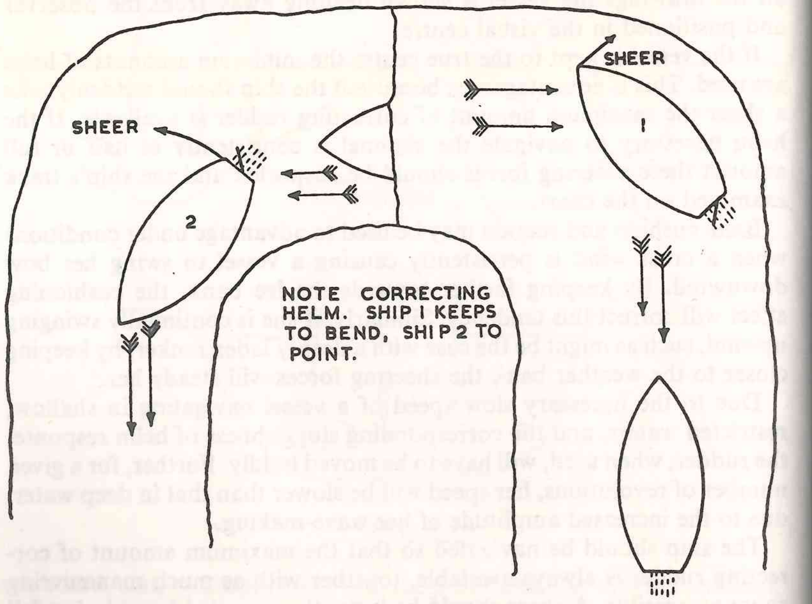


FIGURE 3.10

A vessel is also shown rounding a bend to port with the stream astern of her. As she changes her course, the stream aft catches her port quarter, causing her to sheer to port. When heading downstream it is advisable to keep close to the point, so that bank sheering forces assist in preventing a sheer.

The most dangerous situation arises when a vessel is heading downstream and executing a bend to starboard. The current catches her starboard quarter as she turns, sheering her to starboard. If now the engines are reversed (because the ship is perhaps out of control) the swing to starboard is aggravated and the ship will come athwart the stream.

(18) EFFECT OF NARROW ENTRANCES

A vessel entering a dock, lock, or pierheads off the river will, if there is a strong current, need tugs to control her entry. A small ship, however, can usually make the entrance unassisted, under bold headway. A larger vessel generally has not sufficient room in which to gather this headway.

As the bows come under the lee of the upstream pierhead her fore body is in slack water, while the stern is still under the influence of the stream. She will therefore tend to sheer towards this pierhead, and a

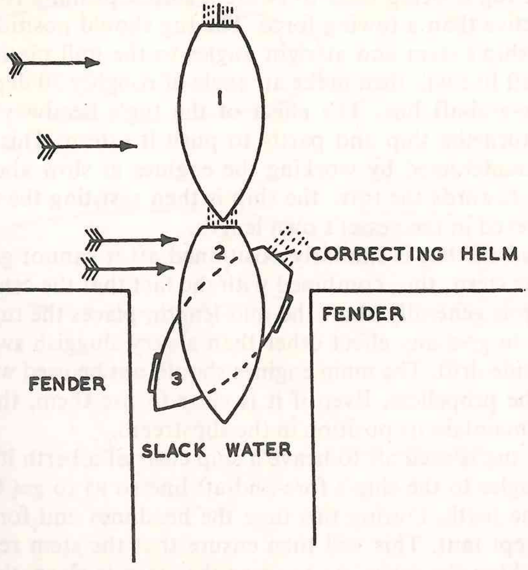


FIGURE 3.11

careful watch must be kept for the first sign of a cant. Bold correcting helm and a surge ahead on the engines will be necessary to counteract this. Since the approach may be made at right angles to the stream, due allowance must be made for downstream drift. Fenders should be rigged at the upstream bow and the downstream quarter (Fig. 3.11).

(19) THE EFFECT OF TUGS

In some localities the assistance of a tug is essential, particularly in conditions of strong current or wind. Elsewhere, the use of a tug or tugs will greatly add to the speed and safety of a manœuvre. In very restricted waters the tugs have almost complete control over the ship, the main engines being used to assist the vessel in gathering way or to complete a swing. Where there is plenty of manœuvring room, the ship is handled in the usual way, using the tugs to push or tow as required.

When using a tug to push, the force should be applied at the position of the centre of gravity. If this is done the vessel will move bodily, but if the tug's stem is a few metres out of position one end of the ship will swing rapidly while the other end remains practically stationary. When a strong wind is blowing on to the other side of the ship the tug's stem should be a little forward of the centre of gravity to correct for the swing of the ship's bow downwind.

When a tug is being used to swing a ship a pushing force is usually more effective than a towing force. The tug should position herself just abaft the ship's stem and at right angles to the hull plating. The tug's fore-and-aft line will then make an angle of roughly 70 degrees with the ship's fore-and-aft line. The effect of the tug's headway will then be partly to turn the ship and partly to push it astern. This latter movement is counteracted by working the engines at slow ahead; with the helm over towards the turn, the ship is then assisting the turn and it is often achieved in the vessel's own length.

If instead the tug is similarly positioned aft it cannot get sufficiently close to the stern; this, combined with the fact that the centre of gravity of the ship is generally abaft the mid-length, places the tug too close to this point to give any effect other than a very sluggish swing and considerable side drift. The main engines should not be used with the tug so close to the propellers. Even if it is clear to use them, the tug will be unable to maintain its position in the slipstream.

When a tug is used aft to heave a ship clear of a berth it will first tow at right angles to the ship's fore-and-aft line so as to get the stern well clear of the berth. During this time the headlines and forward springs must be kept taut. This will then ensure that the stem remains steady without raking the quay. As soon as the stern is clear, the ship works her engines astern for a moment, the tug swings round so that it leads out on the quarter, and the forward lines are let go.

When employing tugs, it should be borne in mind that a tug will have considerable difficulty in correcting a violent sheer. For this reason, the amount of way gathered should never be excessive.

When casting off an after tug, if the vessel has sternway on her, whether or not the engines are stopped, the line will be very liable to run in under the stern and foul the rudder or screws. The line should therefore be let go while the ship is carrying headway, and it will then stream astern, even more rapidly if the engines are working ahead due to the screw stream. There is no need to stop engines when letting go a tug while the ship has headway upon her.

Unfortunately it is not practical to secure a towline to a tug close by

its stern-rail. The line is usually secured very near the centre of flotation, and for this reason the tug may be *girded* or *girted.*

Fig. 3.12 shows a tug being girded. It occurs when a towline under stress is allowed to lead directly abeam from the tug. The craft is unable to turn, and may capsize, often with heavy loss of life. The list taken by the tug may be so acute and rapid that the crew may not be able to slip the hook. The men standing by the towline on board the towed vessel should therefore be instantly ready, at all times, to let go the line.

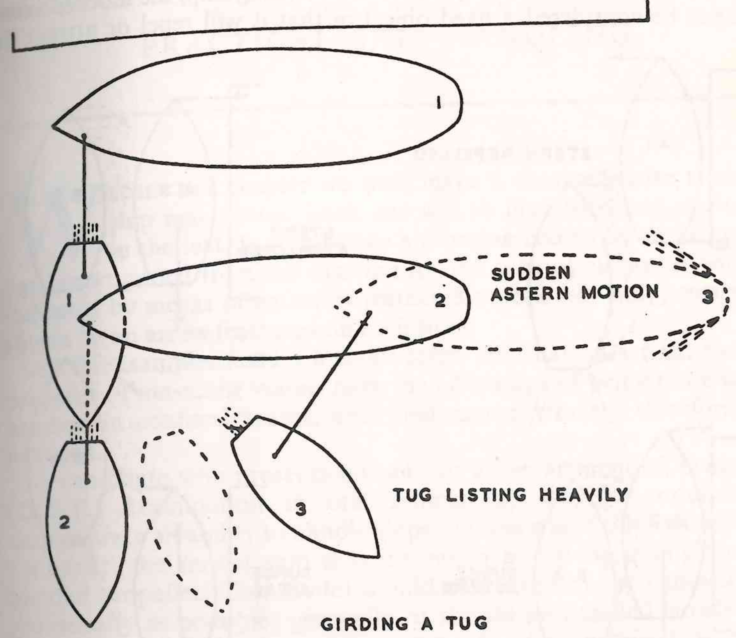


FIGURE 3.12

In the figure the ship has been towed broadside off the quay from (1) to (2). Without warning to the tug, she then moves ahead or astern; in the figure she has moved astern to (3). Her motion takes the tugmaster unawares, and before he can swing into line with the towrope the latter leads abeam and his craft is girded. Ample warning must be given to tugs if the ship is required to suddenly move ahead or astern. This is not so important if the towline is bowsed to the stern of the tug with a *gobline.*

(20) THE EFFECT OF PASSING A MOORED SHIP

Such a vessel will surge considerably, to and fro in the wash of a passing ship. The speed of the latter must therefore be reduced whenever a vessel is to be passed close by at, say, a river berth. The surging is due to the cushioning and suction effects existing at a travelling ship's bow and stern. There is also the fore-and-aft flow of water down her side to be considered. Fig. 3.13 shows the movements to which a moored ship will be subject. Due to the speed of the travelling ship, the moored vessel cannot be considered a fixed object in that it will repel or attract the

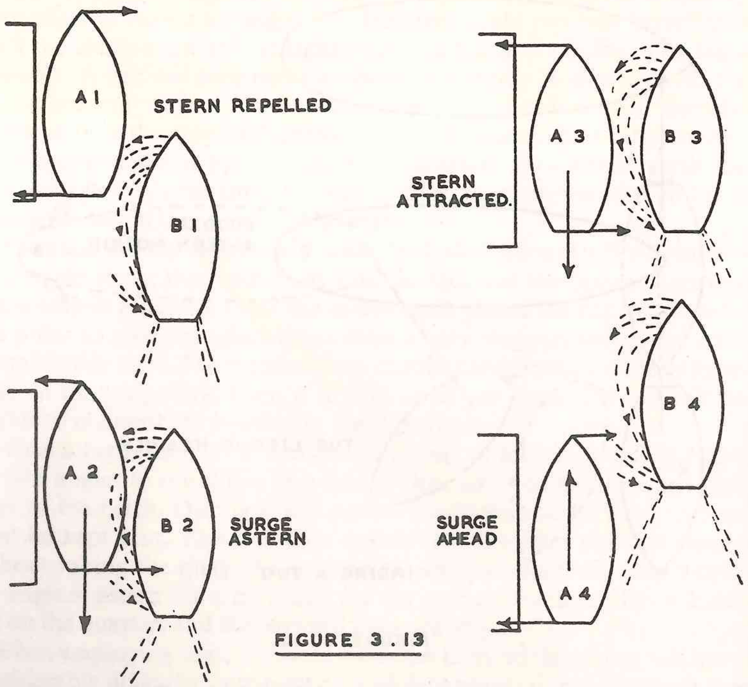


FIGURE 3.13

former's bow and stern. On the contrary, the moored vessel is regarded as a floating object which is subjected to these sheering forces. Strictly speaking, ship 'A' should have her lines tended during the passage of 'B', and the latter should proceed as slowly as possible in order to keep her wave-making to a minimum. Ship 'B' must also be kept well clear of the other bank so that she does not take a colliding sheer into 'A'. The forces acting here are known as *interaction* and can be very dangerous in close-quarters situations when ships are overtaking, passing, steaming abreast or picking up a tug at speed.

CHAPTER IV

PRACTICAL SHIP HANDLING

Within this chapter we shall make a comprehensive study of ship manœuvres. Each one will be illustrated and explained in the text. In some cases a mooring line or an anchor cable has been omitted from the drawing for the sake of clarity. A wind is indicated by means of an arrow feathered on one side only; current is shown by an arrow feathered on both sides.

All the examples feature a single-screw ship having a right-handed propeller. Twin-screw vessels have the advantage of being more easily handled in confined spaces, and their manœuvres are therefore not included.

A candidate who presents himself for a Department of Transport (D.o.T.) examination in oral seamanship will be required to demonstrate an ability to handle ships. Unless stated otherwise by the examiner, the model ship is to be taken as having a single right-handed propeller. This model should be moved by the candidate as realistically as possible; generally, it should be handled slowly; the gathering and reduction of way must be demonstrated as being gradual, there being a slight delay between engine orders and response; the running-ashore of mooring lines must be indicated before the ship is required to be checked by them; the delay between a helm order and swing-response must be shown, together with a gradually increasing rate of swing.

In studying the next few pages, the reader is advised to concentrate on the drawings, taking careful note of each consecutive position of the ship before passing on to the next. The helm, engine movement, headway, sternway, mooring lines, and the growth of anchor cable, if any, should be studied for each position.

As the reader progresses, he will appreciate that only a very few basic principles are involved in each manœuvre, and these he will soon master.

Fig. 4.1. Securing to Two Buoys in Calm Weather

The approach should be made with the minimum of headway in order to avoid a swing developing when the engine is worked astern. In calms, with no wind braking-effect present, the risk of overshooting exists. For this reason, the vessel is headed for the headbuoy fine on the starboard bow. When the engine is working astern to reduce headway the swing is favourable.

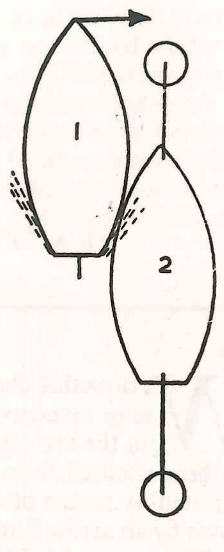


Fig. 4.2. Turning the Vessel before Securing to Two Buoys in Calms

The headbuoy is approached on the port bow and a line secured. The engine is then worked slow ahead on the taut line, with the helm hard over towards the buoy. The vessel is thus swung to (2), when a line to the sternbuoy is used to complete the swing.

By keeping the headbuoy to port, the transverse thrust effect is favourable.

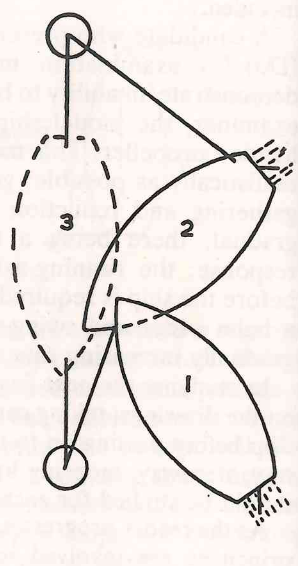


Fig. 4.3. Securing to Two Buoys with Current Ahead

The vessel approaches under slow headway over the ground with the headbuoy fine on the port bow (1). While the line is secured to the headbuoy, the engine must be worked slow ahead. With the buoy situated on the port bow, the effect of transverse thrust is favourable. The vessel is then allowed to drop downstream so that the sternbuoy can be picked up.

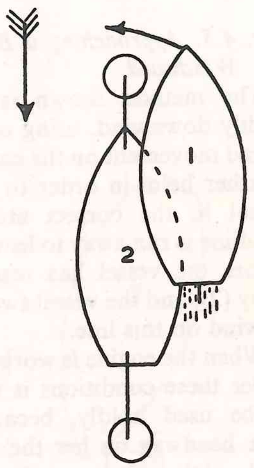


Fig. 4.4. Securing to Two Buoys with Current Astern

This is very similar to Fig. 4.2, since the vessel will secure to the first buoy on her port bow (1). She will then, having been given a slight cant to port, allow the current to carry her round to (2) and (3). Once she is beam-on to the stream, her engine should be worked slow ahead with port helm to relieve the stress on the headline.

In this instance the buoy could very well have been picked up on the starboard bow.

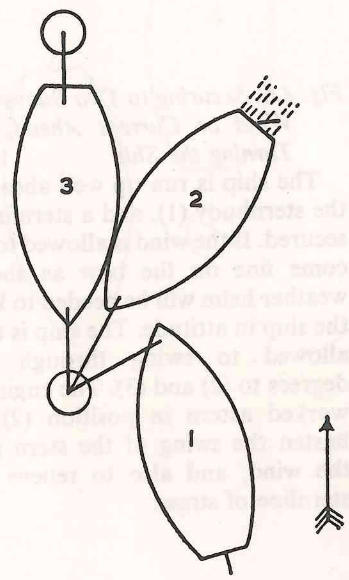


Fig. 4.5. Approaching a Buoy from Windward

The method shown is to drift bodily downwind, using occasional ahead movement on the engine with weather helm in order to keep the vessel in the correct attitude. A headline is run away to leeward well before the vessel has reached the buoy (2), and the vessel swung head to wind on this line.

When the engine is worked ahead under these conditions it will have to be used boldly, because with little headway on her the ship will tend continually to run beam-on to the wind.

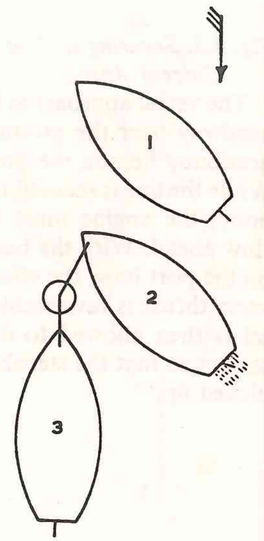


Fig. 4.6. Securing to Two Buoys with Wind or Current Ahead, and Turning the Ship

The ship is run up well ahead of the sternbuoy (1), and a sternline is secured. If the wind is allowed to become fine on the bow as shown weather helm will be needed to keep the ship in attitude. The ship is then allowed to swing through 180 degrees to (2) and (3). The engine is worked astern in position (2), to hasten the swing of the stern into the wind, and also to relieve the sternline of stress.

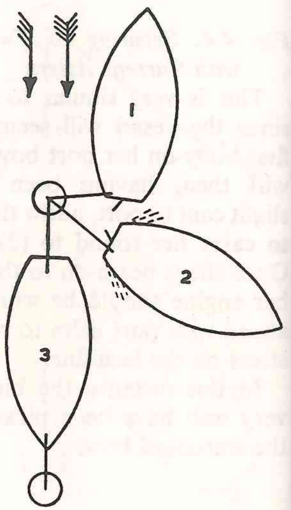


Fig. 4.7. Securing to Two Buoys in a Very Strong Wind

It will be extremely difficult to keep the vessel head to wind while securing to the headbuoy, for as soon as headway is lost the vessel will quickly pay off to one side.

Taking advantage of the fact that the vessel will keep her stern up to windward more easily when under sternway, the buoys are approached sternfirst (1). At (2), when the sternway has been run off, a headline is secured. It should be noted that if the vessel is allowed to have the wind on the starboard quarter as shown she will quickly drift athwart the line of buoys with the wind coming on to the starboard beam. It is therefore preferable in (2) to have the wind right aft or fine on the port quarter. This is difficult to achieve with adverse transverse thrust. At (2), then, the engine is worked ahead with port helm until the ship is swinging to (3), when she is allowed to drift further, to (4). Notice that at (1) the wind is on the port quarter —transverse thrust then assists the vessel to reach the wind's eye. Had the buoys initially been left to starboard, the headbuoy would probably have been missed altogether.

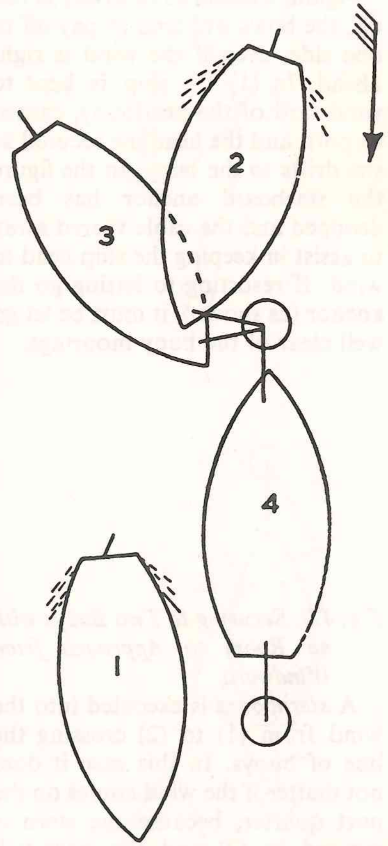


Fig. 4.8. Securing to a Buoy with a Wind Ahead

Again, as soon as headway is run off, the bows will tend to pay off to one side, even if the wind is right ahead. In (1) the ship is kept to windward of the headbuoy, canted to port, and the headline secured as she drifts to the buoy. In the figure the starboard anchor has been dropped and the cable veered away to assist in keeping the ship head to wind. If resorting to letting go the anchor (as shown), it must be let go well clear of the buoy moorings.

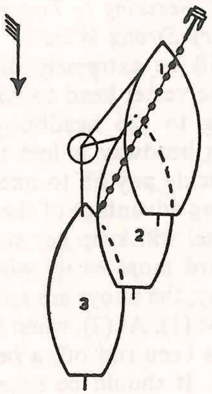


Fig. 4.9. Securing to Two Buoys with no Room to Approach from Windward

A *sternboard* is executed into the wind from (1) to (2) crossing the line of buoys. In this case it does not matter if the wind comes on the port quarter, because the stern is secured in (2) and the bow will rapidly fall downwind until (3) is reached. This should be compared with Fig. 4.7.

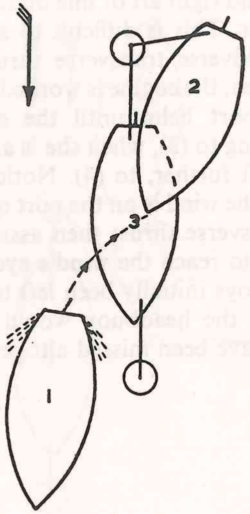


Fig. 4.10. Clearing from Two Buoys with Wind or Stream Ahead

The sternline is let go and the vessel canted to starboard by slacking the headline. At the same instant the engine is worked ahead with weather helm (2), and as headway is gathered the headline is let go and the ship clears as in (3), still using weather helm to hold her in attitude.

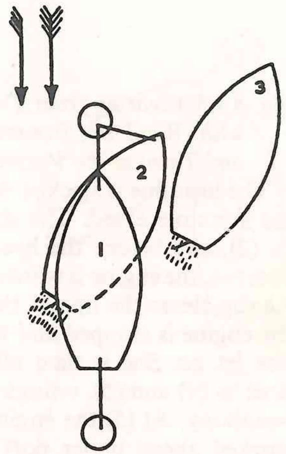


Fig. 4.11. Clearing from Two Buoys with Wind or Stream Astern

The vessel is canted as in (2) by easing the sternline. At the same instant, before the vessel overruns the headbuoy, the engine is worked astern. As way is gathered, the lines are let go and weather helm used to straighten the ship into the line of wind or stream.

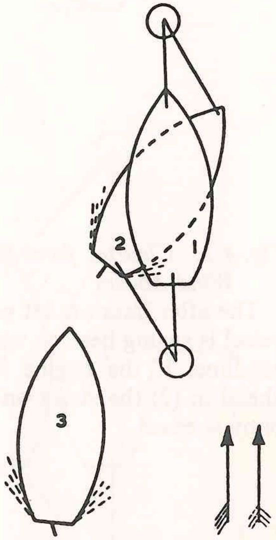


Fig. 4.12. Clearing from Two Buoys with Wind or Stream Astern, and Turning the Vessel

The headline is slacked down and the sternline eased. The ship cants to (2), and before the headbuoy is overrun, the engine is worked astern. As she clears the line of the buoys, the engine is stopped and the sternline let go. She is then allowed to drift to (4) and (5), swinging on the headbuoy. At (5) the engine can be worked ahead under port helm to ease the stress on the headbuoy.

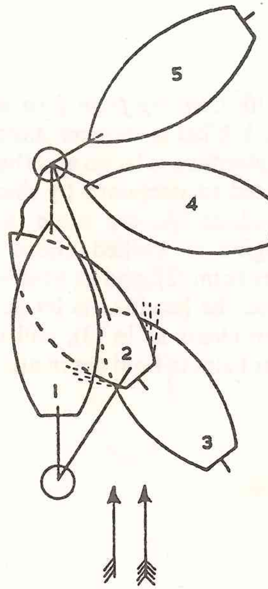


Fig. 4.13. Clearing from Buoys with Wind Abeam

The after lines are let go and the vessel is swung head to wind on the headline. If the engine is worked ahead in (2) the stress on the headbuoy is eased.

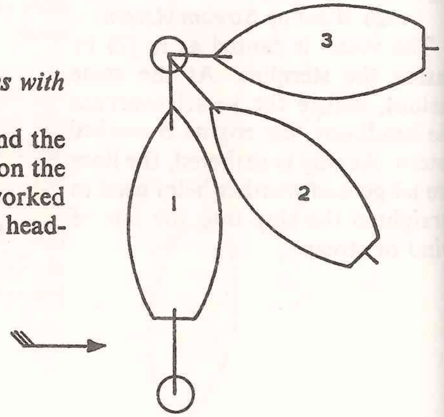


Fig. 4.14. Clearing from Buoys with Wind Abeam, to Head Downwind

If desired, of course, the headline can be let go and the vessel swung downwind on the sternbuoy. In the figure, the sternline is let go and the vessel drifts to (2). Here the engine is worked astern under starboard or weather helm, and the headline is let go as way is gathered. The stern is rapidly bored upwind as in (3) and (4). This is a more satisfactory method if the fairway lies astern of the berth, because with the wind on the port quarter in some position (5) not shown, under ahead engine movement and port helm, the ship will swing very quickly to the fairway.

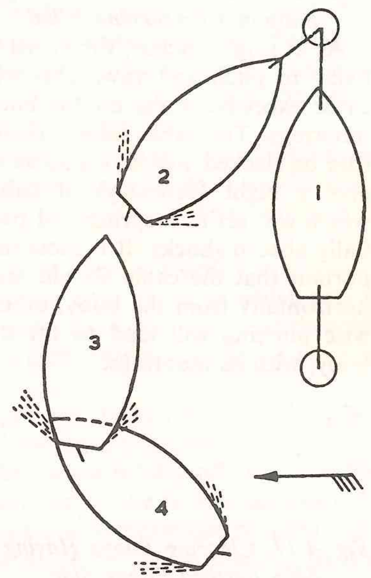


Fig. 4.15. Lying at Buoys with a Freshening Wind Abeam

The lines must be slacked down, however little room is available, so that the vessel lies at (2). In this attitude the lead of the lines enables them to more easily oppose the force of the wind.

If they are hove taut, as in (1), the two lines are working against each other to such an extent as may part them. They are expected to resist a force by acting at right angles to it.