Fig. 4.16. Lying by Cable to a Single Buoy in a Freshening Wind

As at single anchor, the vessel is likely to pitch and yaw. This will cause excessive stress on the buoy moorings. The cable should therefore be slacked well down so as to give a bight (catenary) of cable which will act as a spring and partially absorb shocks. It is most important that the cable should lead horizontally from the buoy, otherwise pitching will tend to lift the buoy, with its moorings.

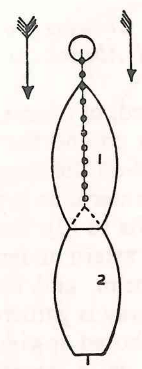
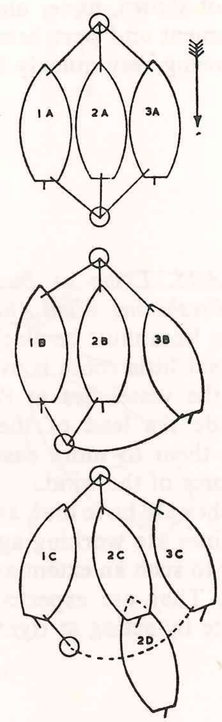


Fig. 4.17. Clearing Buoys Having a Ship Berthed Either Side

With a current running down from ahead, one of the outer ships, say (3B), slacks down her sternline until it sinks well to the bottom. A wire will do this easily, but in the case of a fibre line it may be advisable to let it go. (3B) then sheers away using port helm. The buoy now moves to a position midway between the sterns of (1B) and (2B). Ship (2C) now casts off the after line and also sheers away under port helm. Ship (1C) sheers away under starboard helm. Finally, ship (2C) eases her headline and, still under port helm, drops astern, letting go the headline when clear at (2D). The stronger the current, the more effective will be the sheers.



Before closing the work on buoys, we shall discuss the methods by which a ship may secure to them. When heading into the wind or stream, work is concentrated on securing the headbuoy, the sternlines being run in a more leisurely manner. Initially a wire is passed through the ring of the headbuoy and secured back on board; this bight is then used as a sliprope. A bight of fibre is similarly run to the buoy and the vessel can ride to this alone, with the sliprope slacked down.

When using bights of line it is the end which has been passed *down* through the ring of the buoy which is eventually let go from the ship. If the other end is cast off it may foul the buoy or its own part as it is unrove.

At the after end of the ship a bight of fibre will suffice unless it is expected that the final letting-go will occur from there, in which case a slipwire is also used. Sometimes fibre ropes have their eyes rove through the buoy-rings and secured to their own parts by means of heavy wooden toggles.

When clearing the buoys fibre ropes are slacked down and let go. When the ship is ready to leave, the slipwires are cast off.

If securing with the anchor cable, the anchor is hung off and the cable broken open. The end link is then shackled to the ring of the buoy. It can either be hove out to the buoy using a wire messenger rove through the ring, or else it can be slid down a single part of wire set up tightly between the ship and the ring and also passing through the enlarged link.

If desired the anchor can be secured in the pipe and the cable passed out through the forward Panama Canal leads.

Before heaving on any lines or cable, it should be ascertained that there are no boats lying across them, nor any men on the buoy.

Fig. 4.18. Mooring Lines

The following is the terminology used in the remainder of this chapter: 'A' Headline; 'B' Fore breastline; 'C' Fore backspring; 'D' Fore headspring; 'E' After backspring; 'F' After headspring; 'G' After breastline; 'H' Sternline. Beam winds produce five times as much stress as fore and aft winds. A 50-knot wind on a 250,000 tonner can cause stresses of 320 tonnes abeam and 60 tonnes fore and aft.

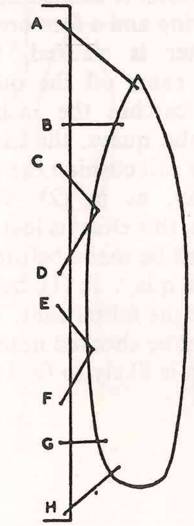


Fig. 4.19. Berthing in a Current

This method applies whichever side-to the ship is berthing. The current should always be stemmed, and there is then no danger of overrunning the berth. The ship is rounded-to under slow headway with perfect control. The stream will be setting the ship down during the approach and for this reason the ship can well be headed for the bow position when berthed. A broad angle of approach is permissible, but the quay should form a tangent to the turning circle. A broader angle of approach than in (1) will not fulfil this condition, and the ship will foul the quay.

Backsprings should be secured as soon as possible. The rudder will be effective even under conditions of no headway.

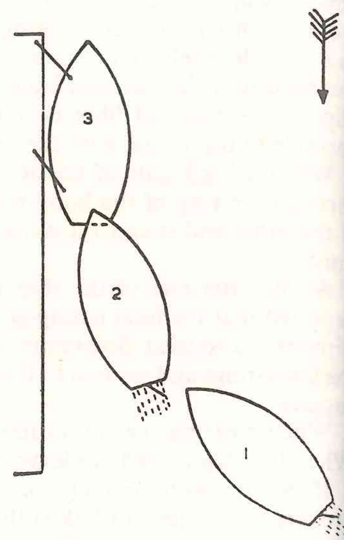
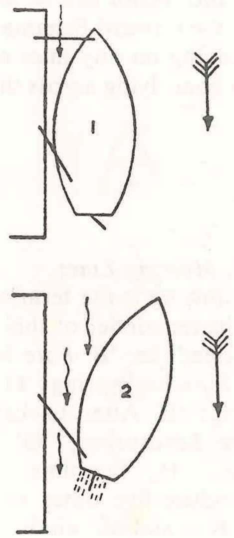


Fig. 4.20. Clearing a Berth with Stream Ahead

The vessel is singled up to an aft backspring and a fore breast. When the latter is slacked, the vessel. quickly cants off the quay as the stream catches the inshore bow. With solid quays, the inshore flow of water will cushion the stern from the quay, as in (2). With open wharves, this effect is lost and headway must be made before the stern fouls the quay. In (1), helm is used to assist the initial cant. The breast line must be checked immediately if the stern is likely to foul the wharf.



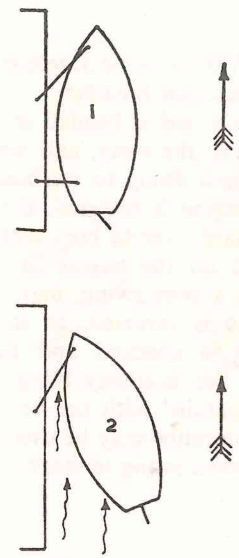


Fig. 4.21. Clearing a Berth with Current Astern

Again, the vessel is singled up as in (1), and offshore helm used to commence the cant in (2). The breast line can be let go quite soon, because even if the wharf is open and there is no cushioning forward, there is no likelihood of the stern fouling.

Fig. 4.22. Berthing Port Side to in Calm Weather

The vessel is headed in at an angle of about 1½ points with the quay, under slow headway and with steady head. As the engine is reversed, a swing to starboard develops and the vessel will arrive abreast of her berth with no way upon her and parallel to it. She will, however, be slowly swinging to starboard, and this must be checked with the headline.

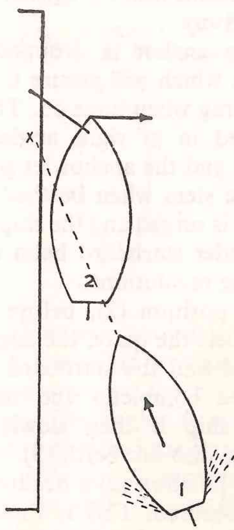


Fig. 4.23. Berthing Starboard Side to in Calm Weather

The vessel is headed in at a fine angle to the quay, and since there will be a swing to starboard when the engine is reversed, the helm is put hard over to port with a burst ahead on the engine in (1). This starts a port swing, and when the engine is reversed, as in (2), the swing is checked and the vessel loses her headway lying close to, and parallel with her berth in (3). The sternline may be used to check a marked swing to starboard.

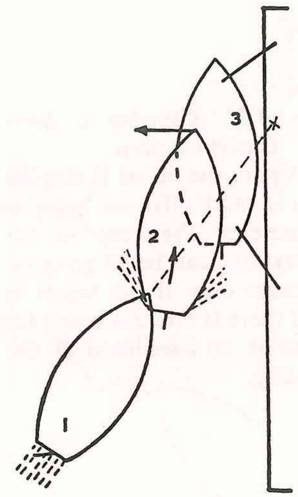


Fig. 4.24. Berthing Port Side to in Calms with the Offshore Anchor Away

The anchor is dropped with a scope which will ensure that it will not drag when hove on. The ship is headed in at right angles to the berth and the anchor let go abreast of the stem when berthed (1). The cable is surged and the ship rounded to under starboard helm and slow engine revolutions.

In position (2), before the ship parallels the quay, the engine is reversed and the starboard swing so caused completes the manœuvre. The ship is then slowly worked astern into her berth (3).

At position (2) a headline is run, and secured. This is then used to check an excessive starboard swing.

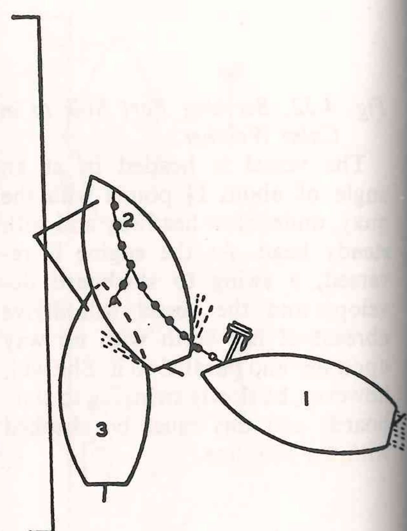


Fig. 4.25. Berthing Starboard Side to in Calms with the Offshore Anchor Away

Again the anchor is let go on sufficient scope, abreast of the stem when berthed. The ship is steamed round the anchor under full port helm, surging the cable as she does so. In position (2), when the ship has swung past the line parallel with the quay, the engine is reversed and the transverse thrust swings her parallel. A sternline is run at (2) and used to check an excessive starboard swing.

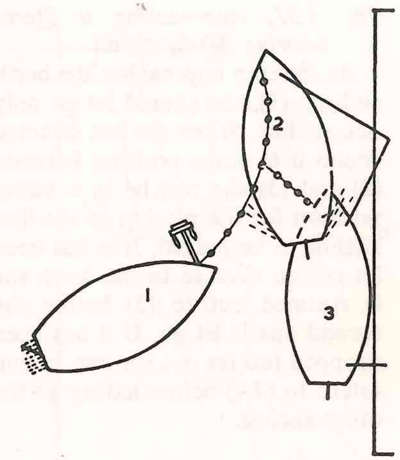
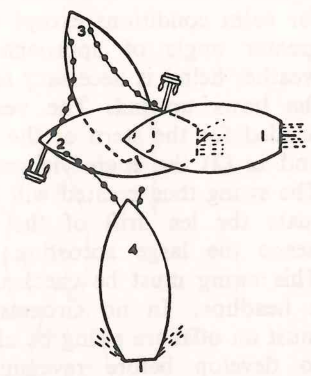


Fig. 4.26. Coming to Stern-moorings in Calms

In (1) the offshore anchor is let go on a slow run ahead. When about a third of the desired final length is veered the vessel is brought up to her cable, and as it grows taut aft, she is steamed round it under starboard helm on slow engine revolutions, letting go the port anchor as she does so, (2). While moving to (3), the port cable must be slack, otherwise it will impede the swing and may drag the anchor due to its, as yet, insufficient scope. In (3), when the ship's fore-and-aft line makes an angle of about 2 points with the line of berth, the cables are checked and the engine is reversed. The screw effect maintains the swing to starboard, but as she gathers sternway to (4), the cables grow on the port bow and will reduce any excessive starboard swing. The engine is stopped and the combined effect of the cables growing to port and the starboard swing brings the vessel into her line of berth with no side movement.



If berthing on the starboard hand instead of the port hand as shown, the vessel must be steamed around her port cable until she again adopts position (3), so that the screw effect will be used to straighten her up.

Fig. 4.27. Approaching a Stern-mooring Berth, Ahead

As the ship approaches the berth end-on, (1), she should let go only one anchor. When she has steamed round it to some position between (2) and (3) she will be in a better position for the placing of the first anchor to be judged. If it has been let go too close in to the berth she is steamed out to (3) before the second one is let go. If it has been dropped too far out she can be run astern to (2A) before letting go the other anchor.

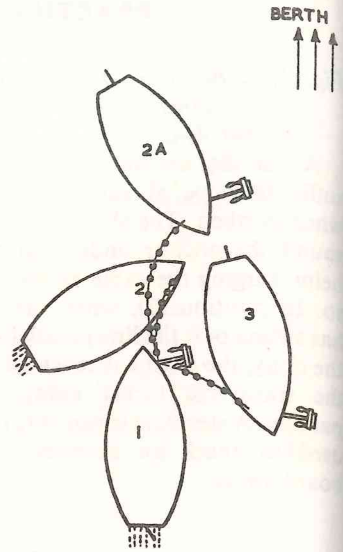


Fig. 4.28. Berthing with Wind Off-shore, on Beam or Bow

The manœuvre is similar to that for calm conditions except that a greater angle of approach (and weather helm) is necessary to hold the bows upwind. The vessel is headed for the stern of the berth, and in (2) the engine is reversed. The swing then created will accentuate the lee drift of the bows, hence the large accosting angle. This swing must be checked with a headline. In no circumstances must an offshore swing be allowed to develop before reversing the engine. When berthing on the starboard hand, the reversing of the engine keeps the bow upwind to some extent. With the wind on the bow (in the berthed position) the ship is headed into it on the approach, leeway is minimised, and there is a good braking effect. In both cases lines must be hove-in as soon as the ship parallels the berth. If an offshore anchor is required (as shown) it is better to let it go when the ship has drifted bodily off the quay with lines secure, rather than on the approach, when it may cause an offshore swing.

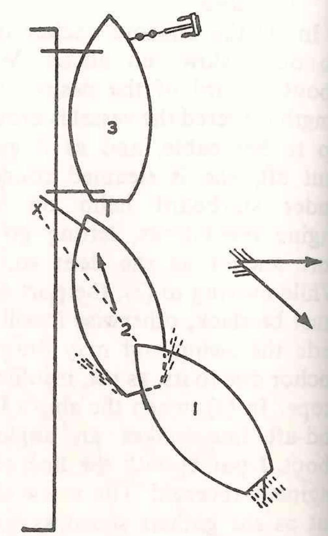


Fig. 4.29. Berthing with Wind On-shore and Abeam

The ship must be rounded-to, parallel, stopped, and clear of her berth in (3), and allowed to drift down to the quay using an offshore anchor if necessary to check the bow. The anchor will be necessary if too much headway exists, for a prolonged astern movement will tend to throw the stern upwind, particularly for a starboard hand berth when the transverse thrust will aggravate the swing.

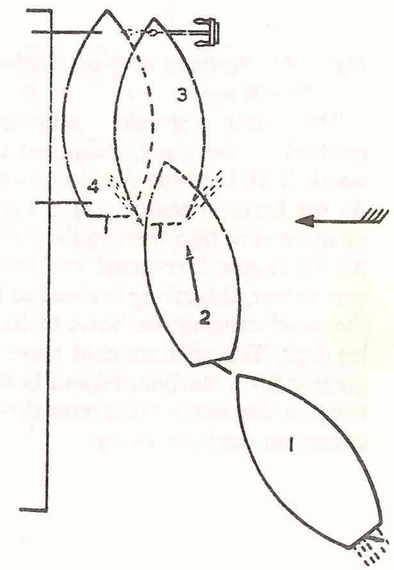


Fig. 4.30. Berthing Head to Wind

The ship is headed for the stem of the berth because of the braking effect available from the wind. In no circumstances must an onshore swing be allowed to develop in (1), because an astern movement will increase the tendency of the ship to run across the wind under reducing headway. The ship must maintain a slow offshore swing so that when the engine is reversed she is right in the wind's eye. A greater swing is allowed for a starboard-hand berth due to the astern transverse thrust producing an onshore swing.

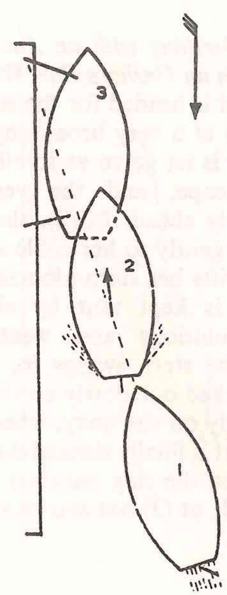


Fig. 4.31. Berthing with an Onshore Bow Wind

The ship should approach parallel to the quay, being set towards it all the time due to leeway. As the berth is neared, (2), a slight offshore cant into the wind is given. As the engine is reversed and headway is lost, this swing is checked by the wind causing the bows to have lee drift. The offshore cant must be greater for a starboard-hand berth, because the astern transverse thrust causes an onshore swing.

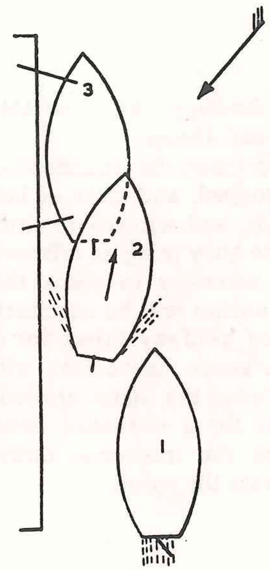


Fig. 4.32. Berthing with an Anchor Away in an Onshore Bow Wind

The vessel is headed for the stem of the berth at a very broad angle. The anchor is let go so as to allow sufficient scope, and the vessel moves slowly ahead. In (2), she is brought up gently to her cable and the wind drifts her stern alongside. The cable is kept taut by slow engine revolutions and weather helm. As the stern swings in, the chain is slacked out slowly until the bow is nearly on the quay, when it is checked. It is finally slacked down quickly when the ship parallels the berth. (Cable at (3) not shown.)

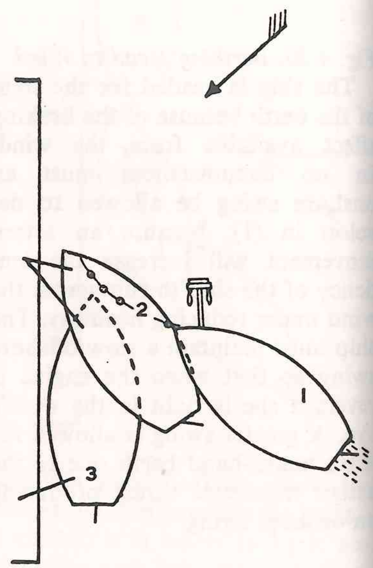


Fig. 4.33. Berthing with an Anchor Away in an Offshore Bow Wind

This time the ship is steamed round her anchor under full lee helm to (2), when a headline is run. The wind now blows the bow offshore, so the cable is slacked down and the vessel allowed to run ahead to (3). When she is parallel the engine is reversed and the offshore swing so produced is checked by the headline. The vessel then moves bodily into the quay as she tries to throw her stern upwind while under sternway from (2) to (3).

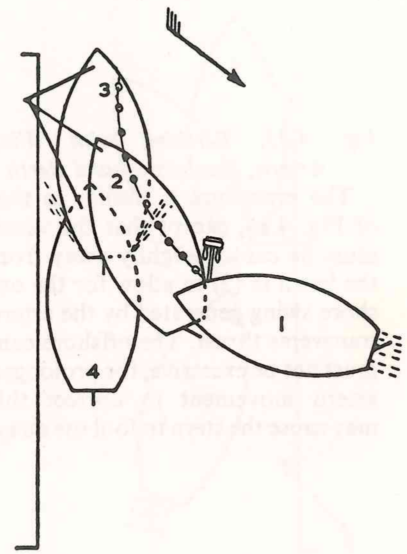


Fig. 4.34. Berthing with Wind Astern, Port-hand Berth

The leeway increases headway in this manœuvre, and the ship's behaviour under the necessary prolonged astern movement is unpredictable. The vessel is run dead before the wind (1), and canted slightly into the berth (2). The engine is reversed and the screw effect throws the stern back into the wind. As the vessel loses headway, she will parallel the berth in (3). The headline in (2) is used only to check an excessive offshore swing due to transverse thrust and the ship's tendency to seek the wind with her stern.

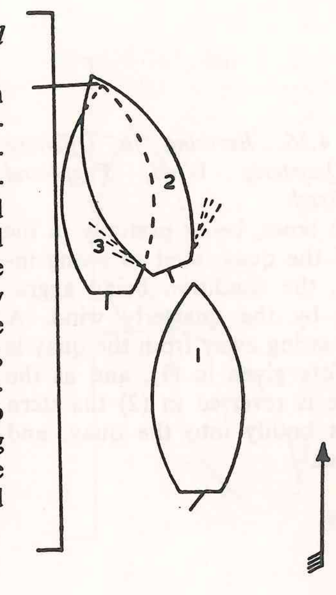


Fig. 4.35. Berthing with Wind Astern, Starboard-hand Berth

The procedure is similar to that of Fig. 4.34, except that the vessel must be canted slightly away from the berth in (2) to allow for the onshore swing generated by the astern transverse thrust. The offshore cant must not be excessive, for prolonged astern movement to correct this may cause the stern to foul the quay.

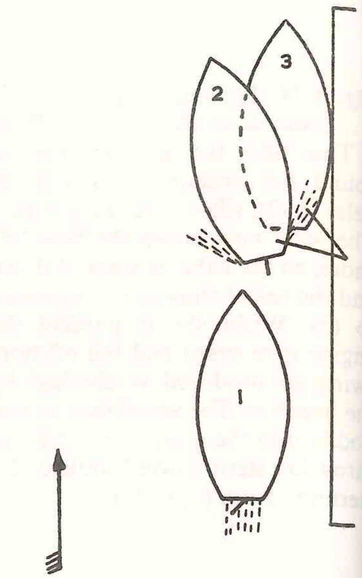


Fig. 4.36. Berthing in Offshore Quarterly Wind, Port-hand Berth

The bows, being partially in the lee of the quay, tend to swing inshore, the condition being aggravated by the quarterly wind. A slight swing away from the quay is therefore given in (1), and as the engine is reversed in (2) the stern moves bodily into the quay, and upwind.

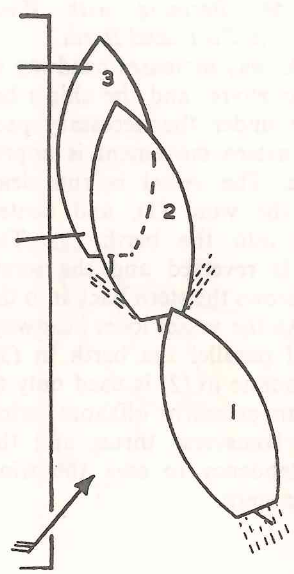


Fig. 4.37. Berthing in Offshore Quarterly Wind, Starboard-hand Berth

Again, the approach is similar to Fig. 4.36, but a starboard swing must not be allowed to develop, because this will be aggravated by the astern transverse thrust. For this reason, a swing to port is generated at (1), which is corrected at (2) when the engine is reversed. A sternline is used to correct an excessive starboard swing.

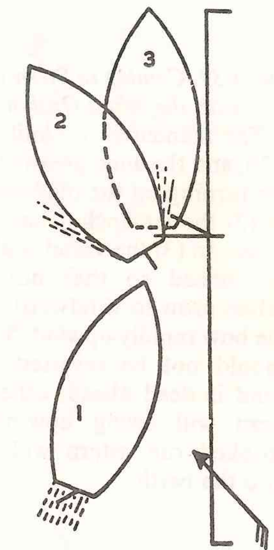


Fig. 4.38. Berthing in an Onshore Quarterly Wind

The vessel is headed into her berth with the wind aft, or on the offshore quarter. When the engine is reversed, the transverse thrust generates a starboard swing which, in the case of a port-hand berth, is aggravated by the starboard quarterly wind. This must be checked as the vessel loses headway in (2) by a headline. The angle of approach for a port-hand berth should therefore be as large as possible. For a starboard-hand berth the manœuvre is more simple, for the starboard swing due to the astern transverse thrust is counteracted by the lee drift of the stern. The angle of approach can therefore be finer.

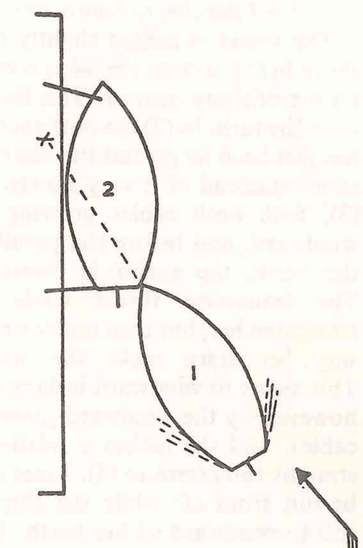


Fig. 4.39. Coming to Stern-moorings, with the Wind Onshore

The manœuvre is similar to Fig. 4.26, and the wind greatly facilitates the turning on the offshore anchor. In (2) the lee anchor has just been let go. In (3) the vessel is allowed to run ahead so that both anchor cables grow to windward, snubbing the bow rapidly upwind. The engine should not be reversed until the wind is dead ahead, otherwise the stern will swing upwind and a crooked run astern will be made into the berth.

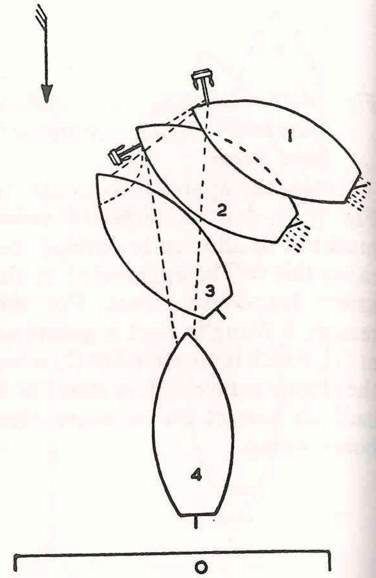


Fig. 4.40. Coming to Stern-moorings, Wind Parallel to Shore, and Aft

The vessel is canted slightly offshore in (1), so that the wind comes on the offshore quarter. This facilitates the turn. In (2) the port anchor has just been let go and the vessel is running ahead of it very slowly. In (3), with both cables growing to windward, and before she parallels the berth, the engine is reversed. The transverse thrust tends to straighten her, but then under sternway her stern seeks the wind. This swing to windward is damped, however, by the windward-growing cables, and she makes a relatively straight run astern to (4). Lines can be run from aft while the ship is still to windward of her berth. She will then slowly drift alongside.

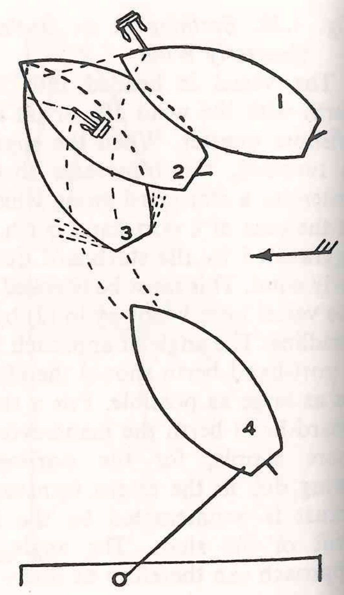


Fig. 4.41. Coming to Stern-moorings with Wind Parallel to Quay, and Ahead—Port-hand Berth

The vessel can be steamed round her anchors, (1), under bold helm and revolutions, and then run astern from (2) to (3), in which case she will arrive to windward of her berth, which is desirable. However, the manœuvre of turning is laborious and severely hampered by the fact that the bows drift to leeward of her cables, the latter then snubbing the bows upwind and resisting the desired turn. It is preferable, therefore, to swing the ship off the wind in (1), and then reverse the engine, which brings her rapidly to (2) as her stern seeks the wind. The anchors are then dropped on the run astern to (3). The swing of the bows to starboard is damped by the windward-growing cables.

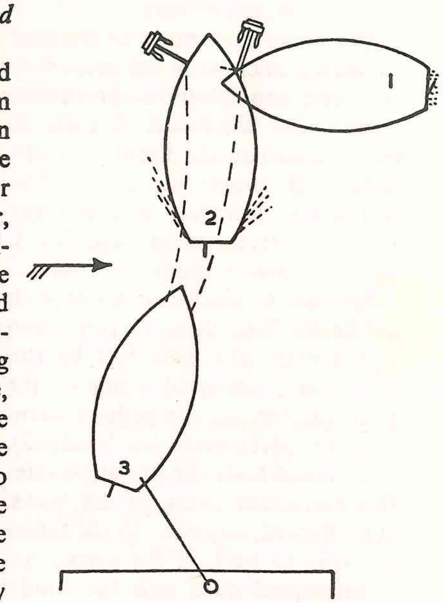


Fig. 4.42. Starboard-hand Berth

The manœuvre is performed as in Fig. 4.41, with the exception of position (2). Here, the stern is allowed to swing farther upwind before the run astern is made. (If this is not done the transverse thrust, which in this case partially resists a sternboard, may cause the ship to fail to reach the windward position (3).) In both figures the position (3) is identical.

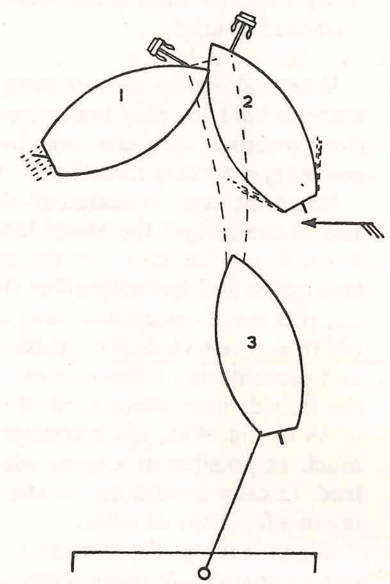
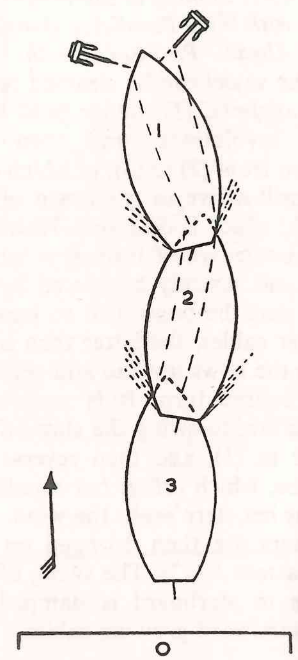


Fig. 4.43. Coming to Stern-moorings with Wind Offshore



The vessel must either be steamed round her anchors in the usual way—a long and laborious procedure against the wind—or, if there is room, over-run the berth well offshore and reverse the engine. She will gather sternway and run her stern up into the wind's eye at (1). This manœuvre needs very careful judgement to place her in line with her berth. Even then, the run astern is not easy. She must not be run astern until the wind is fine on the port quarter. As she gathers sternway, her stern seeks the wind, (2), and transverse thrust aggravates this starboard swing of the bows. It is checked, however, by the cables growing to port. If the astern run is attempted dead into the wind's eye she will run to leeward of her berth with the wind broad on the starboard quarter.

When taking up stern-moorings it should be remembered that two anchors hold the ship better than one alone. Provided they are let go close together, they can later be hove-in simultaneously. The lengths necessary may vary from 2 to 7 shackles.

When the berth is neared aft the sternway is checked with the cables, and at the instant the vessel loses way the cables are quickly slacked
2 or 3 fathoms down 5 or 6 m. If this is not done the ship will surge ahead on her taut cables and seriously affect the running of the sternlines.

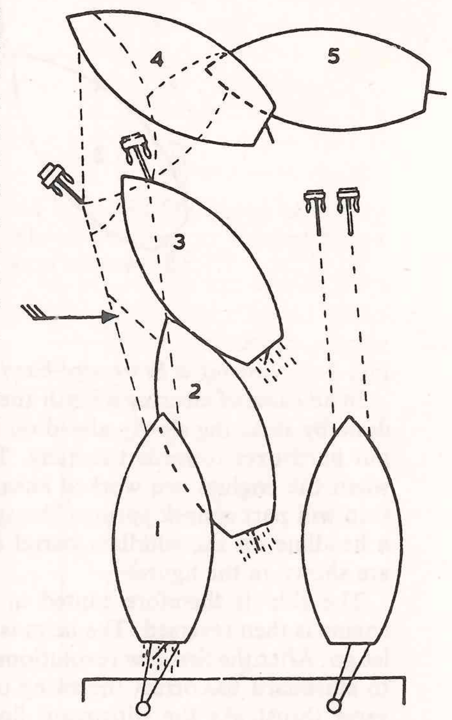
Cross moorings are normally used aft, the port lines leading to starboard and vice versa. This method does hold the ship rigidly in position and prevents any transverse movements. In a beam wind however, it is the lee side lines which tend to take the stress.

As in Fig. 4.15, the moorings and cables must be slacked down as much as possible in a cross wind, so as to give them a more natural lead. In calm conditions the sternlines can always be tautened by heaving in a few links of cable.

When leaving, the sternlines are let go completely and not slacked out, as no useful purpose is served by so doing. The ship is then hove-out

to her anchors. The engine is not used to check the momentum of the ship, since the bights of cable will do this quite effectively. The ship is then steamed around one anchor to face the fairway direction. In a wind the ship is allowed to swing head to it, the weather anchor being weighed last. When swung, the ship can conveniently be headed in any direction, for with the fairway abaft the beam, she will readily pay off to either side.

Fig. 4.44. Leaving Stern-moorings in a Very Strong Cross Wind



The sternlines are let go and the vessel steamed out to her anchors under bold engine movement and full weather helm. When the stern closely approaches the lee ship in (2) the helm is put amidships to momentarily check the swing. The ship is now under good headway, and when clear in (3), weather helm is again used. The ship may well overrun her anchors in (4), but the bights of cable will check this and snub her head to wind.

If the stern is not swung towards the lee obstruction and the ship heaves herself out to her anchors, or steams out to them with amidships helm, she will make rapid bodily leeway. As she drifts down on to the lee obstruction, her cables grow broad on the weather bow and drag the bow upwind. The stern is flung into the other ship and the application of lee helm increases the pull of the cables. The object at all times is to get upwind as quickly as possible.

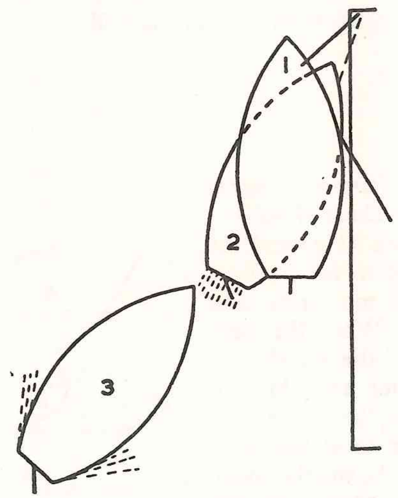


Fig. 4.45. Leaving a Starboard-hand Berth in Calms

In all cases of clearing a berth the stern must be canted clear. This is done by steaming slowly ahead on a fore headspring, while the helm is put hard over towards the quay. The spring must be absolutely tight when the engines are worked ahead, otherwise any momentum of the ship will part a slack spring. The spring may be made tight by putting a headline on the windlass barrel and heaving on it. These two lines are shown in the figure.

The ship is therefore canted in to the quay forward, (2), and the engine is then reversed. The helm is initially amidships and the lines are let go. After the first few revolutions astern the rudder is put hard over to starboard to correct the swing to starboard generated by the transverse thrust. As the slipstream flows in between the fore body and quay, the undesirable starboard swing is further damped, but as soon as she clears the quay the swing may tend to develop again, the transverse thrust overcoming the full rudder angle. In this case the engine must be stopped in order to have a straight run astern.

Fig. 4.46. Leaving a Port-hand Berth in Calms

Here, both the transverse thrust when reversing the engine in (2) and the cushioning slipstream between the forebody and quay cause the stern to swing rapidly back into the quay. The helm will be of no avail, because this will occur before sternway is gathered. However, the undesirable swing of the bow on to the quay in Fig. 4.45 does not exist here, and providing the manœuvre is correctly done, the clearing is, in many ways, more simple. The stern must be canted out to a very large angle as in (2) before the engine is reversed. By the time the stern has swung back parallel to the quay, the ship will be under sternway and will be at (3). Starboard helm may then correct the swing of the stern inshore, but even so, a burst ahead on the engine with port helm will soon achieve this.

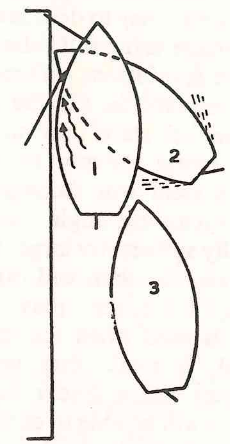


Fig. 4.47. Clearing the Berth in an Offshore Wind

This manœuvre is simple. The vessel can either be eased bodily off the quay on her fore and aft lines, or else as shown, her after lines are let go and she swings to (2). By reversing the engine and letting go, her stern will run back up into the wind to (3), when the swing is checked by a burst ahead on port helm. If desired, starboard helm can be used instead, continuing the swing under headway. This is useful for a fairway which lies astern of the berth.

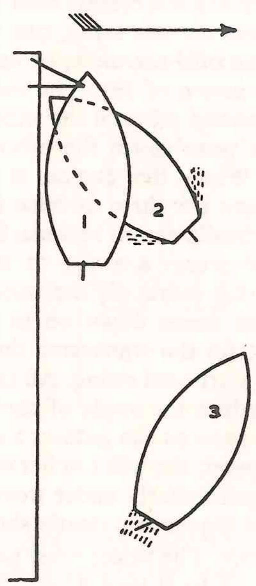
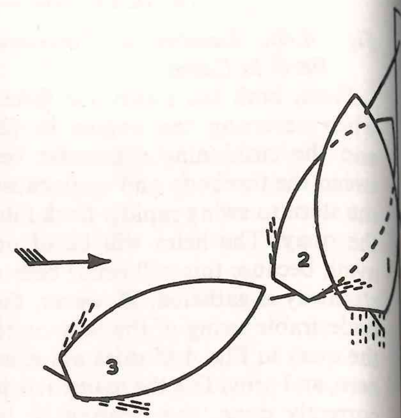
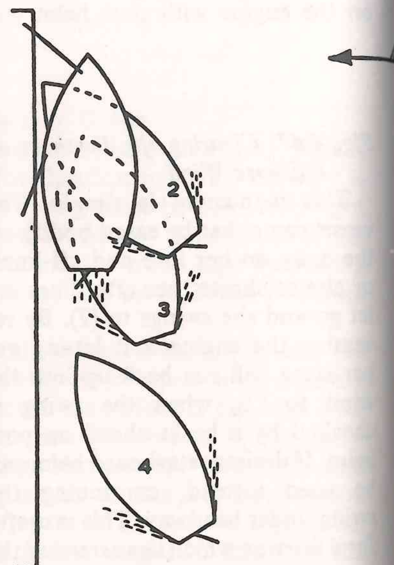


Fig. 4.48. Leaving a Starboard-hand Berth in an Onshore Wind



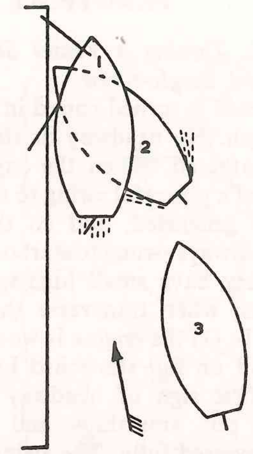
The stern must be canted off the quay to a much larger angle than in calms. It is quite easy to do this even in a fresh breeze using full helm and bold engine revolutions. When the engine is reversed in (2) the ship rapidly runs her stern upwind and the bows swing sharply to starboard. The stem will damage the quay if the canting angle has not been initially sufficiently large. With a large angle, the stem will rapidly draw away from the quay. Full port helm is used when the engine is reversed. A small ship with a straight stem and a fender on her inshore bow will be able to cant herself off at right angles to the quay.

Fig. 4.49. Leaving a Port-hand Berth in an Onshore Wind



The ship will not readily clear her berth unless she has a tug, can run a line to an offshore mole, or has a clear run astern of her. The vessel must be canted off until the wind is as fine as possible on the offshore quarter. When the engine is reversed there are three adverse factors: (*a*) the slipstream between bow and quay causes a swing to starboard of the bows; (*b*) the wind is setting the vessel down on to the quay aft; (*c*) the transverse thrust creates a starboard swing. All these factors reduce the angle of cant at once. As soon as she gathers sternway, however, she will run her stern upwind, particularly under weather helm. The sequence is clearly shown in the figure. The vessel must have good sternpower for this manœuvre and cant off to at least 45 degrees from the line of the berth.

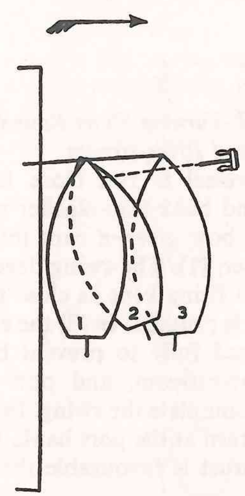
Fig. 4.50. Leaving with an Onshore Quarterly Wind



For both port- and starboard-hand berths the ship must be sprung off to such an angle that the wind catches the inshore quarter, (2). This may be extremely difficult, for the stern tends to cling strongly to the quay in such a wind. A tug or a sternline to an offshore mole may have to be employed.

The wind on the inshore quarter then assists the canting-off of the stern. When the wind is in this relative position the engine can be worked astern, and the ship will run easily clear of the quay into the wind's eye, (3). A slightly larger angle of cant must be made before reversing the engine for a port-hand berth, because the astern transverse thrust is adverse.

Fig. 4.51. Leaving a Berth with an Offshore Anchor Down, Offshore Wind



The sternlines are let go and the cable hove. The stem will tend to lead downwind more rapidly than the stern, and therefore the latter should be allowed to cant off before heaving cable, (2). A headline should be used to check the head, otherwise the bows may drift rapidly across the anchor and be snubbed sharply upwind. Alternatively, both fore and aft lines can be eased until the anchor is weighed; the lines are let go, and the engine is reversed to produce an offshore swing of the bows.

In calms the stern is canted off by slacking the cable a little and steaming ahead under full onshore helm on a fore headspring. The lines are let go with the exception of a headline, and the cable is hove. The headline checks the bows and keeps the vessel parallel to the berth while heaving.

Fig. 4.52. Turning a Vessel Short Round, Single-screw

The vessel is turned round in her own length. No headway or sternway is gathered. When the engine is reversed a powerful swing to starboard is generated, and so these ships are always swung to starboard, unless they have small high-speed propellers, when transverse thrust is small. In (1) the engine is worked full ahead on full starboard helm. At the first sign of headway the helm is put amidships and the engine reversed fully. The swing to starboard continues, (2). The sequence is repeated in (3) and (4), and so on, until the vessel is turned. If the astern power is small the watch for headway must be extremely diligent.

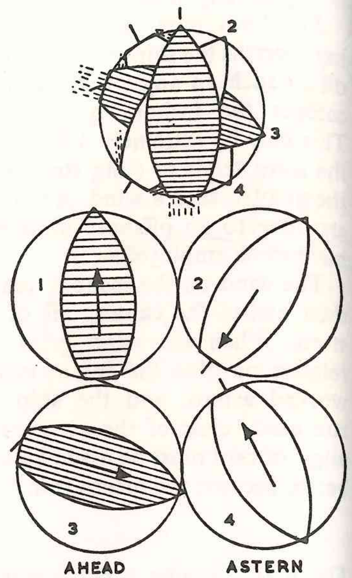


Fig. 4.53. Turning Short Round in an Ahead River-stream

The vessel is run close to the port-hand bank into slacker water, and the bow given a cant into the fast water, (1). The swing develops, the stern being kept as close to the bank as is prudent. In (3) the engine is reversed fully to prevent bodily drift downstream, and port helm used to complete the swing. In making the turn at the port bank, transverse thrust is favourable throughout.

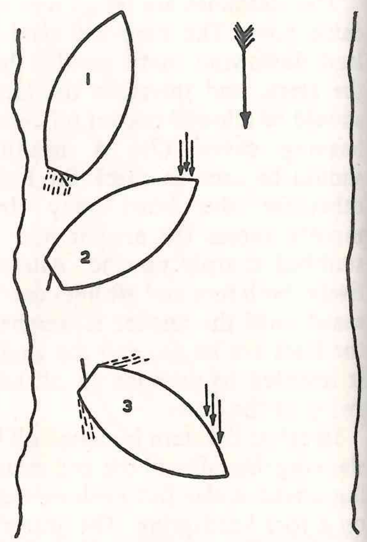


Fig. 4.54. Turning Short Round in an Astern River-stream

In (1) the bow is swung into the slacker water at the starboard bank and the engine is reversed. The helm is over to starboard for the cant inshore and is about to be placed amidships.

The reversed engine produces a favourable transverse thrust and also prevents excessive lee drift. In (2) the upstream anchor is let go and held at short stay. This rapidly snubs the bow round to (3), by which time the engine should be working ahead under starboard helm to complete the swing to (4). The anchor is held at short stay so that an excessive stress on the cable causes it to dredge rather than be strained. In (4) the cable appears to have been further veered, but this is only for the sake of clarity—actually the vessel swings very nearly in her own length at (3).

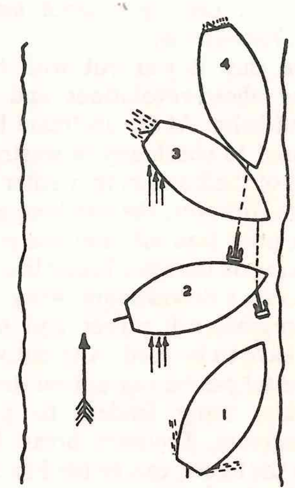


Fig. 4.55. Entering a Dock from a Stream Running Across the Entrance

The drawing needs little explanation. The ship is best secured to the lee pierhead, (1), while the upstream lines are run—these being labelled (1). Several inshore fenders are rigged overside and the vessel is hove ahead. The lines are moved without delay, as appropriate, to the positions labelled (2), and the ship is moved or *warped* into the entrance while pivoting on the lee knuckle. Engine ahead-revolutions and inshore helm assist the turn. The very long after backspring in (2) takes a considerable stress while the stern is in fast water.

Had the entrance been made from the weather pier and a line parted, an impact might have been made on the lee knuckle.

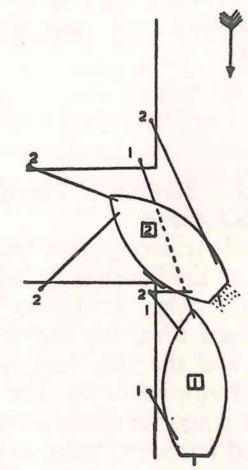


Fig. 4.56. Leaving a Dock into a Cross Stream

The ship is run out with bold engine ahead-revolutions and upstream helm. At (2) upstream lines are used to check any downstream swing of the bows as they enter fast water. However, the headline soon has a poor lead aft, and too much checking on the stern breast line will aggravate a downstream swing. For this reason, full power and helm may have to be used. Alternatively, the vessel can be run out on the lee knuckle, using fenders to pivot downstream. The stern breast line, (3) in the figure, can be used to control the downstream swing.

In all cases of entering a dock direct, due allowance must be made for downstream set. A small ship can be run in under good headway, but there is not likely to be sufficient room for a big ship to gather this headway, and tugs may be necessary.

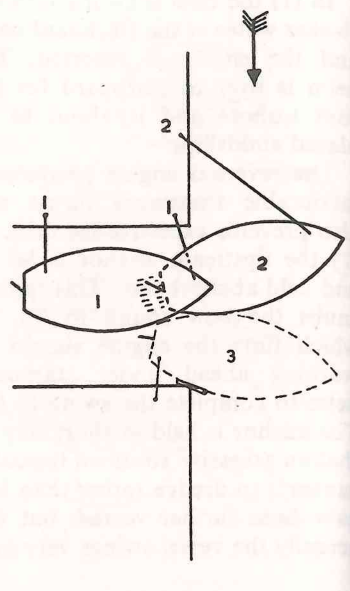


Fig. 4.57. Turning a Vessel with Wind Ahead

The ship is swung under headway to (2). As the headway is lost, the starboard swing continues. It is accentuated when the engine is reversed, and the ship rapidly runs her stern upwind to (3). The swing is then maintained on ahead-revolutions and starboard helm, to (4).

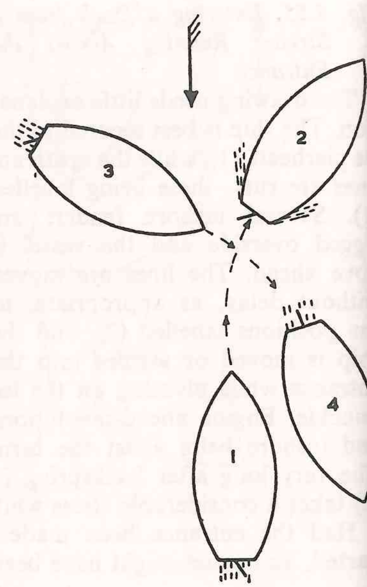
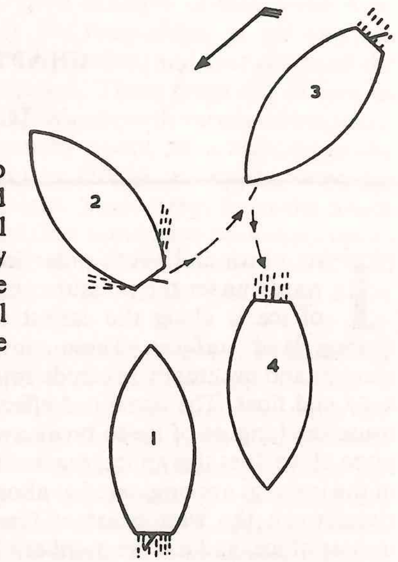


Fig. 4.58. Turning in a Bow Wind

The ship is swung off the wind to (2), and the swing is accentuated with a reversed engine and full weather helm to (3). If the sternway is continued sufficiently, when the engine is worked ahead under full port helm the ship will have made ground to windward at (4).



MOORING LINES AND TAILS

Mention has already been made on page 85 (Figure 4.18) about the stresses produced on a ship by winds, the ratio between fore-and-aft stresses and beam stresses being about one to five for a given wind. ~~For~~ the ship quoted, a loaded 250,000 tonner with an underkeel clearance of 2 metres, a 1 knot current from ahead can produce forces on the ship of 5 tonnes compared with 230 tonnes when the same current is abeam. Mooring lines must therefore be used to maximum efficiency and this is achieved when the line leads from the ship at a low angle to the horizontal. Never mix lines of differing materials—some will stretch more than others and introduce uneven loading.

Mooring tails increase the elasticity of a wire line by up to 600%. They should be at least 11 metres long, parcelled with leather, canvas, or plastic at the eyes and preferably joined to the wire using Mandel or Tonsberg shackles. These are straight-sided and both the head and the pin (which is removed using a key) are rollers, keeping chafe to a minimum. In normal use, tails should be replaced every 18 months, be at least 25% stronger than the wire and obviously be of the same lay, otherwise unlaying occurs under stress.

CHAPTER V

ICE

THE north and south polar ice caps are continually flowing outwards under the pressure of accumulated snows. The movement of ice is along the easiest routes, which are valleys and flat, sloping land surfaces. These moving masses of ice are known as *glaciers* and eventually protrude into the sea, where they acquire buoyancy and float. The combined effects of buoyancy, wind, and currents cause the tongues of ice to break away from the land, and every time a piece of ice does this an *iceberg* is *calved*. In the North Atlantic the bulk of the icebergs are originated at about twenty of the hundreds of glaciers situated on the west coast of Greenland. These bergs are irregular masses of ice, and a large number of them drift into the North Atlantic Ocean under the effects of wind and current. Every spring and summer they present a menace to shipping as far as, and occasionally south of, the 42nd parallel. It is estimated that about 7 500 bergs break away from Greenland glaciers every year, of which about 400 drift south of Newfoundland, some forty finding their way south of the 42nd parallel. This
1800 miles journey from Greenland to Newfoundland, roughly 2880 km, is accomplished by the bergs in periods varying from a few months to three years.

One of the worst years in the North Atlantic from this point of view was 1972, when as many as 1 587 bergs found their way south of the 48th parallel. Another bad year, closely approaching these statistics, was 1912 when, on April 14th, the *Titanic* foundered in 41° 46′ N, 50° 14′ W with the loss of 1 517 lives.

Disintegration of the bergs commences immediately they are calved, and is a product of the effects of swell, heavy seas, wind, solar radiation, warm sea-water, and, to some extent, rain. Heavy erosion is caused at the waterline, and as a result of this and general deterioration, the berg calves smaller pieces which fall into the water with a loud roaring noise. As the berg melts, cracking of the ice occurs, and this is clearly audible under ideal conditions up to a mile away. In trade routes the bergs may
270 ft 1700 ft have heights above the water of up to 80 m and lengths of 500 m.

In the Antarctic temperatures are generally lower. Here, in addition to the formation of glacier ice and irregular bergs, the ice cap flows into

the sea and forms a vast barrier of floating ice around the continent, many hundreds of metres thick. A good example of this is the Ross Barrier. In the spring and summer the inequalities of air and sea temperature produce uneven rates of expansion, and vast pieces of the barrier break adrift and move northward. These bergs are known as *tabular* icebergs, and resemble floating islands with vertical sides and a level surface. These ice islands are usually about 50 m high, measured 180 ft
from the waterline, and may be up to 110km in length. Some are 70 miles
reported as being up to 500 m in height. These bergs from the South 1700 ft
Polar cap drift up to the 55th parallel, but some have been reported as far north as 33° S in the Longitude of 50° W. Others have been seen along the 35th parallel in the vicinity of the Great Australian Bight and the Cape of Good Hope.

All icebergs have the bulk of their volume submerged. Usually about one-ninth only is visible, but this depends entirely upon the amount of rock, earth, or air which is trapped within the ice, and also upon the amount of loose snow lying upon the berg. Generally, the volume which is emerged lies between one-tenth and one-third. An iceberg south of the Grand Banks of Newfoundland may survive as a danger to navigation for up to a fortnight, but after June this decreases to about ten days. The bergs which are grounded upon the Banks seem to survive for long periods, possibly up to one month.

Off Newfoundland, the frequency of sea-fog, the density of fishing vessels, and the continuous flow of traffic add other dangers to the existing perils of ice. In 1898 the North Atlantic Track Agreement was devised, which laid down routes to be followed by east- and west-bound traffic, each route having a separate season. These seasons were varied from year to year depending upon the conditions. Many shipowners took part in this agreement, and naturally it left Masters and Officers more free to concentrate upon the hazards of ice. Collisions became less frequent, but ice tragedies continued, culminating in the loss of the *Titanic*. The following year (1913), an International Ice Patrol was set up to keep a vigilant watch on the most dangerous ice areas. Today the patrol is maintained by surface and air craft, and is managed by the United States Coastguard, while the cost is shared between the various maritime Governments.

During the ice season, the Patrol broadcasts in bulletins at 0000 and 1200 G.M.T. every day, commencing some time in March. After receiving the first bulletin, Masters are asked to transmit full weather reports every six hours while they are situated between the 40th and 50th parallels and the 42nd and 60th meridians of west longitude. This serves a dual purpose, for it assists the Ice Patrol and enables the latter to keep a close track on ships in the vicinity. The Ice Patrol may report vessels which are observed not to heed ice warnings.

Before sailing, Masters are advised to obtain all possible information regarding ice located in the vicinity of their intended course. On the voyage they should exercise the utmost vigilance in darkness or poor visibility, and make sure that every ice bulletin is received and brought to their notice immediately. The following are some of the many terms used in connection with ice navigation:

Beset: a vessel which is hemmed in and surrounded by ice. The ship cannot be controlled, but is not necessarily under pressure from the ice.

Boring: the operation of forcing a way through ice under the ship's motive power.

Calving: the breaking away of ice from a berg, glacier, or barrier.

Concentration of ice over the sea is measured in eighths of the sea surface. When one-eighth is ice covered the water is said to be open. *Close ice* refers to a coverage of six to eight-eighths, while a coverage of eight-eighths with no water visible is referred to as *consolidated ice.*

Crack: a small break in an ice field, which is unnavigable.

Fast ice: ice which is attached to the ground.

Field ice: a large area of sea ice driven closely together. It may have a vast surface area and is greatly influenced by wind and currents. It is mainly confined to the Arctic and coastal areas, and cannot survive for long far from the shore. It is of very shallow draught, but may be extremely hard, particularly if grey or green-coloured. Field ice is deceptively soft in appearance and is easily penetrated on the lee edge, which is ragged, while the weather edge is closely packed and well defined. Within a field, small pieces may prove to be dangerously large, thick, and heavy.

Floe: applies as a general term to all fragments of ice.

Floeberg: a piece of thick ice having a hillocked or hummocked effect
50 ft rather like a berg. It may exceed 15 m in height above sea-level.

Growler: a small floe calved from a berg. Often green in colour.

10 ft *Heavy ice*: ice which is more than 3 m in thickness.

Hummock: a mound or hillock which is produced in ice under the pressure of surrounding ice.

Ice crust: is new, transparent ice which achieves no hardness or
16° F strength until it is cooled below about −9°C. It is almost pliable due to the entrapped layers of salt.

Lead: a long, narrow, navigable channel within an ice field.

1½ ft *Lilypad ice*: small, round cakes of ice up to about 0·5 m in diameter.

Nipped: a ship which is beset and under pressure of ice.

Pack ice: otherwise called *sea ice* or field ice. When the pack has no lanes or leads visible it is referred to as close pack. When open, with many lanes visible, it may be called *loose, sailing*, or *drift ice*, and can sometimes be navigated at full speed.

Pancake ice: newly-formed pieces, circular in shape, and up to 2 m 6 ft
in diameter. The rims are often raised.

Rafted ice: an effect achieved in close pack-ice when one cake of ice overrides another, under pressure.

Rotten ice: ice which is honeycombed due to thawing.

Screwing pack: is pack ice under constant rotation due to wind effects. The motion of the ice is dangerous to a ship's plating.

Shore ice: ice which has been cast ashore.

Slewing: the act of forcing a ship through close pack by working the engines ahead and the rudder from side to side. The floes are forced apart.

Slob: is dense, sludge ice.

Sludge: or *brash*, consists of small, soft ice and slush, and is usually the wreckage of pack ice.

Slush: ice crystals on the water's surface. It possesses no hardness, and is the first stage of surface freezing. The water appears oily and opaque.

Young ice: newly formed ice with no traces of hummocking. It is up
to 20 cm thick. 8 in

Working: boring or slewing through the ice.

NAVIGATION IN ICE

(a) Preparation of the Vessel

When the vessel is expected to pass through pack ice, which in the North Pacific may be very prolific, the crew should equip themselves with clothing suitable for such a voyage. The deck machinery, and if possible the rigging too, should be covered with canvas. The heating systems throughout the vessel must be checked, pumping gear overhauled, and all drainage checked. Quantities of de-icing compound may be put aboard and the decks and superstructures coated with it just before encountering freezing temperatures and heavy weather. The compound may be applied by paint-brush or spray gun. Pickaxes and *ice mattocks* should be provided. A mattock resembles a pickaxe, but
has only one spike, the end of which if flattened out into a 10–12-cm 4–5-in
blade. The instrument is used similarly to a carpenter's adze, with the legs well apart, and employing a short chopping motion.

It is advisable to make sure that the ship is well equipped with damage control gear and leak-stopping equipment, including cement, sand, steel plates, shoring, collision mats, and patent rivet-stoppers. A quantity of softwood wedges may prove to be of value. In freezing temperatures deck steam engines should be drained and the weather-deck fire main isolated and drained. Winter-grade oils should be used where recommended. Petrol engines, if water-cooled, should be drained or equipped with anti-freeze, and batteries cared for according to the maker's instructions. Some thought should be given to a suitable jury rudder for the particular vessel, and the necessary gear obtained.

This summary of precautions is by no means complete, but is intended to cover salient points.

(b) The Indications of Ice

One of the most reliable indications of the presence of field ice and of an extremely large berg, such as a tabular type, is *ice blink*. This is a whitish glare in the sky, on the horizon in the direction of the ice, and may extend to 15 degrees altitude. It is due to the intense reflection of light from the ice surface, and according to many experienced Arctic navigators is most marked in a clear, fine atmosphere when the sky is uniformly covered with cloud. The sea appears black beside the ice, and reflections from the sea produce a *water sky*. This effect is most marked within an ice blink, particularly when the ship is beset, and appears as black streaks or patches within the blink. It is useful in that it indicates open water and leads. If the ice blink is yellowish it may indicate an ice-covered land mass. If the ice is not snow-covered the same yellow haze may be encountered despite the absence of land. The ice blink is most brilliant after a fresh fall of snow upon the ice field.

Ice blink is often seen, fortunately, at night as well as by day, particularly if there is moonlight. The horizontal length, and to some extent the height, of the blink give a good indication of the field area. By day, under cloudless conditions, there may be no ice blink, but refraction may produce a mirage of the ice.

Other signs include an abrupt smoothing of the sea and swell, which may indicate ice to windward. Birds and seals sighted far from land may be in the vicinity of a pack. A sudden wall of fog may be experienced on the edge of an ice field and also large expanses of sea smoke, when the sea appears to be steaming. The sounds of disintegration and calving of growlers has already been discussed, this also being a warning.

Radar should detect a large berg in sufficient time but ice-echoes are one-sixtieth as efficient as ship echoes. Small ice and bergs may be lost in the *sea clutter*. The use of the whistle to return an echo from ice is unreliable, because the contours of the ice may prevent such an echo; further, a fog bank is likely to return a false echo.

Any sudden changes in sea or air temperature should not be relied upon as an indication that ice is near.

If growlers are sighted, several in a group, it may indicate that a berg is to windward, from which they have been calved. Since a growler may be sufficiently big to cause serious damage, a berg sighted at night or in poor visibility should be passed to *windward*.

All these warning signs are only supplementary to a good lookout, and this should be maintained in suspected waters from both forward and aloft, the men being provided with binoculars. In clear weather a berg may be sighted 20 miles away, depending upon the observer's height above sea-level, while in light mist or drizzle the distance is reduced to 1–3 miles. In a low haze the tops of large bergs may be detected at distances up to 10 miles. In fog the berg will appear as a white, luminous mass. On a clear night without moonlight it is unlikely that a sharp lookout will detect a berg at distances beyond about 500 metres, unless the bearing is known, and the sea may then be observed breaking against it, viewed through binoculars, at a range of up to a mile.

(c) Entering the Pack

The ice will have a deceptively quiet appearance, but is to be highly respected at all times. If the far boundaries of the field are visible it is better to detour the pack and avoid it altogether. If the far boundaries are not visible the hazards within the pack are unknown and the ship may be beset and nipped. In both cases, then, we arrive at the wisest conclusion of all, which is to avoid pack ice at all costs.

If entry is inevitable it should be made at right angles to the *lee edge*, where the ice is broken and loose. The vessel is entered very slowly, and speed is gradually increased to a safe level, endeavouring never to lose way, for then the floes will close in on the propeller and rudder. Lookouts should be posted high up to watch for leads, the latter possibly closing very soon after being sighted. The conning should be done from the bridge so that a better appreciation of the ice size is possible.

At all times, the stern must be cared for, bearing in mind that a rudder movement to avoid a floe will swing the stern towards it. Men should be posted aft, equipped with torches, whistles, or a telephone, so that the bridge can be informed immediately the propeller is endangered, particularly in the case of twin-screws.

It is unwise to enter hummocky or rafted ice where pressure exists and the vessel is likely to be nipped. The hummocks generally lie in a direction at right angles to the line of motion of the floes, and parallel to cracks and leads.

The navigation of pack ice requires patience, constant vigilance, preferably experience, and extremely good judgement. The ship will probably handle sluggishly at the low speeds, and a turn may require a burst ahead on the engines, using full helm. The shorter and beamier the ship, the better she will turn. Engine movements from ahead to astern, and vice versa, should be made carefully to avoid stressing the shafting in low temperatures, which are detrimental to steel and iron.

When the current is in the same direction as the wind the ice tends to open, but in the reverse conditions a close pack is formed. In such a pack the floes will have to be forced apart by slewing, and a thick fender should be rigged over the stem. When cleaving the ice the rudder will have little effect, and the ship will follow the crack.

Sharp alterations of course should be avoided, and the speed should be kept to steerage way in close pack, while up to 8 knots can be used in scattered pack ice. It is frequently necessary to work the engine astern in pack ice and gather sternway. When this is done the rudder should be kept amidships to afford some protection to a single screw. Twin-screws are very vulnerable when moving astern in ice, and the action of sternway should be accompanied by bursts ahead on the propeller(s) whenever ice approaches the screw(s). The resulting wash will tend to clear a channel in which to continue backing.

At night it is preferable to heave-to, since the lanes cannot be seen. The vessel should be stopped alongside the lee edge of the ice, where she will drift with the pack. If she is stopped along the weather edge the plating is likely to be seriously damaged by grinding between the hull and the ice. When hove-to at night a watch must be kept for large floes and bergs which may work through the field towards the ship. Such a watch should be aided by the use of powerful lights. During the night sea-water-lubricated tail-end shafts are in danger of freezing up, and in the case of single-screw vessels the after peak tank should be filled with water, kept warm by means of a steam-hose injection. In addition to this, the cast stern tube becomes excessively brittle at low temperatures. In twin-screw ships the stern tubes should be similarly kept warm. Modern practice is inclined to oil-lubricated tail-end shafts and provided the correct grade of oil is used, the danger of freezing up is small.

A twin-screw ship should preferably navigate field ice in the wake of an ice-breaker. When employing such a vessel it is desirable that the following ship should not have a beam greater than the breaker, because the leads created will be quite narrow. Following an ice-breaker may entail sharp turns on the edge of floes, and fenders should be liberally used.

When navigating in sludge the condenser inlets may become choked with ice particles, and a case is on record where a ship was able to combat this by connecting the fire main to the main sea injections. The fire main was kept supplied with warm water by coupling it to the condenser discharge, the water cooling sufficiently for the condenser to function. Hot water should be used to flush water closets in order to prevent soil pipes from freezing up. Any winches or deck machinery likely to be

required for use should be kept slowly running if supplied by steam, once temperatures approach freezing point.

Sometimes, a vessel may navigate between the pack ice and the coast. In this case an offshore wind is desirable, and a grave danger exists if the wind changes to an onshore blow, for the ship will be beset and stranded.

(d) When Beset

The vessel will be out of control, and vessels with straight sides are especially vulnerable. A ship beset in early winter is in grave danger from a build-up of pressure within the pack, and from bergs working through the field. Frequent damage to the rudder and propeller(s) is likely when beset. Initially, action should be taken as for a nipped vessel.

(e) When Nipped

There is likely to be considerable damage to the hull, rudder, and propeller(s). The action usually taken, when nipped forward, is to order full speed and use full, swinging rudder. The action may be accompanied by bursts of full ahead and full astern in the case of a ship strengthened for ice navigation. If this fails, attempts should be made to trim and/or list the vessel, so that she frees herself. A ship beset and suffering increasing pressure from the pack may have her entire hull bottom nipped off, leaving her lying on the ice. When the ice parts in the spring, or before if winds and currents are suitable, the ship founders. If at any time a man descends to the ice and walks over it he should carry a boathook held horizontally across his chest so that if he falls between floes or through a crack in a floe, he has some means of support.

(f) Navigating Near Bergs

These are passed leaving them to leeward to avoid possible growlers. Due to erosion and melting at sea-level, it may appear that they are small, and close navigation is possible. Tongues or ledges of ice are likely to project outwards from them below water for distances *in excess of ten metres*, and they must therefore be given a wide berth. 35 ft

(g) Positioning the Ship

An artificial horizon may be used for sights when surrounded by pack ice. A bucket of oil is suitable. If a back-angle is possible, this should be used, i.e. the part of the horizon on a reciprocal bearing from the body is utilised if clear of ice. The introduction of satellites and Loran and Decca transmissions has greatly simplified the problem of position finding in pack ice.

(h) Towing in Ice

It has been found that a very short towline is desirable, but in the case of large vessels with high forecastles this entails a difficult lead. A bridle is generally preferable to a single towline. Towing is only possible through pancake ice or open pack, a concentration of up to five- or six-tenths being the maximum permissible for this manœuvre. If the towing vessel has to stop, a strong wash astern from the propeller(s) (i.e. engine(s) worked full ahead briefly) will prevent the tow from overriding.

(j) Anchoring and Mooring

A vessel should never be anchored near a glacier coast due to the risk from calving bergs. If forced to anchor in ice the chain should be kept at short stay. There is a great danger of such a vessel dragging, particularly if the pack bears on her weather side. If anchoring near fast ice the vessel should be ready to leave immediately the wind blows onshore, for with ice already cast ashore, it follows that more may approach from windward. The windlass engine, if steam-driven, should be kept running slowly while at anchor. In bays with drifting ice the shallowest, safe depths should be chosen for an anchorage, for then large bergs or floes will probably ground before striking the ship.

When hove-to at night it is not normally necessary to secure to the ice. It is better to stop near small floes rather than big ones, because the former, under pressure, will hummock and raft and relieve the ship of stress. If it is essential to secure, the vessel should lay alongside a floe having a concave bight in it with two projections, rather like an artificial dock. The hull is then clear of ice, except at the projections (where fenders can be used), which will protect the ship to some extent from drifting floes. Such a floe is sometimes called an *ice dock*. The vessel is secured either with a special ice anchor dropped on to the ice or else by cutting a shallow, flat-bottomed hole in the ice as far from the ship as possible and setting a baulk of timber in it called a *deadman*. Water is then poured into the hole to freeze the deadman into the ice. A heavy strop is attached to the timber. The mooring line may then be passed ashore to the deadman, where the eye of the line is secured to the strop by means of a wooden toggle.

(k) Ice Accretion

The addition of top-weight ice adversely affects the stability of the vessel and causes damage to gear, and injury to the crew, particularly in the case of ice falling from rigging and the masts, aerials, etc. Sea-water spray will freeze on to a cold superstructure when the air temperature is below −6°C and the water temperature is below −1°C, the freezing 20°F 30°F

point of sea-water being −2°C. In a wind of twelve knots and above, under such conditions, the ice may build up on decks and structures at a rate sometimes in excess of 5 cm per hour, particularly in a head-wind. 28½°F 2 in

Glazed frost is likely to occur on the vessel when rain falls on to the freezing structures, and the build-up of this ice may be very rapid. Fresh-water ice, such as this, is very brittle and easily broken away, unlike salt-water ice. The formation of glazed frost on the decks will prevent people from keeping on their feet, and salt should be sprinkled on it.

The danger of a list arises when spray is shipped on only one side of the vessel. It is most important to clear the ice as quickly as possible, and in this connection, all snow should be swept up and jettisoned at once before it packs tight. If washed away with salt water by means of a hose the air and sea temperatures should be checked beforehand, otherwise the water may freeze. The use of a de-icing compound will minimise the accretion of ice and facilitate its removal thereafter. The ice should be chopped away with picks, shovels, and mattocks as quickly as the men can work. The use of a steam hose to melt the ice may be attempted, but it may be found that the steam is sublimating into hoar frost, further aggravating matters. Sublimation refers to the transition of a gas into a solid without passing through a liquid stage.

The loss of some vessels, particularly fishing craft, has been attributed to a rapid build-up of ice and later capsizing. Sub-freezing temperatures and ice accretion must be reported to all ships and local Authorities immediately.

Ice accretion on wheelhouse windows can be minimized by the use of electrically heated glass in conjunction with fresh-water sprays and electric wipers. Some vessels have steam pipes fitted around exterior metal doors so that the *dogs* do not freeze up, preventing them from being opened.

The International Ice Patrol, previously mentioned, is paid for by contributions from Belgium, Canada, the USA, the USSR, Spain, Japan, Denmark, France, Italy, Holland, Norway, Sweden, and the United Kingdom. Every year on 14 April, the Patrol drops a wreath at the site of the sinking of the TITANIC.

CHAPTER VI

LIFE-SAVING AND DISTRESS

The importance of instantly recognising all distress signals and being fully conversant with their use, together with the procedure for rendering assistance, cannot be too strongly emphasised. For this reason a whole chapter is devoted to this section. The reader should thoroughly familiarise himself with the text, contents of current Notices to Mariners published by the Admiralty, and the excellent Merchant Shipping Notices published by the Department of Transport in the U.K. (D.o.T.). These publications are obtainable free by Masters from Mercantile Marine offices and Custom Houses.

Most maritime countries provide a life-saving service for persons in distress in their coastal areas. One of the biggest factors in providing assistance is the radio watch required to be maintained by vessels of 500
k/cs tons gross and upwards. The watch is kept on a frequency of 500 kHz
k/cs if radio-telegraphy (W/T) is fitted, and on 2182 kHz with radio-telephony (R/T). The watch is to be maintained at all times except when the operator is performing other necessary duties, during which times he should endeavour to keep a loudspeaker watch. Silent periods are laid down from 15 to 18 and 45 to 48 minutes past each hour of G.M.T.,
k/cs during which the frequency of 500 kHz must not be used except for distress, urgency, or safety signals. In the case of R/T the silent periods
k/cs for 2182 kHz are from 00 to 03 and 30 to 33 minutes past each hour of G.M.T. During all these silent periods even vessels which do not come under the Merchant Shipping (Radio) Rules requirements are asked to maintain a watch.

When an operator hears a distress call he must answer it, at the same time allowing a sufficient interval for ships to acknowledge it which are closer to the distressed vessel. He must then inform his Master of the call, whether other ships acknowledged it, and the positions of those ships. The Master may then instruct him to repeat the call on the distress frequency, particularly if his own ship is unable to render assistance or if other ships have not acknowledged the initial call. All relevant particulars must be entered into the Radio Logbook.

Many British ships have portable W/T equipment for use in lifeboats.
k/cs These units are able to transmit on 500 and 8364 kHz and to receive on

500 kHz. They are also able to automatically transmit on 500 kHz, the k/cs k/cs
auto-alarm signal (12 dashes having one second intervals, all made within a minute), followed by SOS sent three times, together with a subsequent long dash, so that listeners can take a radio bearing of the transmitter. On 8364 kHz the same signal is automatically keyed with k/cs
the exception of the auto-alarm signal. A manual key is also provided.

Private distress signals sent to a specific address are unwise, since in the absence of a general distress call the public services are unable to render assistance or to relay the call publicly. If the sender permits of Lloyd's being informed, then and only then, the Coastguard will be notified, who will alert rescue services where necessary.

VESSELS MISSING OR OVERDUE

By contacting Lloyd's Intelligence Department the latter will send out a general message to shipping on the owner's behalf, via a Coast Radio Station. Lloyd's will also alert appropriate Coastguard stations.

For fishing vessels, however, the Coastguards may be informed direct, or preferably through the local Inspector of Fisheries (or similar officer), who commence a search and rescue service on their own initiative.

PUBLIC DISTRESS SERVICES IN THE UNITED KINGDOM

In addition to vessels in the vicinity of the distress call, assistance may be rendered by any of the following:

Coast Radio Stations (controlled by British Telecom Int.), who
keep watch on 500 and 2182 kHz. A call is relayed on all frequencies k/cs
to ships at sea and also to shore Authorities by other suitable communication. These stations are mostly able to take radio bearings
of the call on 500 kHz—some can also do it on 2182 kHz. They keep k/cs k/cs
H.M. Coastguard informed throughout.

The Royal National Lifeboat Institution is maintained by charity.
Each of the 120 off-shore boats has R/T operating on 2182 kHz. All k/cs
are fitted with VHF/FM and MF radio together with VHF and MF radio direction-finding equipment.

Her Majesty's Coastguard is a life-saving organisation which keeps a radio watch at 99 centres on VHF Channel 16. The area covered extends from the UK west to 30° West and between 45° and 61° North.

The Royal Navy provides search vessels, aircraft, and helicopters.

The Royal Air Force provides a similar service to the Royal Navy. They are primarily responsible for service and civil aircraft casualties, although they extend their service to all persons when able to do so.

Air traffic control centres, which assist in gathering and relaying search data.

Lloyd's are notified of casualties by Coast Radio Stations, and are then responsible for informing ocean-going tugs.

Officers of the Fishery Departments, who contact the Coastguard when fishing vessels are overdue.

DUTIES OF MASTER

A Master, or person in charge of a vessel, must assist every person at sea in danger of being lost, even if that person is from an enemy State. He must do this so long as there is no serious danger to his own ship, passengers, or crew. As soon as he receives the distress call, he must proceed as quickly as possible to the distress area and indicate his intentions to the distressed person or persons. He may be exempted from going if:

(1) he is unable to do so; or
(2) he considers it unreasonable; or
(3) he considers it unnecessary; or
(4) he is released from the above statutory obligations.

The Master of a vessel in distress may *requisition* a ship which has answered his call. That ship must then proceed to him with all speed. Masters are released from their obligations to render assistance as soon as they hear of other ships being requisitioned (provided the latter are complying), or when they are officially informed that assistance is no longer necessary.

If the Master fails to abide by these statutory requirements he is guilty of a misdemeanour. If he does not render assistance, the Master of a British ship registered in the United Kingdom must enter his reasons in the Official Logbook. Every distress message received must be entered in this Logbook.

VESSELS IN DISTRESS

Signals to be used are:

(1) A gun or other explosive signal fired at intervals of about a minute.
(2) A continuous sounding with any fog signalling apparatus. (The DOT suggests that this is unwise, and recommend that SOS should be made continuously on the apparatus.)
(3) Rockets or shells throwing red stars, fired one at a time at short intervals.
(4) SOS made in the Morse code on the W/T apparatus, or by any other signalling method.

(5) The spoken word 'Mayday' transmitted by R/T.
(6) The International Code flag signal 'NC'.
(7) A signal comprising a square flag having above it or below it a ball, or anything resembling a ball. (This is called the *distant signal.*)
(8) Flames on the vessel such as a burning tar barrel. (The DOT recommend that rockets or red flares are much more efficient.)
(9) A rocket producing a red flare on a parachute, or a red hand flare.
(10) The auto-alarm signal in W/T or R/T.
(11) An orange smoke-signal.
(12) A vertical motion of a person's extended arms.
(13) Signals transmitted by an Emergency Position Indicating Radio Beacon. (See page 370.)

Distress Rockets and Flares

Ships of Classes 1 and 7 are required to carry twelve rockets, each ejecting a red flare on a parachute. Vessels of certain other classes may instead carry red hand-flares, each throwing five red stars to 45 m altitude. 150 ft

Line-throwing and distress rockets, red flares and smoke signals should be renewed three years after manufacture. The condemned ones may be jettisoned in deep water well away from coasts to guard against the possibility of their being washed ashore.

Use of Distress Signals

No distress signal is to be used for any other purpose. The use of signals which are likely to be confused with distress signals is prohibited. Distress signals are to be used only upon the Master's orders, and then only if (*a*) his ship is in serious and imminent danger, or (*b*) another ship or aircraft is in similar danger and cannot itself use a signal, or (*c*) if assistance is required additional to that already available.

The signal must be revoked if assistance is no longer required. Failure to do this may cause unnecessary waste of time and anxiety to other persons.

Procedure for Transmitting Distress or Urgency Signals

Frequencies used are 500 kHz (W/T) and 2 182 kHz (R/T). Any other frequency may be used, however, provided assistance will be summoned more quickly on that frequency. The W/T alarm signal is automatically keyed and sends twelve dashes in one minute. This operates the auto-alarms of other ships. It indicates to ships and coast radio stations that k/cs k/cs a distress call is about to be transmitted. It is immediately followed by SOS sent three times to operate certain other auto-alarms. Then follows the W/T distress call after a period of 2 minutes which allows operators to stand by. The call consists of SOS sent three times, followed by the word 'DE', followed by the ship's call sign sent three times. Then follows the message, which consists of the ship's name, position, nature of distress, and assistance required. Included in this, for a vessel drifting, would be the estimated rate and direction of drift. Lastly, there should be sent two 10-second dashes to enable radio bearings to be taken. Other signals, visual and sound, should be used also, in darkness and poor visibility.

The R/T alarm signal consists of two tones transmitted alternately and automatically over a period of 30 seconds. After 2 minutes the R/T distress call should be sent consisting of the distress signal 'Mayday' spoken three times, followed by the words 'This is', followed by the ship's name spoken three times. The distress message is then sent as for W/T.

The W/T Urgency Signal

XXX in the Morse code, repeated three times, and the spoken word 'PAN-PAN' three times on R/T, are used to indicate an urgent message regarding the safety of the ship or a person on board, or within sight. It does not necessarily indicate imminent danger or the need for immediate assistance.

This signal has priority over all signals other than distress signals. It is only used as a general signal (to no specific address), when a Master uses it to warn ships and stations that he may shortly have to use the distress signal. In such cases the signal must be revoked if precautionary action on the part of other persons becomes unnecessary.

ASSISTANCE AVAILABLE FROM AIRCRAFT

Aircraft can assist by dropping markers, smoke or flame floats, and survival equipment, consisting of a nine-person rubber dinghy and two bags of supplies. They can carry out an air search, locate a casualty, keep it under observation, and guide surface craft to it. Flying-boats may be able to alight and pick up survivors. Helicopters may also pick up survivors.

Use of Search and Rescue Helicopters

These can rescue 10 to 18 survivors depending on the type of machine. Some carry Decca Navigator equipment. They do not normally operate more than 450 km from base, and have VHF and/or UHF radio and perhaps 2182 kHz R/T. The ship approached by the helicopter should:

270 miles

(*a*) Use an orange smoke signal to indicate herself, or alternatively
(*b*) use a signalling lamp to give a steady light.
(*c*) Head the ship according to the pilot's recommendations. The helicopter will approach from leeward. The chosen area of deck should be marked with a yellow circular patch 5m in diameter.
(*d*) Tow a man to be rescued, astern, in a boat on a long painter, if the helicopter cannot pick up direct from the ship.
(*e*) Never secure the winch wire or allow it to become fouled.
(*f*) If on fire, have the wind about 2 points on the port bow.
(*g*) Indicate surface wind direction with flags, etc.
(*h*) Do not touch the winchwire until it is earthed.
(*i*) Clear all loose gear from the transfer area.

The helicopter will recover a man in the water by:

(1) Lowering a strop to him on the winchwire (if he is able to help himself), or
(2) lower a crew member from the helicopter to the man if he is helpless.

In bad weather the Hi-line technique may be used whereby the winchwire is extended using a rope messenger. Once this is lowered to the deck and in hand, but not secured, the helicopter will move to the side and descend, paying out the wire as it does so, until the hook and strop are on deck.

AIRCRAFT

Radio is not carried by all civil aircraft. An aircraft distress call will normally be transmitted by radio on the frequency in use at the time between the aircraft and the appropriate Air Traffic Control Centre. If unable to make contact, the aircraft may use any other frequency to alert any D/F station. In addition, if possible, the call will be made on 500 kHz.

Distress Signals

(1) By W/T on 500 kHz 'SOS' sent three times, followed by 'DE', then the call sign sent three times, the position, nature of distress and type of assistance required.
(2) By R/T, the word 'MAYDAY' spoken three times, followed by the call sign sent three times and then the information as in (1) above.

(3) Visually, a red pyrotechnic light or lights, a red parachute flare, or the group 'SOS' on signalling apparatus.

Merchant ships will normally be informed of aircraft casualties at sea by Coast Radio Stations, broadcast on 500 kHz or 2182 kHz. Ships may instead become aware of the casualty by

(*a*) Picking up or intercepting calls made by the aircraft on 500 or 2182 kHz or on VHF Channel 16, or
(*b*) by hearing and finding the direction of the 500 kHz transmission made from a survival craft or
(*c*) by picking up messages from Search and Rescue (SAR) aircraft.

An aircraft which has located a casualty, or ship or aircraft in distress, may notify ships in the area by passing a message in plain language on a signalling lamp prefixed by the group XXX. It may also to attract a ship's attention,

(*a*) Fire a succession of white pyrotechnic lights, and/or
(*b*) repeatedly switch the landing lights on and off, and/or
(*c*) repeatedly and irregularly flash its navigation lights.

If the aircraft wishes to guide the ship to the casualty or distress area, it may fly low around the ship, or cross ahead of her at low altitude, opening and closing the throttle or changing the propeller pitch. (To cancel any instructions, the aircraft may carry out this procedure astern of the ship.) The aircraft will then fly off in the direction in which the ship is to be led. British pilots will rock their wings when flying off towards the casualty. The ship should acknowledge all these messages by sending a series of 'T's in the Morse code. The ship will either follow the aircraft or indicate by visual means or radio that she cannot comply.

Search and Rescue aircraft, when searching for survivors, will fire green pyrotechnics. These will obviously be answered by distress flares (or other visual signals) from the survival craft.

Safety Signals

Aircraft may transmit messages concerning the safety of navigation as follows:

(*a*) By W/T, the call is prefixed by the group 'TTT' sent three times in the Morse code, followed by 'DE' sent once and then the call sign transmitted three times.
(*b*) By R/T, the call being prefixed by the word 'SAYCURITAY' spoken three times, followed by the call sign.
(*c*) By signalling lamp.

General Information on Aircraft

Navigation markers, or low flying, do not in themselves indicate distress signals. Aircraft survivors in rubber dinghies will indicate their predicament by using red-star pyrotechnics, heliographs, flashing SOS on a lamp or torch, using bright-green surface dye, or flying a yellow kite supporting the radio aerial.

Aircraft often sink rapidly a few minutes after ditching at sea, and rescue ships should make all speed to the area. Ships' Masters should discuss the best procedure as to rescue while on their way to the area. If the ship receives the distress signal direct from the aircraft she should take a radio bearing of it and send this, her position, and her intended action by radio to the nearest Coast Radio Station.

All rescued survivors should be questioned as follows, so that full information as to other possible survivors may be obtained:

(1) 'Did you bale out or ditch? What was the date and time?'
(2) 'At what altitude did you bale out?'
(3) 'How many others baled out?'
(4) 'How many persons were in the aircraft when she ditched?'
(5) 'How many people were present after ditching?'
(6) 'How many did you see in the water?'
(7) 'What buoyancy gear had they?'
(8) 'How many persons were originally in the aircraft?'
(9) 'What caused the casualty?'

If an aircraft is forced to ditch the Captain of the aircraft will be greatly assisted in locating a ship if she:

(1) Assists with homing bearings, or transmits a continuous signal so that the aircraft may use its radio direction finder, or
(2) makes black smoke by day, or
(3) directs a searchlight vertically upwards by night.
(4) Provides a lee; this may be done by steaming in a circle and spreading vegetable oil.
(The aircraft will usually ditch—a dangerous and difficult operation—on the starboard side of a ship, since the Captain usually sits on the port side of the plane and has a better view from that side. He will ditch head to wind, but if seas are high he will probably land in the trough.)
(5) Illuminates the sea without dazzle.
(6) Streams six flares or battery-lights, in line astern, 180 m apart. 600 ft
(7) Informs the pilot of surface weather and pressure.
(8) Has a boat ready for launching, boarding nets rigged, and some heaving lines ready.

SUBMARINES

A sunken submarine will try to indicate her plight and position by:

(1) Releasing an indicator buoy.
(2) By firing yellow, white or red smoke candles or pyrotechnics.
(3) By pumping oil to the surface.
(4) By blowing out air.

The Indicator Buoy (Type 0050)

Many submarines, particularly British ones, are fitted with two buoys, one at each end, which can be released from within the vessel. They are
27 in 18½ in cylindrical, aluminium, 68 cm in diameter, 47 cm deep, and have
6 in 3000 ft a freeboard of 15 cm. A stirrup attached to the sides carries up to 915
of ½-in m of 4-mm galvanised steel wire rope. A light on the top-centre flashes white, once a second, for 60 hours and is visible in good visibility and
1¾ miles darkness up to 3 km with the naked eye. A ring of cats-eye reflectors is mounted around the light. A whip aerial is fitted. Both buoys are painted with high-visibility orange paint. On each is painted a serial number and 'Finder inform Navy, Coastguard or Police. Do not secure to or touch.' For identification the buoy is marked 'Forward' or 'Aft'.
k/cs An automatic radio, operating on 4340 kHz transmits:

Serial Number (three figures)	sent 3 times in 30 seconds
SOS	sent 6 times in 30 seconds
SUBSUNK	sent 3 times in 30 seconds
Long dash	lasting 30 seconds

The message is immediately repeated, the two occupying 4 minutes, followed by a 6-minute silence. An operator on a ship should report this signal at once, indicating signal strength, ship's position, and the bearing of the signal which has to last at least 36 hours.

When finding the buoy the ship should report at once, and if possible give the submarine's name.

If a single buoy is sighted, it is quite possible that it is adrift, but the report must still be made. The buoy may have broken adrift from a submarine which has *not* sunk. It should be weighed by hand to ascertain whether it is adrift, but a boat must not be secured to the buoy or wire.

A vessel finding a moored buoy must stand by, well clear and preferably down tide, with engines stopped and a boat lowered ready to pick up escaping survivors. To warn the crew of a sunken submarine that help is at hand, Naval vessels will drop small explosive charges at least
¼ mile half a kilometre away. Merchant vessels should run their echo-sounding machines, or hammer on the ship's plates below the waterline.

The submarine may then release a pyrotechnic float to indicate her position and to acknowledge these audio signals.

A glass-reinforced plastic buoy has red and white vertical stripes. Type 0060 has the same wire as Type 0050. Type 0070 has 1830 m of wire 3 mm in diameter. These buoys transmit radio signals for at least 72 hours on 8364 kHz and 243 MHz and have more powerful lights.

LIGHT-VESSELS AND LIGHTHOUSES

These are equipped with R/T for the purpose of transmitting distress calls concerning their crews or other persons in distress near by. They also make the following visual distress signals:

(1) rocket(s) throwing red stars accompanied by a detonating signal, a sound rocket, or the firing of a gun; or
(2) the International Code group 'NC' by means of flags; or
(3) the distant signal, i.e. a square flag having either above or below it a ball, or anything resembling a ball; or
(4) a detonating signal, which by night, upon being fired reveals a small, yellow/white flash accompanied by a report. On reaching its ultimate height of about 100 m, a larger similar flash occurs 300 ft
together with a loud, cracking report. By day, the effects are similar except that puffs of white smoke are visible both on being fired and at the zenith of trajectory, the latter volume of smoke being much larger and lingering for some considerable time.

The shore Authorities will reply to these signals;

By day, with an orange smoke signal or three 'Thunderlights' fired at minute intervals or, By night, with three white stars, fired at minute intervals.

These two signals will also be used by lighthouse and light-vessel crews to indicate to persons in distress near by that their plight has been observed.

Danger Signals

Light-vessels, and some lighthouses, may display, or make, any of the following signals:

The International Code flag group 'NF', the single Code flag 'U', or the flashing of the letter 'U' in Morse code on the signalling lamp, or the sounding of the letter 'U' in Morse code on the fog-horn. All these are used to indicate to a vessel 'You are standing into danger'. Attention may be drawn to the flag signals by means of a detonating signal, or the firing of a gun.

The International Code flag group 'PS1', which means 'You should not pass too close to me'.

Communication with Ships by the Crews of Light-vessels and Certain Lighthouses

This may be effected by hoisting the necessary Code flag groups, or by making the ship's call sign in Morse on the signalling lamp, or by flashing the letter 'K' in the Morse code. A light-vessel may also use a white flare, or make 'K' in the Morse code on the foghorn in fog. These signals are not distress signals.

USE OF ROCKET LINE-THROWING APPLIANCES AND LANDING SIGNALS

Under the Safety Convention, life-saving stations will reply to a vessel's distress signal as follows:

By day, with an orange smoke signal or three 'Thunderlights' fired at minute intervals or, By night, with three white stars, fired at minute intervals.

These signals indicate that the vessel has been seen and that assistance will be given as soon as possible.

In many countries the following signals are used when small boats are landing survivors of wrecked vessels:

To mean 'THIS IS THE BEST PLACE TO LAND': by day, a vertical motion of a white flag or the arms, and by night the vertical motion of a white light. A second white light may indicate a direction. Alternatively, a green star rocket or 'K' in Morse.

To mean 'LANDING HERE IS HIGHLY DANGEROUS': by day, the horizontal motion of a white flag, or the arms extended horizontally. By night, the horizontal motion of a white light. Alternatively the letter 'S' may be used in Morse or a red star rocket.

To mean 'LANDING HERE IS HIGHLY DANGEROUS. A MORE FAVOURABLE PLACE LIES IN THE DIRECTION INDICATED': by day, a white flag is moved horizontally and is then fixed in the ground. A second white flag is then carried in a certain direction. By night a similar procedure is carried out with white lights. Alternatively, a white star rocket in a certain direction or 'S' in Morse followed by 'L' or 'R' to mean alter course left or right.

Breeches Buoy and Rocket Life-saving Apparatus

Signalling should be established by radio or Morse lamp, but where this is not possible the following may be used:

To mean '*Affirmative*', i.e. 'Rocket line is held'; 'Tail block is fast'; 'Hawser is fast'; 'Man is in buoy'; or 'Heave away':

A green star signal or, the vertical motion of a white flag or the arms or a white light (at night).

To mean '*Negative*', i.e. 'Slack away'; 'Avast hauling'; or 'Rocket line is not held', etc.:

A red star signal or, the horizontal motion of a white flag or white light (at night) or the arms extended horizontally.

When possible, the Coastguard will fire a rocket across the ship with a line attached, such as an 8-mm hemp line. If the crew of the ship fire a rocket ashore first, the Coastguard will get hold of this rocket-line and then attach a stronger line to it. When they signal affirmative, the crew should heave on their rocket line in order to get this stronger line aboard.

As soon as either the stronger line or the shore rocket-line is held, signal affirmative and then wait for a similar signal from ashore. As soon as it is seen, heave in on the line, and a tailed block with an endless fall rove through it will be hove on board. This is called the *whip* and may be 12 mm fibre rope. A jackstay (about 24 mm fibre rope) will be secured to the becket of the tailed block. The jackstay may be 220 m in length, often with another 135 m which can be secured using a special sleeve which the traveller can pass over. Make the tailed block fast at a convenient position, to a strong point, as far away from breaking seas as possible, with a clear working area around it, making sure that the whip does not chafe on any part of the ship. Cast off the rocket line and signal affirmative. As soon as this is seen, the shore party will set the jackstay tight and haul off the breeches buoy to the ship by means of a travelling pulley. The outhaul of the whip is called the *weather whip*, the inhaul being known as the *lee whip*. While this is being done, the Officer-in-charge should instruct all hands in the procedure for using the buoy. The weight of the body should be taken partly by the elbows on the buoy itself, the person should normally face ashore and be prepared to bear off with his feet if crossing reefs or finally surmounting cliffs.

If a *tally-board* is not sent out to the ship with the tailed block or buoy, the Officer-in-charge must make sure that each person leaving the ship is correctly tallied so that he does not finally leave a ship with people still aboard.

The person in the buoy should sit well down and grasp the steadying line. When he is secure signal affirmative, and the Coastguard will haul him ashore and then return the buoy for the next person. Normally all women, children, passengers and helpless persons should be landed before the crew but if communications are difficult between ship and shore, it may be sensible if the first person landed is a responsible member of the crew. Most rescue companies will have trained signalmen and be equipped with VHF radio. The breeches buoy is shown in Fig. 6.1.

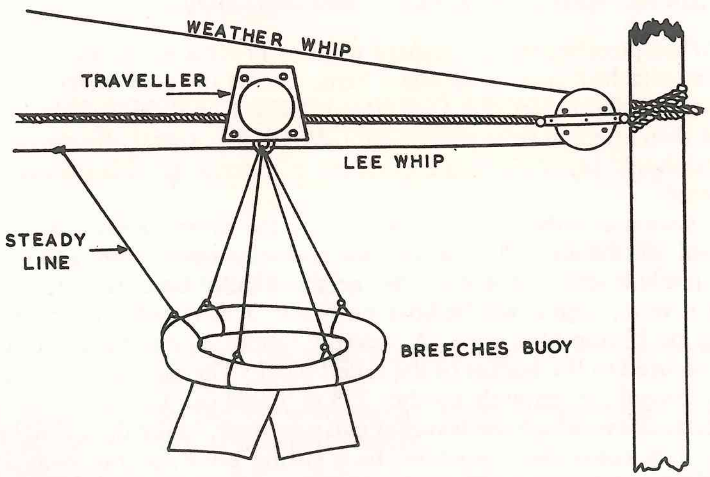


FIGURE 6.1

Use of Rockets for Tankers or Vessels with Flammable Spirit

It may be extremely dangerous to fire a rocket across such a vessel, due to the liability of flammable vapours being present. The rescue vessel should lie to windward of the tanker and fire a rocket only when it has been ascertained that it is safe to do so. When such a risk of ignition exists, the distressed tanker should hoist code flag 'B' at the masthead, use a red light in the same position by night, and supplement these signals in poor visibility by sounding the International Code group 'GU' on the fog-signalling apparatus, which means 'It is not safe to fire a rocket'.

The code group 'GT1' may be used by the rescue vessel since it means 'watch out for my rocket'.

When firing a rocket across the wind it is advisable to aim slightly downwind before igniting the rocket. The wind will then act on the bight of rocket line and deflect the rocket up into the wind. If a direct aim is used this deflection into the wind will probably cause the rocket to miss the target (Fig. 6.2).

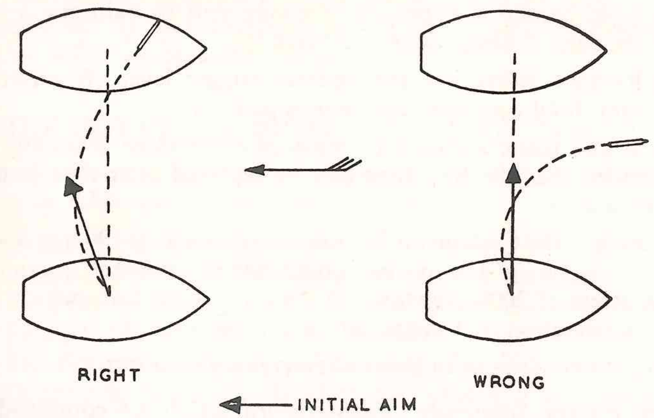


FIGURE 6.2

The Schermuly 'Speedline' International Rocket Apparatus

The Merchant Shipping (Life-saving appliances) Rules require that, among others, ships of Classes 1 and 7 shall carry a line-throwing appliance. These are passenger and non-passenger vessels engaged in long international voyages, and are generally the type of vessel considered in this book. The required range of the appliance is 230 m. 250 yds
The Speedline gear is a completely self-contained unit with two important advantages over the older pistol type of apparatus:

(1) The set of four units normally carried by ships can be dispersed at strategic positions through the vessel.
(2) Each unit can be fired independently as required.

The unit consists of a plastic body/launcher incorporating the handle/trigger assembly, and containing the rocket, igniter and 275 m of ready-flaked line. 900 ft The unit is weatherproof, being sealed at both ends by transparent, polythene caps. This enables the date of manufacture of the rocket and the igniter to be checked without removal. Full pictorial instructions are printed on both sides of the plastic body and can be read by either right or left-handed users.

Plate 1 shows the Speedline unit in relation to the size of an adult hand and also the unit being fired towards a life-raft. Notice that the optional buoyant head is being used in this example. Plate 2 shows the buoyant head about to be fitted.

The unit has been designed for maximum ease of operation as follows:

(1) Remove the front end cap and attach the free end of line to a strong-point.

(2) Hold handle horizontally, allowing unit to naturally assume the correct firing angle (see Plate 1).

(3) Remove safety pin and squeeze trigger lever. When rocket fires, hold container until line is paid out.

Rockets and igniters should be replaced every three years and it is recommended that the Speedline unit be replaced after nine years in service on a ship.

13 in 7·5 in The length of the container is 330 mm, the diameter is 190 mm and the
10 lbs total weight is 4·6 kg. The line has a diameter of 4 mm and a minimum breaking stress of 2000 Newtons. (A Newton is the force which gives 1 kg an acceleration of 1 metre per second per second.)

Other equipment for use in times of emergency comprise:

The Pains Wessex Schermuly 'Manoverboard' which is a combined day and night marker, safe to use on oil or petrol-covered water. It is designed to be attached to lifebuoys by means of a lanyard, and when released it indicates its position by dense orange smoke and two water-activated lights at 3·5 candela. It can also be connected to a bulkhead-mounted lifebuoy and released manually. It produces orange smoke for 15 minutes and the two lights burn for 45 minutes (Plate 2).

The Pains Wessex Schermuly 'Buoysmoke' is similar to the *Manoverboard* signal but without the electric lights. It would be used where it is desired to install separate light and smoke signals. The mounting brackets fit both signals (Plate 2).

The Pains Wessex Schermuly 'Pinpoint' is a hand-held red distress flare for use in lifeboats or life-rafts. It burns for 60 seconds at 15,000 candela,
9 oz 10 in weighs 260 grams and is 245 mm long. The flare is encased in a steel tube and is fitted with an integral twist-and-strike firing mechanism in the handle, which is simply rotated until two arrows align. The end of the handle is then struck a sharp blow with the palm or on a hard surface. The flare is held up, outboard and pointing downwind.

The Pains Wessex Schermuly 'Para Red' is a hand-held distress rocket which conforms to the requirements for both ship and lifeboat/raft
980 ft rockets. It ejects a parachute-suspended red flare at a height of 300 metres when fired vertically and which burns for 40 seconds at 40,000
164 ft candela. It burns out at 50 metres above sea level. Both end caps are

removed together with the safety pin. The signal is then held firmly, the trigger lever is squeezed and the signal is pointed slightly downwind. In low cloud conditions, the rocket should be fired at 45 degrees elevation to give maximum visibility.

The Pains Wessex Schermuly 'Lifesmoke' is safe to use on petrol or oil-covered water. It has a metal case and releases dense orange smoke for 3 minutes with a simple cord-pull ignition.

THE INFLATABLE RUBBER LIFE-RAFT (Plates 3 and 4)

On abandoning ship into this type of craft, the following actions should be taken but not necessarily in this order:

(1) Rescue survivors in water and take aboard if possible.
(2) Inflate the floor in cold weather and top up buoyancy chambers.
(3) Take charge of all sharp objects, especially belts with sharp buckles. Examine footwear for similar hazards.
(4) Bail dry and carry out repairs to chambers. Plug leaks.
(5) Connect up to other rafts which may otherwise drift away.
(6) Search for missing persons.
(7) Issue anti-seasickness pills.
(8) Distribute crews evenly and bunch together for warmth.
(9) Rig emergency transmitter if aboard.
(10) Give first aid and make casualties comfortable.
(11) Watch for frostbite and hypothermia.
(12) Collect useful flotsam.
(13) Identify bodies and cast adrift, having removed useful objects.
(14) Take charge of weapons, potential or otherwise.
(15) Post lookouts.
(16) Rig lights and close weather canopy.
(17) Take charge of pyrotechnics.
(18) Rig the sea anchors. Start collecting rainwater.
(19) Issue food and water on second day. Sick and injured may need water earlier. Reserve one sponge for mopping up condensation.
(20) In a closed raft, people wearing wet clothing will soon find that the air becomes saturated and no further cooling of their bodies occurs. A heat balance is achieved. An experiment with seven men in a life-raft showed heat balance occurring after 15 minutes. In fact the temperature then began to rise and at no time, although in very cold conditions, did shivering take place.

These rafts are manufactured from rubberised, abrasion-resistant, nylon fabric, of high-visibility flame or orange colour. They are of three-ply material on the hull, two-ply being used for the self-erecting canopies, which are attached to the automatically-inflated arches or columns. The raft is inflated by carbon dioxide gas contained in a cylinder, or cylinders, attached to the underside of the hull. Inflation is commenced by a pull on the operating cord, which is thereafter used as a painter.

The raft has two main buoyancy chambers, independent of each other, and each capable of supporting the full load of equipment and persons in case of a puncture, so that if necessary the raft can be 100% over-
4 ft² loaded. An area of 0·37 m² is provided for each person that the raft is certified to carry.

The tent formed by the canopies, being of double thickness, provides insulation against extreme temperatures, protection from the weather, but is capable of being opened at each entrance to admit fresh air. At the initial inflation the canopy entrances are open to facilitate boarding. The floor is double-skinned, and inflatable by means of hand bellows. This not only provides extra buoyancy but also insulation from cold sea. In the tropics, by keeping it deflated, the interior of the raft may be kept cool. At each entrance a ladder or step is provided for boarding purposes.

In an emergency it is essential to make sure that the operating cord is well secured to a strong-point, and this should also be regularly checked while at sea. The raft, complete in its container, is then thrown overboard, the cord pulled out to its full length, whereupon a *further* sharp
80 ft pull actuates the inflation process. The length of cord is 25 m, but shorter or longer cords are permitted, to suit the size of ship. Under no circumstances should cords be withdrawn and shortened by ships' personnel. The raft, after about 30 seconds, is sufficiently inflated for survivors to board it, either from the water or directly from the ship. It is not considered good practice to jump on to the canopy. In the past it has caused serious injury to those already aboard. A raft which has inflated in the inverted position, may be righted by standing on the gas cylinder and heaving on the righting-line or straps.

The raft may be manœuvred towards swimmers or other rafts by using the paddles, or else by repeatedly heaving the drogue in the required direction and pulling on it. Casting the drogue is easier if it is weighted, say with a shoe.

As soon as the occupants board the raft the person in charge should examine everybody's footwear to make sure that the soles and heels contain nothing which would damage the life-raft material.

After rescue, the raft should be recovered or else destroyed. If this is not done, the empty life-raft will attract rescuers and cause great trouble and anxiety.

Stowage

The rafts must be stowed so that not only can they be speedily launched but will also float clear if the ship founders before launching is possible. They must be fully protected from paint contamination, rats, heavy seas, salt-water accumulation, funnel-exhaust smoke and sparks, and icing conditions. Passengers and children should be warned of the danger which may arise if the rafts are tampered with. Life-rafts packed in canvas valises may be stored on perforated platforms, gratings, in suitably drained drop-side boxes, or in collapsible deck seats. These boxes should be sufficiently small to prevent chafe and preferably padded on their internal surfaces. The raft is stowed with the lifting handles freely accessible.

All new containers are marked with the last service date, length of painter, maximum stowage height, launching instructions, the maker's name and a serial number. The entire success of the rafts is dependent upon their being released and jettisoned quickly. Some vessels incorporate ramps inclined at least 20 degrees to the deck, at the bulwark or rails, so that the rafts, which are stowed up to three in number on each ramp, can be rolled overside during conditions of adverse list up to 15 degrees. The ramps are fitted with rollers, and the rafts are secured by webbing belts. In some cases each of the three rafts is capable of being released separately. Again, the belts are released with one hand-movement.

The cylindrical glass-fibre container for a single raft is in halves bolted together, each bolt incorporating a shear-pin assembly so that the container bursts open on inflation. Other types use special joints of calculated bursting strengths. A steel carrier can be supplied, bolted to the deck, to which the container is secured by means of a webbing belt and Senhouse slip, with or without a hydrostatic release. With this type of container no further protection is necessary.

The raft should never be stowed vertically, for the gas cylinder will work its way to the bottom of the container and chafe the fabric. The operating cord must be kept secured to the ship, for then, if the vessel founders before the raft can be launched, the buoyancy of the container will pull the cord, actuate the inflation mechanism and, when inflated, the buoyancy of the raft will snap the cord. The cord is designed to snap under a stress of 900 kg, and even some eight-man rafts will have suffi- 2000 lb
cient reserve buoyancy to achieve this. The raft can then float free of the ship. It is imperative that the lashings are cut or cast off (if no hydrostatic release is fitted) before the vessel founders. If this is not done the raft will probably sink with the ship, and still attached to it.

Inflatable rafts must be serviced by appointed agents about once a year. The crew should leave them strictly alone except for checking the lashings, the protection afforded, and the anchorage of the operating cord. At boat drills the method of operation should be clearly explained to every member of the crew.

In the plates a raft is illustrated having a central column. This has the advantages of erecting a canopy having a lesser wind surface than the arch-type raft, providing a back support for persons sitting in the centre of the floor, a foot-brace for others, a virtual pneumatic jack if the raft is inverted, and a smaller stowage volume. This type of raft has an inflated entrance step. A type designed to accommodate twenty-five

399 lb 365 lb persons weighs 180 kg in a glass-fibre container or 163 kg in a canvas valise.

THE R.F.D. TYPE 20 MC, SINGLE-POINT SUSPENSION, INFLATABLE LIFE-RAFT FOR FULLY LADEN LAUNCHING

This raft has been introduced for use in passenger ships, especially those having a high freeboard. Criticism had been levelled at inflatable life-rafts in the past because survivors were required to descend ladders, or to leap from heights, before boarding. The 20 MC raft obviates these efforts, and it is therefore suitable for passengers of all ages and in all states of health.

The raft is inflated at deck level, and by the use of a single-arm davit, is lowered fully laden, by gravity, to the water. Here, it is released automatically. Boarding is facilitated by a flexible apron which serves the dual purpose of bowsing the raft firmly to the ship's side and providing a gangway. The suspension provides the means of recovering the raft, complete with survivors, by hoisting it aboard the rescue ship.

The design of the raft follows standard principles, but it incorporates a special design feature of a built-in, single-point suspension sling. The suspension is designed in the form of web straps, a number of which are secured to the outside of the buoyancy chamber and the remainder to the upper floor surface. The straps cross at the apex of the single column, at which point a single hoisting shackle is fitted. The normal method of launching is not precluded, for if necessary the raft can be jettisoned in its valise and inflated by pulling on the operating cord. The packed raft should be stowed near the davit gear in lockers, seats, or on ramps.

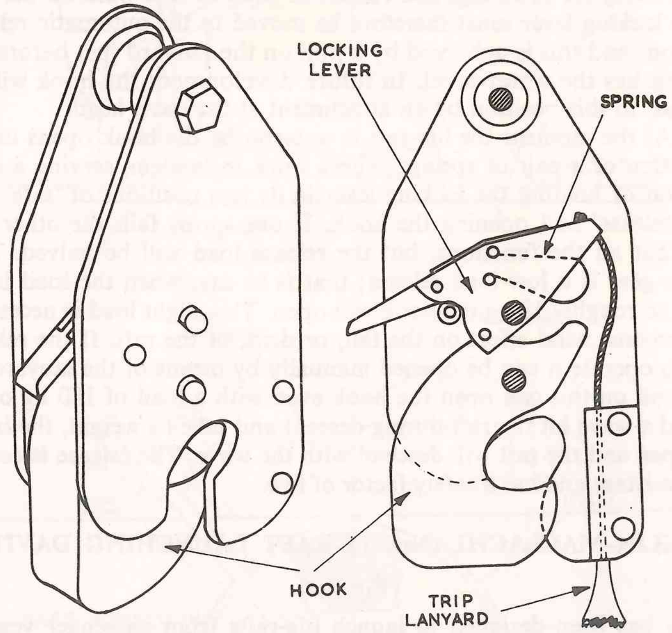
12 ft 6 ft This twenty-person raft has a diameter of 3·7 m, a height of 2m,

308 lb and a weight, in a canvas valise, of 140 kg.

THE R.F.D. LIFE-RAFT RELEASE GEAR

This is shown in Fig. 6.3, and it will be seen that it consists basically of two side plates, a hook, and a locking lever. Since the gear is for use in unfavourable conditions, the operation has been kept as simple as

possible. The D.o.T. required a release which was instantaneous when the full weight of the raft was waterborne, but not so as to jeopardise the safety of the raft and its occupants in the early stages of boarding, should a wave reach the boarding station and take the weight of the raft.



R.F.D AUTOMATIC RELEASE HOOK
SAFE WORKING LOAD 2270 KG

FIGURE 6.3

It was therefore necessary to have the release absolutely safe until boarding was completed and lowering commenced. This necessitated a safety-pin, or the equivalent, which would not be overlooked in an emergency. The release is noticeable in Plate 4.

Method of Operation

(1) The release gear is removed from its stowage adjacent to the davit pedestal, by pulling the lanyard which opens the hook.

(2) With the life-raft at the deck edge, the hook is closed on the suspension shackle protruding from the top of the valise. The action of closing the hook automatically springs over the locking lever and renders the release safe.

(3) The davit fall is raised, inflation of the life-raft follows, and the life-raft is boarded while suspended over the side. The shock of the inflating raft cannot cause the release to open, neither can a wave taking the full weight of the raft.

(4) When boarding is complete the bowsing lines are released and the raft is ready for lowering, and release as soon as it is waterborne. The safety locking lever must therefore be moved to the automatic release position, and this is achieved by a pull on the lanyard just before the raft reaches the water-level. In future development the hook will be 'cocked' to this position by an attachment at the davit head.

(5) At the moment the life-raft is waterborne the hook opens under the action of a pair of springs. These work in tandem, serving a dual function of holding the locking lever in its two positions of 'safe' and 'auto-release' and opening the hook. If one spring fails the other will carry out all the functions, but the release load will be halved. This release gear is a low-load release; that is to say, when the load is re-
40 lb duced to roughly 18 kg the hook will open. This slight load is necessary to overcome wind effect on the fall, or drift, of the raft. If the release fails to operate it can be opened manually by means of the lanyard. A
400 lb hard pull on this can open the hook even with a load of 180 kg on it. Should a wave hit the raft during descent and take its weight, the hook will open and the raft will descend with the wave. The release is corrosion-resistant and has a safety factor of five.

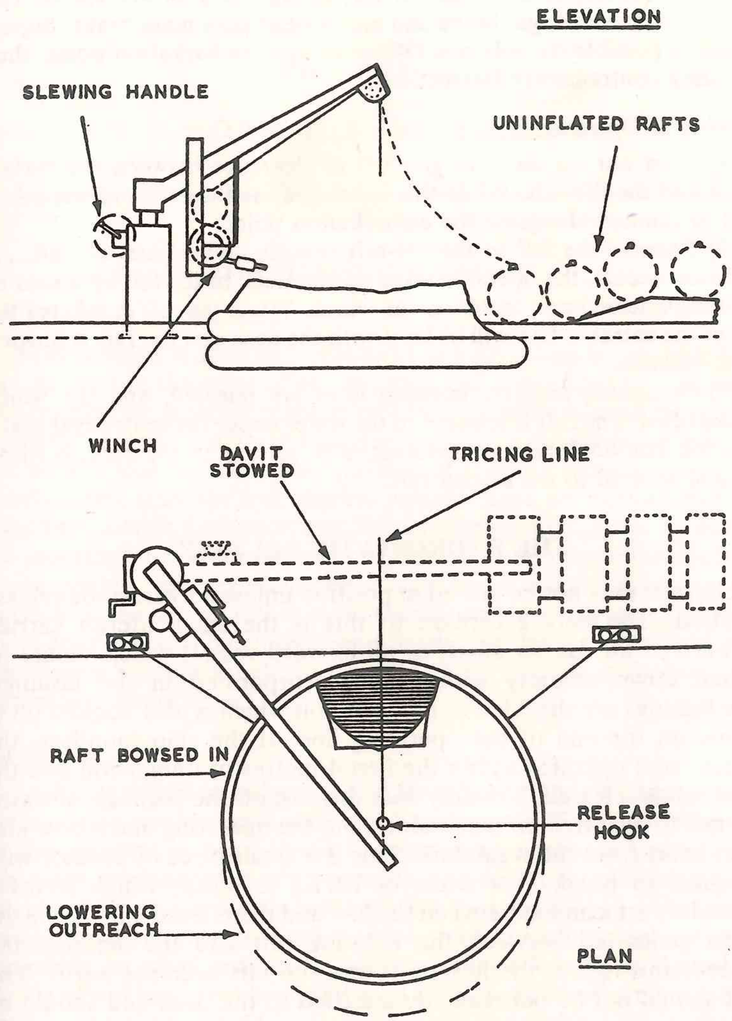
WELIN-MACLACHLAN LIFE-RAFT LAUNCHING DAVIT

(Fig. 6.4)

This has been designed to launch life-rafts from passenger vessels, where speed, safety, and the minimum of operation requirements are of paramount importance.

The main feature is the automatic return of the fall from the water level, after the raft has been released. The automatic-release hook ensures that the operator will not be expected to observe the raft after
40–50 ft it leaves the embarkation level for the water, which may be 15 m below. The automatic fall-recovery ensures that there is no chance of the hook thrashing after the raft is released, or remaining at the water-line, or on a downward course to damage the life-raft canopy, or other rafts.

The recovery works on the spring-blind principle, the energy created
60–90 ft by the lowering raft (at 20–30 m per minute) is used to recover the fall
200–300 ft at a speed of 60–90 m per minute until it reaches a pre-arranged position where it is stopped automatically. During the entire loading and launching operation the davit head remains outboard, and only the hook is pulled inboard by a tricing line to attach the following raft.



WELIN-MACLACHLAN LIFERAFT DAVIT

FIGURE 6.4

Manual recovery is also allowed for, though at a slower speed. The winch has a centrifugal brake and also a dead-man main brake. Supervision is possible by only one Officer at each embarkation point, thus avoiding contradictory instructions.

Method of Operation

1 ft (1) Turn out the davit to give 0·3 m clearance between the curtain plate and the life-raft. While this is being done the rafts are unpacked and positioned alongside the embarkation point.

(2) Connect the fall to the life-raft shackle and inflate the raft. As inflation occurs, the operator takes up the slack in the fall by means of a spring-release hand crank on the winch. When the raft is inflated the sill of the entrance flap will be level with the deck and the raft is bowsed in to bollards.

(3) Occupants embark, bowsing lines are released, and the winch brake lifted. The raft is lowered to the water under the centrifugal brake control. The hook releases automatically, returns to the deck, is triced in, and secured to the second raft.

THE HYDROSTATIC RELEASE

Liferafts may not be lashed in position unless a hydrostatic release is fitted. The only exception to this is the small liferaft carried forward or aft (on an all-aft or all-forward vessel) which should be lashed down securely with a slip incorporated in the lashings. The lashings are shackled to the drawbolt which is also hooked on to a ring on the end of the operating line. If the ship founders, the release unit operates within the first 4 metres of immersion and the drawbolt is released. Not only does this cast off the lashings, allowing the raft to float free in its container, but the operating line is now also free, apart from the weak link. This is a small piece of cord or wire designed to break at a stress of 227Kg ± 45Kg, which forms a secondary attachment between the line and the release unit. Once the stress generated between the inflating raft and the sinking ship exceeds this figure, the link parts and the raft becomes adrift. The unit should not be permanently attached to the deck and should be surveyed annually, unless it is of a type which is discarded after an expiry date. Each should be marked with the date of manufacture, the depth at which it will release and an expiry date, if any.

CHAPTER VII

DAMAGE CONTROL

(1) COLLISION DAMAGE

(a) At Anchor or Moorings

When a vessel is anchored or secured to buoys there is very little that can be done in the event of an imminent collision except to veer away on the cable, or mooring wires, as rapidly as possible and use the rudder (if there is a current) to sheer the vessel away from the danger or to make the blow a glancing one. The question of slipping moorings or cable hardly arises, since the task requires valuable time, and further, engines must be available for instant use. Should it be possible, however, to slip the mooring wires from the bitts very rapidly or to release the windlass brake quickly, this may prove beneficial in that it will allow the vessel to move with the impact rather more than if she were still secure. Watertight doors should be closed immediately the danger is realised and Emergency Stations should be signalled. The rapid use of fenders is of paramount importance.

(b) At Sea

Lookouts should be ordered to hail the Officer of the watch every half-hour or else communicate with him by telephone. They should report to him personally when relieved. In vessels where bells are made during the night the lookout is often instructed to repeat them either on the telephone or on the crow's-nest bell. The lookout should report every navigation mark, light, and unidentified object either by telephone or by indicating on a bell once, twice, and three times for objects sighted on the starboard bow, port bow, and dead ahead respectively. In low visibility extra lookouts should be posted forward and aloft—particularly the latter if the fog is low-lying.

In anchoring depths both anchors should be let go when collision is imminent. They may both be lost, but a collision may well be averted. It is better to lose both and *avoid* a collision than to lose one and *have* a collision. On the other hand, the Officer of the watch should bear in mind the fact that the use of one anchor may well cause a beneficial sheer away from the danger, resulting in a glancing blow. In narrow waters it may also be preferable to run the vessel aground and so avoid damage to both ships. This should be done by driving ashore head-on to avoid damage to the bilges and after part of the ship, where damage is difficult to repair. Impact should be reduced by astern movement of the engines and the use of both anchors.

If collision is unavoidable the blow should be made a glancing one; bow to bow, quarter to quarter, or bow to quarter. If direct impact is inevitable the other vessel should if possible be struck forward of her collision bulkhead. The latter can then be shored up, the vessel trimmed by the stern, and slow headway resumed. If a vessel is struck amidships in the region of her largest compartments, serious and disastrous flooding may occur.

The Law

Under the Merchant Shipping Act the Master or person in charge of a vessel involved in a collision shall, provided there is no danger to his ship, crew and passengers render to the other vessel all possible assistance to save the ship and her complement from danger arising from the collision. He shall stand-by until such assistance is no longer necessary. The Masters, or persons in charge, shall also:

(i) Exchange names of vessels.
(ii) Notify each other of ports of registry, departure, and destination.
(iii) Enter a witnessed statement in the Official Logbook.
(iv) Notify the Department of Transport (D.o.T.) within 24 hours of arrival at the next port.

After Impact

(1) Close all watertight doors and inform the engine-room of the situation. Emergency Stations will enable fire, boat and damage control parties to be briefed.

(2) It is to be hoped that in the event of a collision, both ships will be going full astern before impact. If a ship strikes another bow-on she should then stop engines and, if the sea is slight, remain embedded in the gash to allow the other ship time to assess damage, prepare for more flooding or to abandon the vessel. If one ship is a loaded tanker, withdrawal (which on occasions is not possible anyway without the help of tugs or other ships) can be extremely hazardous due to friction and sparking. Drenching with foam may be advisable followed by a total evacuation of personnel from the impact area. In anything other than a slight sea, the movement of the two ships may widen the gash and produce massive sparking. Bear in mind that the Master of a ship which holes a tanker cannot be expected to remain embedded. He has a clear duty to his own ship, crew and passengers

which may be seen as an immediate withdrawal regardless of the other ship's safety.

(3) Swing out lifeboats, ensure that no premature abandonment takes place, and prepare liferafts.

(4) Check for casualties and missing persons. Muster passengers.

(5) Hoist appropriate shapes and show correct lights. (Rule 27)

(6) Ascertain whether anchors and cables will still function.

(7) Transmit MAYDAY or PAN-PAN signals. Even if not in distress, the use of a PAN-PAN does alert shipping to a possible future distress call.

(8) Report any oil pollution to the nearest coast radio station.

(9) Assess own ship's damage, including the possibility of sprung hatches, and sound round. Commence damage control, counter-flooding or pumping. Little damage control is possible on modern ships and some of what follows in this chapter is now of historical interest only. Even so, a 1 sq. m hole situated 4 m below sea level, will admit 21,600 tonnes of water per hour. The flow is proportional to the area and the square root of the depth of the hole. Thus if the hole can be raised, the flow is reduced. It can be halved by half-plugging the hole. Unfortunately the mechanics of flooding are such that the depth of the hole is likely to increase as the situation changes adversely.

It should be decided quickly:

(*a*) whether the pumps can cope with the initial inrush;
(*b*) if they cannot, whether plugging is rapidly possible.

If in the latter case the decision is negative, then the vessel must be abandoned if it is considered that bulkheads are liable to collapse under the pressure of water in the flooding compartments. No dogmatic statement can be made with regard to the abandoning of ships—the matter is entirely in the hands of the Master or person in charge. The possibility of bulkheads holding and the ship remaining seaworthy should be considered however.

Collision Mats (Historical Interest)

These may be made of thick rope; they vary between 3 and 4 m 8 and 12 ft square, and have a cringle spliced into each corner to which bottom and top lines are secured. Some are made of several layers of canvas, plain on the outboard side and having *thrumbs* on the inboard side. Thrumbs are pieces of yarn pulled through the canvas so that their bights protrude to give a soft, cushioning effect. There are patent collision mats available of canvas construction with thrumbs, but having several galvanised-iron bars secured across their length, parallel to one another. These bars not only assist in the rigging and storing of the mats but also bear against the damaged plating, thus stiffening the mat.

A collision mat could be made from several thicknesses of canvas—such as tarpaulins—edged with rope, and having wire rope seized around the edge to give stiffening. The making of such a mat on board a damaged ship would be subsequent to at least partial plugging of the hole. The mats are primarily intended for below-water gashes, the idea being to rig the mat as rapidly as possible so as to bring the inflow of water under the control of the pumps. It is not suggested that their use will stop the inflow—there will be edge-leaks and also seepage to contend with even after the mat has been rigged as efficiently as possible. They are used on the assumption that the damaged plating has been turned inwards, the mat being unrolled over the outer plating. Long
1½-2-in lengths of 12–16-mm wire rope (*bottom lines*) are passed over the bow, under the forefoot, and dragged aft to the gash—let us assume the latter to be on the port side. The starboard ends of the lines are manned on deck and the port ends secured to the cringles on the bottom of the mat. Two similar *toplines* are secured to the cringles on the top of the mat and led well forward and aft, and belayed.

The mat, which has been kept rolled up, is now lowered over the side to the top of the gash (easing on the toplines), and is unrolled over the gash by heaving on the bottom lines from the starboard side. All lines are then set up very tight. It is absolutely essential to keep the bottom lines bar tight throughout the operation—a little imagination will assist the reader to visualise an underwater gash with water pouring through under great pressure—the slightest easing of the lines will cause the mat to be swept into the gash and ripped. Possibly the compartment has ceased to flood, so that pressures within and without are equal. The rigging of the mat is then simplified. However, as soon as the pumps begin to reduce the level within the compartment, a pressure on the outside of the mat will begin to form, increasing as the level is lowered in the compartment. The mat must be able to withstand this maximum pressure.

Temporary Repairs

When estimating the extent of damage it should be borne in mind that it is likely to occur at places quite remote from the area of impact; plates may be *set up*, rivets may be sheared, pipes may be fractured, and the pumping system damaged. Bilges and tanks should be sounded throughout the vessel after collision and repeated continuously until deemed no longer necessary.

A gash above the waterline will have to be closed either with a collision mat or with a *patch*. Salvage personnel use these patches on underwater damage, but this is not possible in the case of a vessel damaged at sea and with no divers available. It says much for the crew of one ship, however, who actually *made* a diving-suit from canvas, sufficiently ill-

fitting to contain air for two or three minutes diving at a time, not to a very great depth of course.

A well-made patch is within the scope of most ships—it takes time to construct, but this will not matter, since the gash is above the water-level. Some of these patches have been so effectively made and fitted

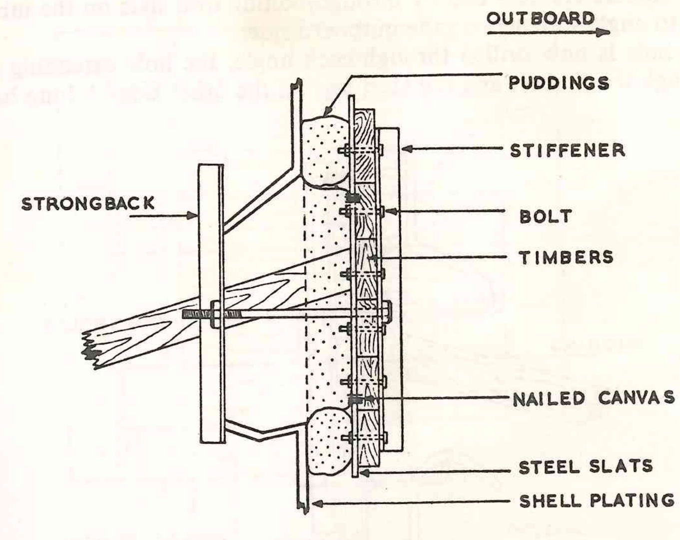


FIGURE 7. I

that a Certificate of Seaworthiness has been issued by Lloyd's surveyors. The materials necessary are now listed. (It is assumed that the Engineers can supply an electric drill and a few nuts, bolts, and a hacksaw with which to remove a few pieces of angle-iron from where they will not be missed for the time being.)

A large piece of strong canvas;
several lengths of uniform timber;
a quantity of oakum, cotton waste, or jute;
galvanised nails;
some steel slats;
nuts and bolts;
several pieces of angle.

The canvas is spread on the deck—the area of the canvas must be considerably larger than the area of the gash. The timbers are cut to size and laid on the canvas. The edges of the timber (all round the rectangle) are now very thickly covered with the oakum or coir, etc., the canvas then being brought over this padding and nailed to the timbers. Better still, long canvas bolsters or *puddings* should be made. These resemble canvas tubes stuffed with oakum. The puddings are then laid along the edges of the timber and the canvas nailed down as before (see Fig. 7.3). The side covered with canvas will be the outer side. The timbers are now tied by through-bolting iron slats on the inboard side to angle stiffeners on the outboard side.

A hole is now drilled through each angle, the hole extending right through the timber, and the steel slat on the other side. A long bolt is

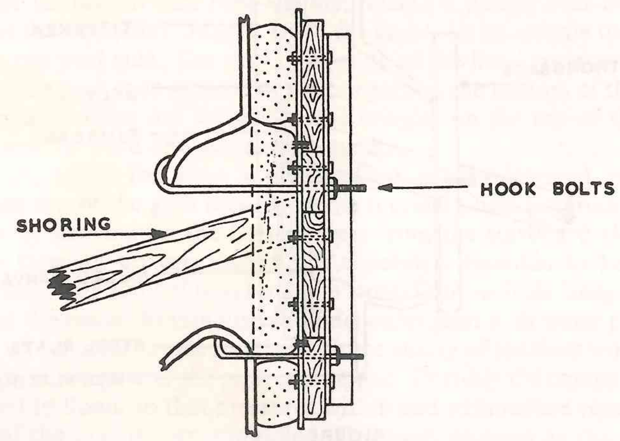


FIGURE 7.2

then procured, or made, to fit each of these holes. The patch is now ready for fitting.

It is placed over the outside of the gash, with the puddings resting on sound plating (see Fig. 7.1). The last piece of angle is now drilled to act as a *strongback* and through-bolted with the long bolts, as shown. The patch should be shored up from within.

If the hole is other than long and narrow, or if the plating is thin, the use of a strongback is not possible. In these circumstances the patch, or *pad* as it is sometimes called, is made in exactly the same way but is hook-bolted to the turned-in plating as shown in Fig. 7.2—again being shored from within the compartment.

The fitting of these patches below the waterline is a matter either for divers or subsequent to beaching. Pads fitted below the water-level will be subjected to severe external pressures when the compartment is pumped out, and for this reason the timber used must be extremely

strong and the patch well shored up from within. From the point of view of the seafarer, who will only be dealing with above-waterline patches, the use of shores is still advisable. Should he, however, find himself in the position of repairing his beached vessel, very careful regard should be paid to the strength of the materials used.

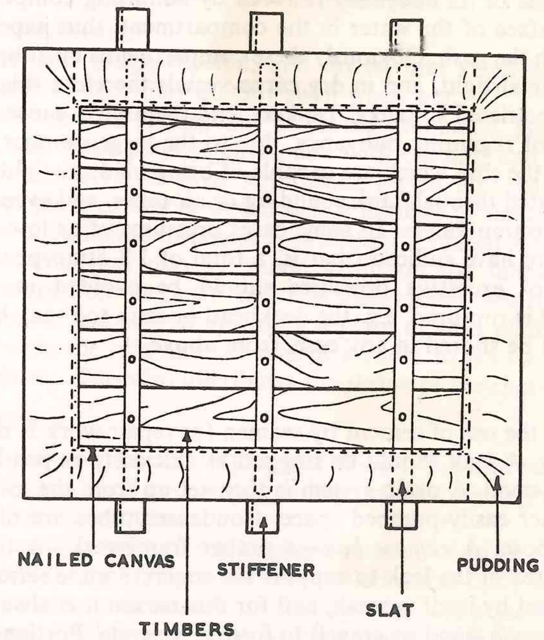


FIGURE 7.3

Permeability

A compartment which is 90% filled with cargo is said to be 10% *permeable*. This is, of course, assuming that the cargo itself is not permeable by water.

A 300 m^3 compartment which is 10% permeable will therefore admit a maximum of 30 m^3 cubic feet of water, i.e. approximately 30 tonnes weight. Further, the presence of cargo will materially assist in preventing the setting-up of decks and tank tops due to water pressure below. It is unlikely that a general cargo, however well stowed, or for that matter any other cargo which normally requires vertical dunnage on the bulkheads, will prevent the collapse of a bulkhead. On the other hand, if the cargo was tightly stowed against the bulkhead and unable to move within itself, then a bulkhead may hold. This is an important

10 000 ft^3
1 000 ft^3
tons

factor when deciding upon emergency plugging of gashes prior to pumping.

Compressed Air

A flooded compartment which for any reason cannot be pumped out may have some of its buoyancy restored by admitting compressed air above the surface of the water in the compartment, thus expelling the water through the gash. Obviously these compartments must be capable of being made airtight, and in dry cargo vessels therefore this practice is normally restricted to tanks. Tankers lend themselves more freely to this method of regaining buoyancy, due to the large number of compartments in the ship which are capable of being made airtight. The air may be admitted through tank sounding or air pipes, and even through the steam-injection valves. In some cases pressures of as low as 0·8 of an atmosphere have sufficed (that is, a total of 1·8 atmospheres). The building-up of excessive pressures should be avoided in case the compartment is ruptured, e.g. the deckhead or tank top may be set up. These should be shored in any case, from above.

Cement

Generally, the use of cement by seamen for repair work is limited to leak-stopping. A leak should be stopped as efficiently as possible until the inflow is small. A drain system is then set up from the leak, to the bilges or other easily-pumped space. Condenser tubes are often used for this purpose. A *cement box*—a timber framework—is then built around the area of the leak to support the concrete while setting.

Cement used by itself is weak, and for this reason it is always mixed with an *aggregate* (sand or gravel) to form a concrete. Portland cement is slower setting than 'Ciment Fondu'. Sand is known as fine aggregate, ½-in and 12-mm gravel is classed as coarse aggregate. The proportions used are: 1 part of cement, plus 2 parts of fine aggregate, to 4 parts of coarse aggregate, all parts by volume. A quicker-setting mixture is 1 part of cement to 1½ parts *each* of fine and coarse. The above mixtures are only a guide, many people having their own firm ideas on this matter, but the proportions submitted here are very effective. Both warm fresh water and washing soda are said to expedite the setting of the mixture. When the water is added to bring the mixture to a working consistency the volume will reduce by about one-third.

As soon as the drain is functioning satisfactorily, the concrete is poured into the box. Once set, the end of the drain tube can be plugged, or else withdrawn altogether, and the hole in the concrete plugged with a suitable piece of soft-wood.

The use of cement is not recommended for leaks in surfaces which are liable to move in a seaway, nor for oily, painted, or greasy surfaces.

Paintwork should be roughened, or else thoroughly cleaned with strong soda solutions. A rusty surface is ideal.

Leaks

For small leaks which do not warrant the use of a patch as described previously, the following equipment is useful:

(1) Cement boxes.
(2) Softwood plugs, tapered, and driven into small holes are very effective, since they quickly swell when wet.
(3) Pieces of steel plating may be placed over small, jagged fractures on the outer plating, cushioned with oakum, and tightened-up inboard using an angle strongback bolted through the plate. A stout piece of timber would suffice in place of the steel, provided it is of sufficient thickness to withstand external water pressures.
(4) A canvas mat may be made, plain on the inboard side and thrumbed on the outer side. It is then placed over the hole, from inboard, and shored up, using a piece of steel plating or timber between the mat and the end of a shore to act as a support or *padpiece*. This also distributes the thrust of the shore.

Sheared Rivets

A rivet hole may be easily plugged using a tapered softwood plug which will soon swell and be gripped by the surrounding metal. Other methods have been used:

(1) Years ago, salvage workers and seamen used an extraordinary method employing what they called a *fish-bolt*, shown in Fig. 7.4. A line was passed out through the hole attached to a piece of rod enabling the line to hang down. A boat's crew would then fish for the rod, hoist it to the surface, attach the fish-bolt and the latter would then be pulled into the ship and fastened. Where there were no bilge keels to foul the exercise, a peg of wood was used in place of the rod, obviating the necessity to fish!
(2) Years ago too, I passed a device around a group of students but it disappeared in transit. Possibly the culprit hoped to brandish it at an Examiner stating that he never travelled without one. The device is similar to a modern wall-fastening and is shown in Fig. 7.5.

   'A' is a metal tube having four cuts in its outboard end 'B', part of the tube being threaded and carrying a nut 'C'. Through the tube runs a rod, threaded, and carrying a nut at its inboard end 'D', having its outboard end conical and of increased cross-section. Its cross-section 'E' is greater than the inner cross-section area of the outer tube.

The bolt is passed through the plating 'F', and the small nut at 'D' tightened. The inner rod moves inboard, its conical end expanding the outer tube against the plating until the fit is watertight. Nut 'C' is then screwed tight.

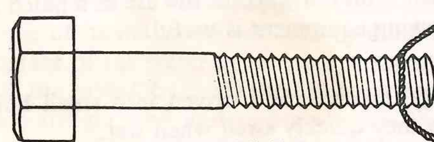


FIGURE 7.4

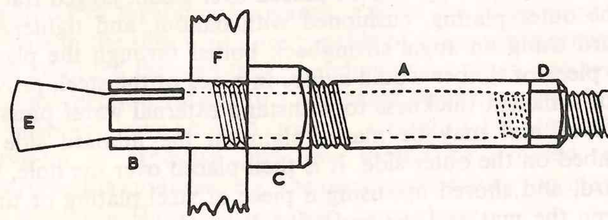


FIGURE 7.5

Shoring

Subsequent to collision damage, Officers should resort to shoring as soon as possible, if considered necessary. Shores are used for supporting damaged or weakened structures, watertight doors, hatches, plating, bulkheads and tanktops under pressure, patches and pads covering fractures, other leak-stopping devices, and for reinforcing decks.

Rectangular vertical areas under pressure, such as doors and bulkheads, should be shored up at a level of roughly one-third of the depth of the water causing the pressure, measured from the base of the structure, i.e. a door under 3 m of water pressure should be shored up 1 m
6 ft 2 ft from the base, on the other side. This is the centre of pressure. The shores should rest on padpieces, flat pieces of wood which distribute the thrust of the shores evenly over their area.

Shores should not normally be longer than thirty times their diameter. Wedges should not be used freely to tighten shores—the use of shores which are *proud* (i.e. longer than an exact fit) is considered a better practice. When resorted to, wedges are used in pairs and hammered towards each other simultaneously. Before rigging shores, oily surfaces should be sprinkled with sand. They are stepped against a rigid structure and not on unsupported plating; a deck should be shored up by stepping the heads and heels of the shores against the beams.

In the absence of rigid parts plenty of padpieces should be used. Shoring should be inspected frequently for signs of loosening. If possible a man should be in constant attendance. Shoring is illustrated in Fig. 7.6.

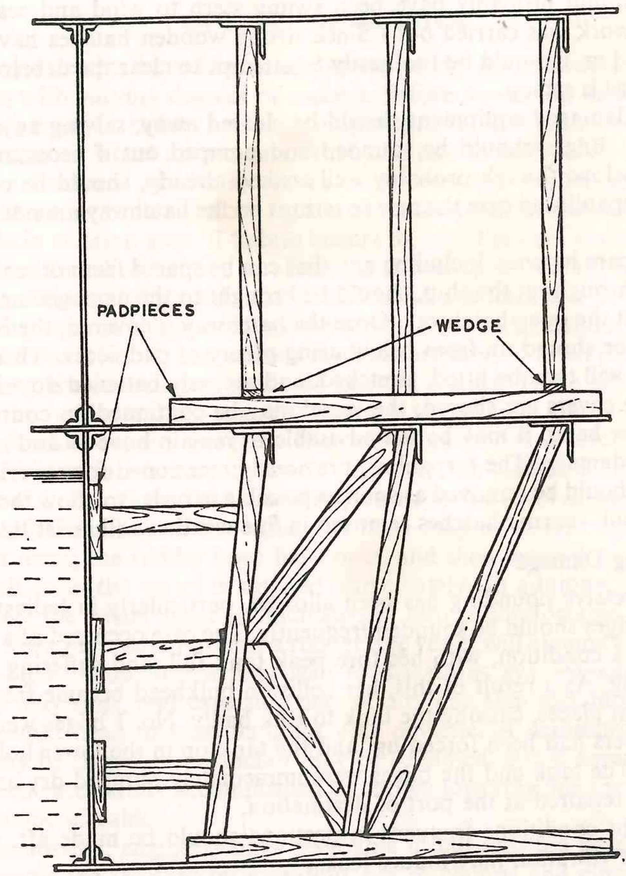


FIGURE 7.6

(2) HEAVY WEATHER DAMAGE

Wooden Hatches

If hatches are stove-in during heavy weather tarpaulins will be ripped and wooden hatches smashed. The locking bars, if fitted, will probably remain intact and rigged. In order to prevent further inrush of water into the compartment, continued loss of buoyancy, and damage to cargo, the vessel should be swung off course so that she lies in as comfortable a position as possible with no water coming aboard at the damaged area. (For example, if No. 1 hatches had been stove-in the vessel would probably have been swung stern to wind and sea while repair work was carried out.) Since strong wooden hatches have been smashed in, it would be foolhardy to attempt to clear the debris before the vessel is swung.

The damaged equipment should be cleared away, salving any whole hatches. Bilges should be sounded and pumped out if necessary; the cargo below, though probably well soaked already, should be covered with tarpaulins in case the new coverings on the hatchway are not watertight.

All spare hatches, including any that can be spared from other 'tween decks throughout the ship, should be brought to the damaged area and cut to fit the open hatchway. Once the hatchway is covered, the hatches should be shored up from below using plenty of padpieces. Three tarpaulins will then be fitted, stretched, and securely battened down. Now that the covers are shored, the vessel may be continued on course. On the other hand, it may be felt advisable to remain hove-to and risk no further damage. The tarpaulins, previously mentioned for covering the cargo, should be removed as soon as possible in order to allow the cargo to dry out—corner hatches removed in fine weather will assist this.

Pounding Damage

If excessive pounding has been allowed, particularly in ballast trim, No. 1 bilges should be sounded frequently. The case occurred of a vessel in such a condition, with her fore peak tank full, and suffering heavy pounding. As a result of this, her collision bulkhead became fractured in several places, causing the tank to leak badly. No. 1 bilges were full, the limbers had been forced up, and the tanktop in the lower hold was awash. The tank and the bilges were immediately pumped dry and the damage repaired at the port of destination.

In light conditions frequent inspections should be made aft, where excessive vibration may induce leaks.

Plating

If plating is leaking at lap joints the crevice may be securely caulked with oakum or similar material. The use of wooden plugs is inadvisable, since it may aggravate the situation. In some cases the lap joint has been drilled through—just as far as the *faying surfaces*, i.e. the plate surfaces which are together, and a stiff mixture of putty injected through the drilling to seal the crevice.

Ventilators

If these are sheared off or damaged in heavy weather, remedial action must be swift, employing wooden vent-plugs and/or canvas. If unnoticed, a bulk cargo could become a *slurry* and shift.

(3) LOSS OF RUDDER

Many attempts have been made at sea to rig up makeshift steering devices with varying degrees of success. Before discussing these, a preliminary word on rudder accidents is appropriate. Should the rudder fail to respond to wheel movements, it may be due to faulty steering-gear, or to a fractured rudder stock. In both cases the rudder should be brought under control before repairs are attempted. In the case of rod and chain steering-gear, if failure occurs in, say, the port steering linkage, then the wheel should be placed hard over to starboard, causing a similar action on the rudder, after which the quadrant can be secured.

In the case of a fractured rudder stock, the rudder cannot be controlled from inboard, and various methods are used to *catch* the rudder, including the lowering overside of knotted chains. These are used to catch the rudder trailing-edge and heave it to one side, after which it is secured while repairs proceed. If a kedge anchor is available it has proved more satisfactory to lower this over the side in a horizontal position, i.e. stock vertical, on wires, down to the level of the rudder. By careful handling of the wires, the fluke may be caught against the rudder arms, the rudder hove hard over, and then secured.

In all cases the vessel is stopped immediately. In addition, in heavy weather, the vessel must be manœuvred into a comfortable position while work proceeds. Without a rudder, the vessel will assume a position beam-on to wind, which may lead to disastrous *synchronous rolling*. Cargo may shift, and capsizing may occur. The ship should therefore be brought head to wind as quickly as possible. A makeshift mizzen sail may be rigged, a sea anchor may be streamed, but in some cases it has been successfully accomplished by simply lowering one anchor on a long scope of cable.

Occasionally, engineers have been able to cut into the rudder trunk and repair the fracture by ingenious use of clamps and circular steel bands. This method is generally limited to fractures which extend over a good length of stock. If the fracture occurs below the stuffing box the method cannot be used unless the vessel can be trimmed sufficiently by the head.

Jury Rudders

When steering with such a device, speeds should be slow, and as soon as the sea or weather conditions deteriorate, the vessel should be hove-to. This will avoid excessive stresses on the *steering machine*.

The basic idea of a rudder is that it shall provide resistance to the water on one side of the ship in order to turn the bow *towards* that side. For this reason, any contrivance which fulfils this function may be used as a jury rudder. It is most important to note, however, that what suits one vessel very well indeed, may prove quite valueless on another. Many of the well-known and successful jury rudders have been copied on other vessels and have proved useless. Rigs described for ships with counter sterns may be totally unsuited for cruiser-sterned ships. Again, some rudders can be quite satisfactorily made for small ships, but when copied on larger vessels may prove to be of inadequate strength despite the larger gear available.

In twin-screw ships the vessel may be steered by running one engine at constant revolutions and varying those on the other engine. On single-screw ships the seaman must try every method at his disposal. Some very long voyages have been made under jury rudder, but the gear must be constantly nursed, and the temptation to increase speed

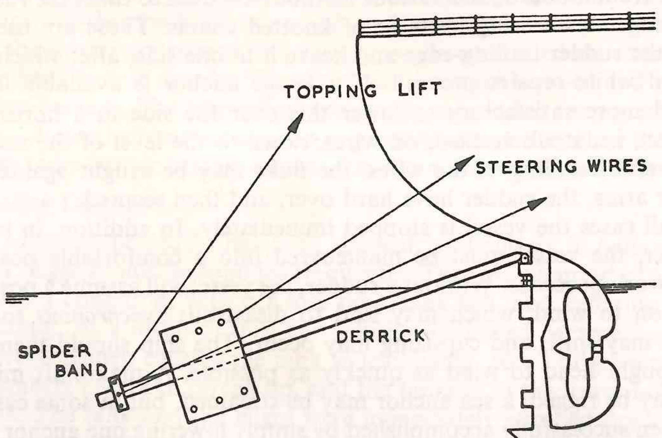


FIGURE 7.7

in fair weather strongly resisted. Given the usual materials carried aboard a ship, and a number of enterprising men, a rudderless ship will soon be brought under control, provided the men are tireless and prepared to make two, or even three different rigs in order to find a satisfactory one.

The following methods are outlined briefly; they have all proved successful in their time on a particular ship, or perhaps on a small number of ships. The method of rigging must be left to the person doing the work—strength of gear available, layout of the vessel, fittings, and new ideas are his prerogative. For this reason, only the very basic ideas are included here. When actually undertaking the task the question of rigging will be rapidly solved.

(1) In the late 1920s a jury rudder was manufactured from a derrick and two steel doors, in the form of an oar having a box blade. The

doors were bolted to the derrick some distance from the derrick head, and the space between the doors was packed with timber, through-bolted to the doors. The 'oar' was hung overside with the doors vertical. The gooseneck was fitted to the top gudgeon under the counter stern, and the spider band at the derrick head was used for attaching port and starboard steering wires, and the topping lift. (A topping lift is necessary not only to control the depth at which the resistance to water occurs but also to heave the jury rudder clear of heavy seas when hove-to.) The method is illustrated in Fig. 7.7. In the case of a cruiser stern some thought might be devoted to using a similar rig, but with the

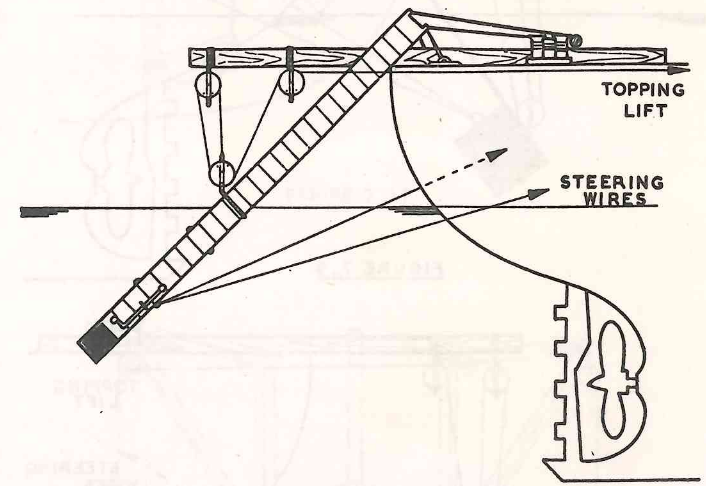


FIGURE 7.8

gooseneck passing through a hole made in the stern plating, the gooseneck being suitably secured inboard with a collar and pin.

(2) A gangway has been used by rigging the steps in the vertical plane and lashing one end securely at the poop deck-edge. This lashing needs careful thought, since the gangway must be very secure against movement both in the fore-and-aft line and the vertical plane, but it must be free to pivot from port to starboard about the poop deck-edge. The foot of the gangway will need to be weighted with, say, derrick span chains or the stock of a stream anchor. Steering wires and a topping lift are used (see Fig. 7.8). The tendency of these jury rudders to lift out of the water will be partly counteracted by weighting the lower end and partly by ensuring a long lead for the steering wires. The topping lift should be rigged either from the after derricks, the docking bridge, or perhaps

from a boom (such as a derrick—although the diagrams show a wooden spar) projecting over the stern as shown in Fig. 7.11. The topping lift must be secured to the gangway below its centre of gravity. A gangway may, instead, be streamed astern as a jury rudder.

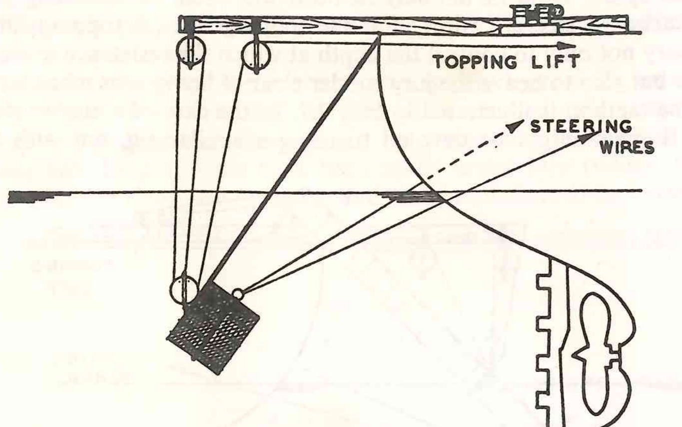


FIGURE 7.9

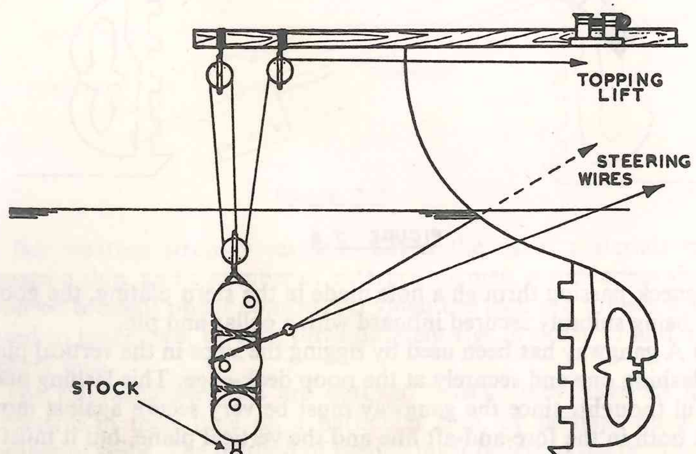


FIGURE 7.10

(3) A very large coil of heavy mooring rope, securely round-lashed, has been successfully towed on its own part. It becomes slowly waterlogged and partially sinks, total sinkage being prevented by the speed of the ship (although slow) and a topping lift. Steering lines are again used to heave it to port or starboard. These steering wires are often led

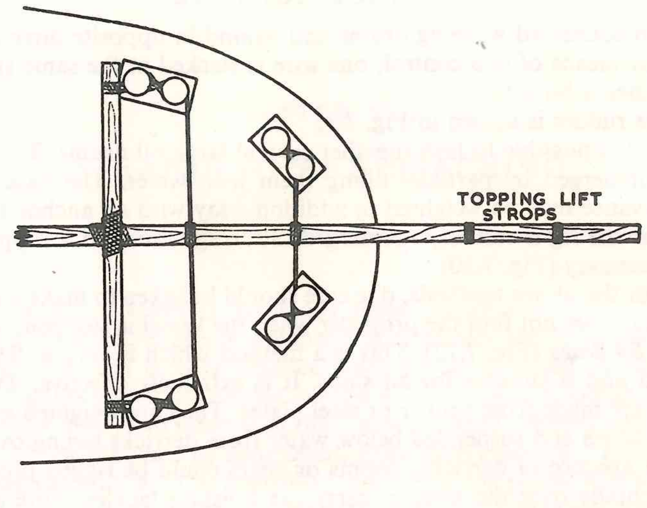


FIGURE 7.11

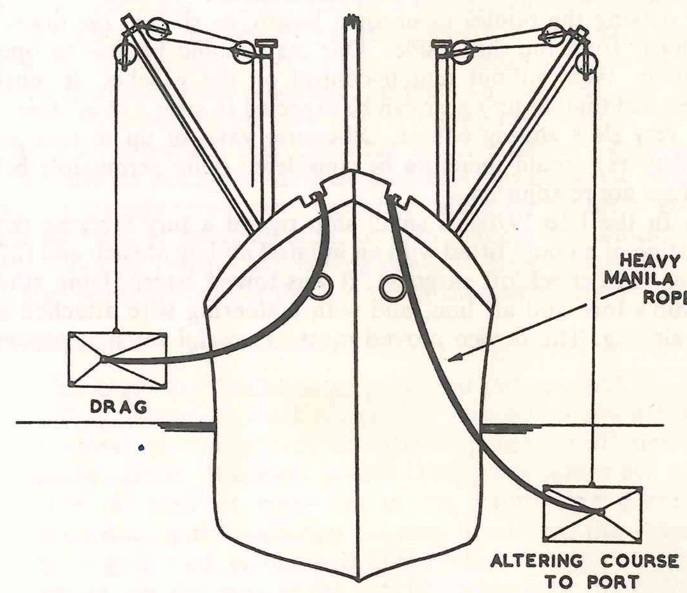


FIGURE 7.12

to two connected warping drums and wound in opposite directions so that by means of one control, one wire is slacked at the same speed as the other is hove-in.

This rudder is shown in Fig. 7.9.

(4) It is possible to lash together several large oil drums. The drums are submerged by partially filling them with water. The base of the contrivance may be weighted in addition—say with an anchor stock—so that the rig is suitably submerged. Steering wires and a topping lift are necessary (Fig. 7.10).

With the above methods, due care should be taken to make sure that the gear does not foul the propeller when the vessel is stopped.

(5) *By drags* (Fig. 7.12). This is a method which is very well known indeed and is suitable for all ships. It is extremely effective. Two flat drags are made from timber or steel plates. They are weighted on their lower edges and suspended below water from derricks swung overside. In the absence of derricks, booms or spars could be rigged projecting horizontally over the side, to carry the hoisting tackles. Fore-and-aft motion is prevented by ropes running from the drag bridles to the forecastle-head leads. When it is desired to alter course to port the port drag is immersed and the starboard one lifted—and vice versa. If speed retardation is of no importance one could be kept immersed at a fixed level and the other raised or lowered as desired.

By making the bridles of unequal length, as shown, the drags will veer away from the ship's sides. One man should be able to operate the drags, even without remote-control on the winches. It must be appreciated that no jury gear can be expected to steer a ship other than on a very slow zig-zag course. Off-course yaws of up to two points ($22\frac{1}{2}$ degrees) should therefore be considered quite permissible before the drags are re-adjusted.

(6) In the late 1970s, a small ship rigged a jury steering device consisting of a boom fitted with an inflated air bag at each end (of the type used to chock off cargoes). It was towed astern, lying athwart the ship's fore and aft line, and with a steering wire attached near each air bag. The device proved most successful for that particular ship.

CHAPTER VIII

STRANDING AND BEACHING

When a vessel is grounded intentionally she is said to be *beached.* If she is grounded accidentally she is *stranded.* A vessel is usually beached when she is damaged to such an extent that the pumps are unable to cope with the rate of flooding. There is therefore always an interval of time, however short, during which the action of beaching can be considered. Even if an emergency exists, the beaching can still often be controlled, and hence the problem of refloating the ship may resolve itself more easily than in the case of a stranded vessel. This is provided the person executing the manœuvre selects his beach, and method of approach, with a view to subsequent refloating. The wise seaman, however, will waste little time in considering such problems if danger of foundering is imminent.

A vessel which has stranded may be in contact with the ground at her bow, her stern, her mid-length, her entire length, or even all along one side, with the other side in deep water. Other shoals or rocks may exist close by, hampering the refloating; currents and weather may be adverse and there may be unfavourable silting-up as a result of these elements; adverse weather may cause her to drive farther aground, and she may also be damaged. All these problems may cause the refloating to be an extremely complicated operation calling for the use of ground-tackle, or tugs, or dredging craft, or even lighters into which to discharge cargo, or perhaps the hauling power of large vessels. Any combination, or perhaps all, of these forms of assistance may be required.

Immediate action upon stranding

(1) The engine(s) should be stopped and put astern if the tide is falling. Some students worry that this action could tear the bottom out of an already damaged ship and she will sink as she moves astern. It is most unlikely that going astern will move a ship off rock or coral but in the improbable event of it occurring, and foundering seeming imminent, the vessel can be re-grounded, or beached. If the tide is falling, possibly on a *spring tide*, this may be the very last opportunity to re-float the ship. Spring tides are not as welcome as they may appear. It

was thought that the *Torrey Canyon* on the Seven Stones Reef would refloat on a rising spring tide. Instead she impaled herself still more on each decreasing low-water level. There have been some unusual instances where ships have refloated by driving full ahead, across a shoal and into deeper water beyond. Under no circumstances should the engine(s) be run astern for long periods as this may stir up silt and sand which can block condensers. Not only can the main propulsion be put out of action in this way but refrigerating machinery may be similarly affected.

(2) The Master must be called to the bridge and the engine-room informed. If the engine is running astern, injection levels should be changed to reduce the risk of silting condensers.

(3) Close watertight doors and make the signal for Emergency Stations. This will enable fire, boat and damage control parties to be briefed. It also affords an opportunity to check for casualties and missing persons.

(4) Swing out boats. This is always a wise precaution in any emergency in case the ship lists and prevents some boats being swung out at a later stage. In some vessels, unhappily, this has been a signal for some of the crew to abandon ship prematurely and without any authority. Prepare all lifesaving appliances, making sure that portable radio equipment is ready and commence marshalling passengers, who should be suitably dressed.

(5) Observe Rule 30 of the Rules for Preventing Collision and show the appropriate lights and shapes.

(6) Ascertain the position of the ship so that

(7) An XXX or PAN-PAN message can be transmitted to all ships and coast radio stations. The advantage of sending an urgency message is that it alerts shipping to the possibility of a future distress call. If there is no danger whatever to persons on board, then a SECURITAY message may be thought sufficient, to warn other vessels that the grounded ship is a danger to navigation. Obviously if the situation is one of grave and imminent danger, then it may be necessary to fire distress rockets and prepare for helicopter or breeches buoy rescue. Since ships go aground in all weathers, the student must consider every possibility. If a ship does ground in bad weather, many seamen take the view that the ship is often the safest place to be and abandoning without careful thought may place the crew and passengers in a very hazardous plight. So long as the ship is not breaking up rapidly, the best advice is to stay on board.

(8) Now that the position is known, the Master must decide whether to call for tugs to stand by.

(9) If the vessel is damaged, oil pollution may be occurring. This should be reported to the coast radio stations of the country most likely to be affected and, under the Merchant Shipping (Prevention of Oil Pollution) Regulations, all possible steps should be taken to prevent or minimise the outflow of oil.

Subsequent action

What should be classed as *immediate* and *subsequent* action is very much a matter of personal opinion and choice. For that reason these two sections thus headed are offered for consideration and guidance.

(10) The Owners/Charterers should be informed. They may wish to contact local Salvage Associations for advice and perhaps to arrange for the ship to be salved on the best possible basis. There may a fulfillment of a charter or a mail contract to be considered.

(11) In the United Kingdom, a Receiver of Wreck will proceed to a stranded vessel and take charge of rescue operations. But he can interfere between a Master and his crew only if the former so requests. The Master may repel any person attempting to board his ship without authority.

(12) The ship should now be examined for damage, never forgetting that the force of impact may have caused hatches to spring away from their seatings and allow water to enter later. All bilges and tanks should be sounded and levels carefully checked against the last recorded figures. Remember that damage may occur in areas quite remote from the point of impact. A ship has enormous momentum and when this is destroyed, perhaps in a few seconds, damage is almost bound to be inflicted upon the ship. Normally, the Chief Officer will be responsible for damage assessment and any attempts at damage control, no doubt in co-operation with the Chief Engineer. They must decide whether the damage to the vessel precludes any immediate attempts at refloating (in which case she must be well-secured to the shore to prevent accidental refloating), or whether she will be able to float and handle reasonably well, or whether damage control is feasible with the crew and gear available.

(13) Soundings should be carried out overside and a general survey of the area (weather permitting) will enable the Master to assess the best direction in which to try hauling-off. Some areas are subject to unpredictable *scouring* of the seabed, the contours of which can change almost daily, particularly in bad weather. The nature of the seabed should be noted so that holding power of anchors can be judged.

(14) It is most useful to read the draughts of the stranded ship and compare the mean with the flotation draughts. The difference, multiplied by the tonnes per cm immersion, gives a very rough idea of the amount of lost buoyancy. For instance, if a vessel floating at 11 m draught grounds and her draught marks now show 10 m of water, then clearly she has lost 100 cm of buoyancy. With a TPC of say 20, we now know that approximately 2000 tonnes of ship and cargo is resting on the seabed. It is most unlikely that any vessel, or even combination of ships, can heave 2000 tonnes along a seabed. On firm sand, a pull of 600 tonnes will be needed and over coral or rock the coefficient of friction may be as high as 1·5, giving a required pull of 3000 tonnes. The first task is to reduce the lost buoyancy.

(15) The local tides should now be examined very closely for range, times of low and high waters, strength of currents and whether the situation is springing or neaping. A rising tide, especially one which is springing over the next few days, could restore a great deal of the lost buoyancy, unless the ship is badly and extensively holed. In an area where there is little tidal range, lightening of the ship is the only alternative.

(16) Lightening will benefit any stranded ship of course but is easier said than done. The simplest way is to discharge all ballast water and any fresh water for which there is no immediate requirement. Make sure that distillation plants are functioning before losing fresh water. In some large passenger ships, buoyancy was gained by launching most of the lifeboats laden with passengers (weather or rescue services permitting). If the ship's ground tackle is to be laid out, that reduction in weight will be to advantage. As far as cargo is concerned, discharging will be a slow process. It will normally be done with lighters—an expensive operation. It will be necessary then to arrange for storage of the cargo, or perhaps a transhipment. In the case of perishable cargoes, cold storage, transhipment or local selling are the usual priorities, in that order. In the event of a tanker having to be lightened, this may be possible using oil barges, or small shallow-draught coastal tankers, and flexible hoses. These craft must have sufficient depth of water to clear the area when loaded. It should be possible to off-load fuel oil using these methods.

(17) Should bad weather, or a swell develop while the ship is aground, she may start to move around and strike the ground heavily, with the threat of serious damage to the hull. She should be *quietened down* by flooding some tanks with ballast.

This can be discharged at any later time with no adverse effect on the refloating process.

(18) Consider moving fluids within the ship from tank to tank to change the trim. In general, on a seabed which produces suction on the hull, such as soft sand, mud and even small shingle, it is better to lighten the seaward end so as to reduce the suction on the flat part of the hull. If she is lifted on to the stranded end, suction is progressively broken. Moving water or oil can achieve a similar effect. If she is sitting on a ledge, it may be better to lighten the stranded end or even shift weight to the seaward part.

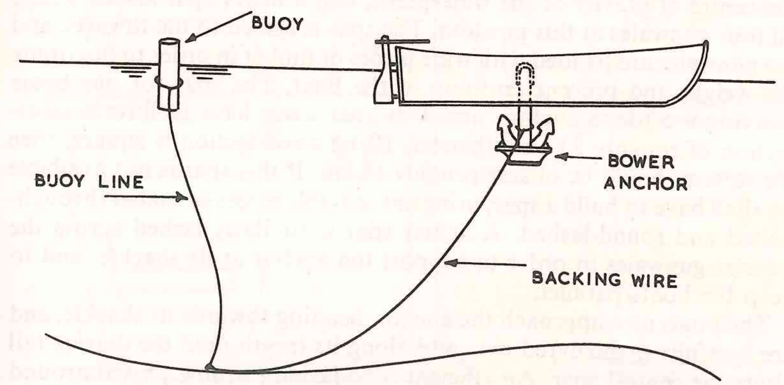


FIGURE 8.1

(19) Ground tackle may be laid out in the direction in which refloating seems most beneficial. By this is meant the laying out of anchors, carefully placed at considerable distances from the ship and connected to her by heavy wire hawsers, perhaps also using some lengths of her chain cable. Heavy purchases are then attached to the gear, often securing the second to the hauling part of the first. This gives a final velocity ratio equal to the *product* of the two separate velocity ratios and obviously the mechanical advantages are also multiplied together. The gear is set up tight and either hove on or left tight to await the enormous forces which will be generated in the gear by a rising tide or on-shore swell. Ground tackle is probably the greatest single factor in aiding the refloating of a ship. Ground tackle also helps to prevent further grounding. For historical interest, I am now including an account of how a bower anchor was carried out

using ship's lifeboats. Further on I shall explain why the practice is obsolescent.

Carrying out a Bower Anchor

For this it is advisable to use two boats. The anchor *may* be slung beneath one boat, but this will require a greater depth of water than may be available. The spare bower anchor can be broken out of its bed and hoisted overside. It will be slung at its centre of gravity and lowered until just awash—in the horizontal position.

The two boats should then be cleared of all unnecessary gear and
some 2–3 ft apart manœuvred side by side, about a metre apart, and heading in the same direction. The centre of flotation of the boats should be estimated, i.e. the centre of gravity of the waterplane, and a heavy spar lashed across all four gunwales at this position. The spar is lashed to the thwarts, and the gunwales are padded with wide pieces of timber in order to distribute the weight and prevent crushing of the boat. The spar for our boats
ton 3 ft carrying a 5-tonne anchor, and 1 m apart, will have to have a cross-
9 in section of roughly 23 cm diameter. If the cross-section is square, then
7 in the square should be of side roughly 18 cm. If this spar is not available we shall have to build a spar, using any suitable pieces of timber through-bolted and round-lashed. A lighter spar is similarly lashed across the quarter gunwales in order to support the anchor at its shackle, and to keep the boats parallel.

The boats now approach the anchor, heading towards its shackle, and are carefully manœuvred over and along its length until the derrick fall abuts the central spar. An efficient rope lashing is now passed around the centre of gravity of the anchor on the shank, and the heavy spar. If a wire strop is used a patent slip must be included. The anchor shackle is lightly lashed to the after spar. If there is sufficient depth of water we may now choose to ease the central lashing as the derrick fall is slacked down in order to submerge the anchor. This will cause a displacement of water and a small but helpful upthrust on the anchor. If the anchor is correctly slung at its centre of gravity there should, in theory, be no
32 ft weight on the after spar. If our lifeboats are 10 m long they will each have a tonnes-per-cm immersion of roughly 0·2, i.e. a weight of 0·2 tonne will submerge one boat 1 cm. Since the 5 tonnes is distributed between two boats, they will each sink about 12 cm.

The boats should be equipped with a chain check stopper, a sharp axe, and have a crew of about three men in each. Into the boats must now
5- or 6-in be loaded, and carefully flaked down, the big 40- or 50-mm wire which is to be finally hove-on. Half can be placed in each boat, making sure that it is clear to run. The end finally going into the boats should be passed clear of everything and shackled to the anchor ring. In order to avoid having to do this with the anchor just submerged, it could well be done

before easing away the derrick fall. The other end of the wire is made fast to a floating fibre rope messenger which is either paid out slackly from the ship, or from the boat on its return. We are assuming at this stage that one bower anchor has already been laid, with a *backing-up wire* attached (equal to about twice the depth of water), and buoyed, as shown in Figure 8.1. Anchors will thus be laid *in tandem*.

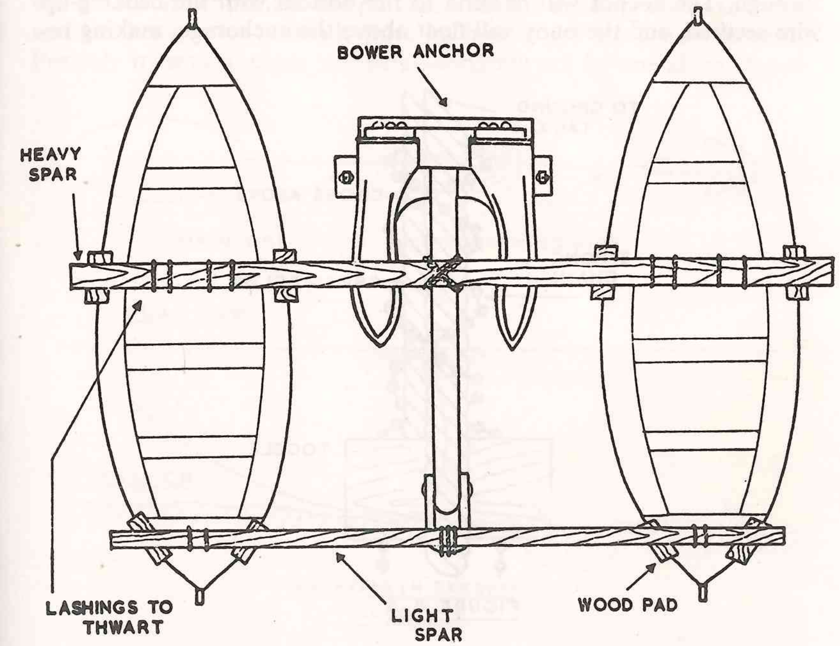


FIGURE 8.2

The boats can now head out to the first anchor site. Fig. 8.2. shows the two boats with the anchor slung in position. The boats are shown wider apart than in practice, for the sake of clarity.

The buoy is picked up and the buoy-wire hove inboard. Eventually
the end of the 25-mm backing-up wire will be brought to the surface. 3-in
The reader should now imagine himself to be in the boats and try to visualise the next step.

Pass the end of the 25-mm wire (having cast off the buoy-wire) under 3-in
the spars, make a round turn on the anchor shank close to the head, and shackle the wire back on to its own part. The wire is now backed-up to the bower anchor and will slide down close to the head when stressed. Secure the buoy-wire to the bower anchor and pay out all the wire,

refloating the buoy. Making sure the heavy wire is clear of everything, pay out sufficient to at least reach the bottom, and pass the chain-check stopper *loosely*. We may find it difficult to estimate how much heavy wire we are paying out, and if we *under*-estimate it, and have a tight chain-check stopper, the falling anchor may assist in removing part of a boat. Cast off the lashing on the after spar and alert the boats' crews. Make a final check to see that all is clear, and cut the central lashing through. The anchor will descend to the bottom with the backing-up wire secured, and the buoy will float above the anchorage, making re-

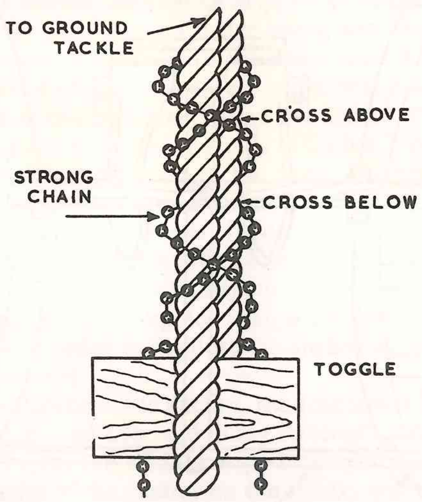
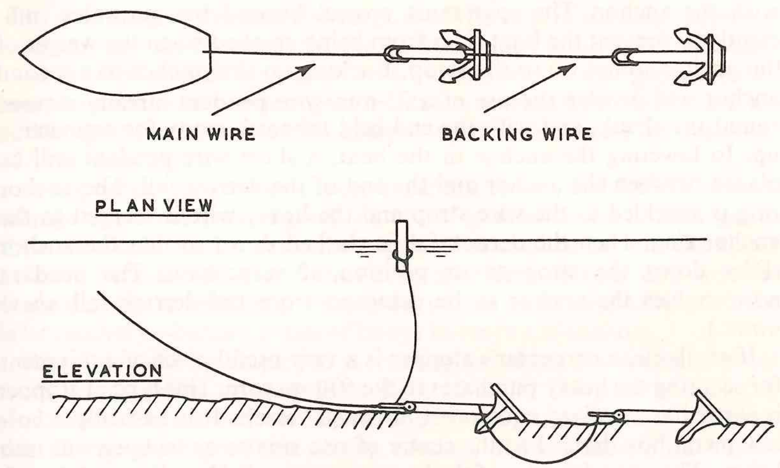


FIGURE 8.3

covery possible later if the ground-tackle has to be slipped and left behind.

Move clear, veer the whole of the wire and return to the ship paying out the messenger. The end of wire is now hauled to the ship and rigged ready for heaving. Let us assume that the ship is aground forward and our ground-tackle has been laid leading right astern. Heavy purchases will be used for stressing the ground tackle, and these may be rigged in many ways. Generally they are as heavy as possible and are often rigged with one purchase secured to the hauling part of the other. This gives a theoretical mechanical advantage equal to the *product* of the respective mechanical advantages. Also the stress necessary on the final hauling part is lowered.

This hauling part is led to the after winches or capstans. To distribute the stress more evenly, the hauling part is often turned round one warping drum and then similarly turned up on the next set of winches forward. Both winches are then run together. The lead of the hauling part should be kept as nearly as possible in one straight line. The purchases will be used to advantage, i.e. pulling in the direction of the moving blocks. If the end of the heavy wire has an eye in it this is most convenient for attachment to the purchases. But if the ship begins to move, and the heavy wire is slowly hove-in, how is the block now secured? Possibly by several chain stoppers—certainly not by one alone. A suc-



ANCHORS IN TANDEM
FIGURE 8.4

cessful method is to use a wooden toggle. This is a short cylindrical piece of hardwood, having a large end-diameter. The heavy wire is turned back on its own part, making as small an eye as possible. The toggle is placed through this eye and a chain lacing or *selvagee strop* is passed around the eye, over the toggle and shackled to the block. The chain tightens under tension (Fig. 8.3).

When overhauling the purchases, several chain stoppers should be passed on to the wire, and perhaps light tackles used similarly to the method shown in Chapter I for heaving up cable when the windlass is out of action.

The standing blocks of the purchases should be made fast round very strong points, such as hatch coamings and bitts. Winch beds are sometimes used. The same applies to chain stoppers—the ordinary deck fittings are often of inadequate strength. Bitts should be watched very closely for signs of lifting.

We have now rigged the gear ready for use and will change the subject for the time being. Fig. 8.4 shows how our tackle is lying.

(In passing, the method of carrying a bower anchor below one boat involves the use of a central spar lashed to the thwarts and resting on padded gunwales in way of the centre of flotation, as before. This time
10 in the sinkage of the boat will be 25 cm. The anchor is suspended vertically, or horizontally, from the bight of a wire strop passing right round the boat and spar. On the spar the strop eyes are joined by a patent slip, for letting go the anchor. Notice that the strop will go down with the anchor. The spar must project beyond the gunwales sufficiently to prevent the boat sides from being crushed when the weight of the anchor somes on to the strop. Backing up this anchor to a second
3-in anchor will involve the use of a 25-mm wire pendant already secured round the shank, and with the end held inboard, ready for connecting up. In lowering the anchor to the boat, a short wire pendant will be placed between the anchor and the end of the derrick fall. The anchor ring is shackled to the wire strop and the heavy wire is secured to the anchor ring. Then the derrick fall is slacked down so that the anchor slides down the strop to its position of suspension. The pendant now enables the anchor to be detached from the derrick fall *above water.*)

If available, a carpenter's stopper is a very useful piece of equipment
6-in for securing the heavy purchases to the 50-mm wire. This type of stopper is carried as standard equipment in Naval vessels. It is basically a hollow metal box, hinged at the centre of one side so as to open out into halves. The opposite sides of the box are not parallel but diverge *inboard.* In one half is a groove to take the wire. In the other is a sliding metal wedge which has the same taper as the sides of the box. This wedge is grooved and fits around the wire when the box is closed and clamped shut. When the wire is stressed the wedge tends to be pulled in the direction of stress, its groove gripping the wire harder as the stress increases. The inboard end of the patent stopper has a chain bridle on it for securing to strong points on the deck—in our case the bridle may be shackled to the purchase block. A spare wedge is usually supplied with each stopper, having a different groove. By changing wedges, a different size of wire may be clamped in the stopper.

THE USE OF TUGS

In coast tidal waters it is generally wise to radio for tug assistance, since they are quickly available. These tugs will be able to assist the

stranded vessel in several ways, but in all cases the Master should avoid any financial bargaining and insist upon signing Lloyd's Salvage Agreement on a 'no-cure, no-pay' basis before assistance is rendered.

Generally speaking, most tugs can exert a pull of from 5 to 15 tonnes, tons
i.e. roughly 1 tonne pull for every 75 kW power of the engines, though tons
some very powerful salvage tugs can exert up to 80 tonnes. The safe tons
working load of a 50-mm flexible steel wire rope will be roughly 15–18 6-in
tonnes, so that in many cases ground-tackle is more effective than a tons
tug's pull. Further, a tug will rise and fall in a seaway, and the stress in her towline will be continually changing. In the case of ground-tackle, a swell or sea can be very beneficial, since providing the gear is kept taut, the rising of the waterborne part of the ship in the swell produces surging, increased stresses in the tackle, which time and time again have resulted in moving a ship. It is for this reason that ground-tackle must comprise the heaviest gear available, since if kept tight there will be no spring in the lines to absorb sudden jerks, and stresses may become very high.

A tug cannot make use of these beneficial forces, and for this reason, salvage operators may suggest the use of ground-tackle in addition to their own pull. In this case, the tugs can be used to lay out the ship's anchors very speedily, and thus save considerable time and trouble. Once the ship is refloated, the gear may have to be slipped and left for later recovery—hence the use of buoys to mark the anchors.

A tug may also be employed in *scouring*, i.e. using the stream of water from her propeller or propellers, directed as far down as possible, to scour away the sea-bed which is silting up the stranded hull. It is often this silting which produces strong suction, holding the ship firmly in place. Scouring will be employed when a stranded ship cannot be moved by her own power, by ground-tackle, or by direct towing. It may be used to make a vessel settle deeper in the water and become waterborne, or to dredge a deep channel to seaward, or to dredge cavities beneath the keel. Any small craft having a suitable trim by the stern may be used, e.g. a trawler.

The area should be roughly surveyed before commencing, and the depths subsequently checked frequently in case undesirable banking is being caused by the scouring. It is quite possible for sand to be scoured from the ship's side and cause a shoal to form to seaward. If this is not carefully checked, she may strand again shortly after refloating. For dredging cavities beneath a keel, the tug should have no more than
2 m below her propeller. For freeing the area along her bilges, greater a fathom
depths—up to 8 m total depth—are permissible. The tug is secured 4 fathoms
to the ship by a hawser from the towing hook, a manila hawser leading from each quarter for heaving the tug up and down the ship's length, and a headrope from each bow for altering the tug's inclination to the

ship's fore-and-aft line. The tug should also have both her anchors out on open moor.

Assuming the use of two tugs, if tunnelling beneath the keel, both craft will be secured on one side of the ship and at about 70 degrees to the ship's side. This large angle prevents deflection of the stream of water by the bilge area. The craft are secured abreast of the masts, since cavities produced here will not unduly weaken the hull. Once the cavities are blown through, they are gradually widened—but not deepened unduly—by moving the tugs. If, on the other hand, the bilges are to be cleared of silt, then the tugs will be secured at a smaller angle to the ship's side—about 30 degrees—and will be continually worked from amidships towards both ends of the hull. Eventually the ship may be left resting on a ridge of sea-bed with deeper water on both sides. By heaving on bow or quarter and by using ship's engines and full alternating rudder, the ship may be slowly *rocked off* and become waterborne. Contrary to first thought, the engines are used *ahead*, otherwise the ship will become rebanked.

If scouring a channel to seaward, the tug is secured to the ship using a hawser made fast close up to the tug's pivoting point. The tug is also anchored to a single anchor leading ahead. As her engines are worked ahead she is slowly hove towards the stranded ship while veering her own cable, slewing her stern from side to side to widen the channel, and buoying and sounding the channel she is making.

Scouring is restricted to certain types of sea-bed—sand, shingle, and mud. Stiff clay is unsuitable. A rocky bottom may well be covered with a thin layer of loose silt, giving a false impression that scouring is possible.

As a matter of interest, the principle of scouring was first used in 1891 in Port Said, when a ship's engineers assembled a battery of pipes, lowered them overside until they were immersed in the banking around the hull, and pumped water at high pressure through them, the pipes being perforated. The silting was loosened and the ship hauled herself clear.

USE OF BOATS WHEN STRANDED

Although work has been included in this chapter on the use of ship's boats for carrying out anchors it is mainly of historical interest and perhaps for the occasional examination question. I am of the opinion that lifeboats can well be used for survey work around the stranded ship or for ferrying personnel in the area but that should be the limit of their use. Furthermore, I have always advocated that ship's lifeboats (except when there is a dire emergency such as abandoning ship) should not be sent away in the open sea when the wind is above a certain level on the Beaufort Scale. I even devised a

sliding scale to impress the point upon students. Winds of between Forces 1 and 5 are for prudent seamen, Forces 6–8 are for budding heroes and 9–12 are for the foolhardy only. This is purely for ships' boats and crews and does not apply to shore rescue services who are better equipped and far more experienced in that kind of work. Sometimes a boat will leave a ship in a Force 4 and have to return in a freshening Force 6 and it can be a very hazardous operation hooking-on in such a sea. The use of nylon pendants on the boat fall blocks (a requirement for passenger ship emergency boats) has reduced the hazard slightly. The fact that eager volunteers are available should not deter a Master from his reluctance to dispatch a boat in poor weather. Obviously in cases of distress, seamen take more risks, but in a stranding there is the added danger of the shallow water effect on waves, making them shorter, steeper and more ready to break.

A number of very good reasons can be put forward to show why the practice of carrying out anchors in lifeboats is obsolescent:

(1) Under some Classification Society Rules, no heavy wire (tow-wire) is required to be carried on vessels of more than 90 m in length.

(2) The lifeboats available may be made of glass-reinforced plastic or similar material and most seamen are of the opinion that these boats are unsuitable for slinging anchors either across or beneath. Steel, aluminium or wooden boats are better for this work.

(3) The lifeboats may be totally-enclosed in which the boat's complement enter through a door/hatch which is then sealed. The boat is probably fitted with an external water spray, for navigation through burning oil or gas and a limited air supply is available to the crew during this time. These boats have only a small ledge around the gunwale adjacent to the domed cover and they are quite unsuited to the carrying out of anchors.

(4) Even if the boats are suited to the work, the anchor may be too heavy. Not only must the TPC of the boat be considered, but the sheer job of handling the anchor may be too much. This chapter has confined itself to the carrying out of anchors which weigh about 5 tonnes—or 4½ tonnes when slung beneath a boat. Even these are too heavy for some modern situations.

(5) If none of the foregoing applies to a particular instance, matters can still come to a halt if no proper lifting gear is available for handling the anchor.

(6) There may be no large purchases available for setting up the

ground tackle in which case outside help is needed. These salvors will place the anchors, using their own craft.

(7) Even if the lifeboats are suitable, there may be only two, of which one is a motor boat. There is an enormous drag on a boat which attempts to carry an anchor through the water. It is as though clusters of buckets have been attached to the keel. For this reason, the motor boat is essential. But if in Figure 8.2 only one was a motor boat, both rudders will have to be well over to counteract a steering bias due to the one engine. Either both boats should be mechanically-propelled or, if possible, one motor boat can tow a pair of non-mechanical boats.

(8) There is considerable risk to life and limb when undergoing this work. Derricks or cranes are being rigged to handle and swing heavy anchors overside, boats are being handled in close proximity to the ship's side, they are being loaded in unusual ways, the work itself is totally alien, instructions may not be clearly understood and followed, and from what the reader has already seen, further hazards exist at the anchor sites. Anchors have been carried out in ships' lifeboats on occasions during the last two decades and one of the worst cases occurred in the 1960s when a petrol-engined boat was being used for the task. An engineer, who was smoking aboard the craft, caused an explosion and the boat overturned. The anchor was lost. Later, another boat was lost repeating the exercise. Fortunately the lost anchor was a light kedge, still carried aboard an ageing ship.

(9) There is risk to the life-saving appliances. It could be argued that indirectly the boats are being used to save life but it is a very thin argument. The boats are being used as work-craft and that is not the reason why they are placed aboard. On the other hand, if it is obvious that if and when the vessel is refloated she will immediately move into a nearby port for extensive work, then perhaps the boats are expendable. A Master must at all times exercise the greatest care in the use of life-saving appliances.

(10) The final point which comes to mind is the weather. Having already mentioned the drag on the boats caused by the submerged anchor, it is not difficult to visualise the problems involved if, after discounting everything above, the anchor is set for transit to the site and a Force 4 breeze springs up. With short seas, a 13 knot wind, a heavy anchor below, and perhaps heavy rudder in use, the boats could well be stopped dead in the water. One Officer told me that he and his crew

spent nearly a whole week carrying out one bower anchor between two steel lifeboats, fighting currents, winds and seas. When they finally began to set the gear tight, the anchor—to their horror—was simply hauled straight back to the ship. This demonstrated both painfully and admirably the value of one anchor backed up by another. It is most important that this is clearly understood.

GROUND TACKLE RIGS

By rigging anchors in tandem, it becomes less likely that the gear will be hauled back to the stranded ship. When an anchor is hove on, the pull should always be parallel to the axis of the shank. If the pull moves up only 5 degrees away from this axis, one quarter of the anchor's holding power is lost. When the angle increases to 15 degrees, the holding power is cut to half. In tandem, the further anchor cannot experience this angular pull unless the nearer anchor is actually lifted off the seabed by the stress on the gear.

Additionally, any tendency of the nearer anchor to drag towards the ship is resisted by the holding power of the other anchor. Ideally, the backing-up wire, or chain, or combination, should be of the same strength as the rest of the gear. Unnecessary reductions of strength must be avoided if the operation is to succeed.

When a vessel is stranded along one side her engines are of little value in refloating her. Ground-tackle will have to be employed with or without towing assistance. Her seaward side must be surveyed to decide which end of her is to be slewed clear. Generally, she will be deeper aft, and the bow is chosen from which to lead the gear. The stern may require an anchor and hawser leading seaward, in order to prevent the after end from driving farther ashore as she is eventually slewed. Banking-up may be occurring all along the seaward side, calling for scouring craft. Fig. 8.5 shows a method whereby ground-tackle may be rigged for such a ship. She will need a considerable length of hawser on her ground-tackle, since if she were, for example, 150 m in length, by the time 500 ft
she has pivoted on her stern a 200-m wire will leave little scope for 100-fathom
further heaving. If the amount of wire available is not sufficient, then some chain-cable will have to be used, as shown in the figure. This will in any case be beneficial, because its weight will assist the applied stress to remain parallel to the anchor shank.

When carrying out a bower anchor with, say, a shackle of chain- 15 fathoms
cable in addition to the heavy wire, great care will have to be used when paying out the cable from the boats. A good method is to stop it around the outside of the boats and cast off these stops when necessary. Cable hooks could be carried in the boats if desired. A shackle of 62-mm stud 2½-in

2¼-in cable will weigh roughly 2¼ tonnes, causing a sinkage of 5 cm in each boat ($D^2/50$ kg per m.)

The wire hawser in Fig. 8.5 is rove through a Panama Canal fairlead and the purchase is fast to a heavy wire strop passed around a hatch coaming. The purchase should be anchored as far away from the fairlead as possible in order to avoid frequent overhauling, and therefore No. 2 coaming will be preferable to No. 1 coaming—depending, of course, upon the length of the purchase fall. The coaming corners are padded with timber to prevent cutting and chafing of the strop. Stoppers are anchored to the windlass or winch beds. The heavy wire hawser is sometimes buoyed along its length at frequent intervals, so that if it should part the ends may be quickly recovered.

A vessel stranded end-fast does not necessarily require such a great length of hawser, though in general it should always be as long as possible. Fig. 8.6 shows a suggested rig for such a ship. The purchases are anchored to a single strop, joining their standing blocks and passing around the padded No. 4 hatch coaming. Stoppers are again anchored to winch beds.

The above two examples are included as a guide only. The ways in which a ship may strand are numerous and cannot be dealt with individually in this chapter. The reader, however, should now have sufficient knowledge to devise a good hauling-rig for all cases.

As far as the gear used is concerned, the seaman has all too little choice. He will probably have only one really heavy wire (say 50 mm), and this may be in two parts. Its total length may be roughly 250 m. The warping power of his winches is also fixed, and he therefore has to select a purchase suitable for the wire and the winch. If he has no heavy purchases he will have to construct one by strapping together several single blocks of appropriate size.

As an example, suppose he has a winch with a warping power of 3
tons 5½-in tonnes and a 45-mm heavy wire. The wire has a calculated safe
tons working load of 15 tonnes. For his fall, he needs a wire having a safe
3-in working load in excess of the winch power, say a 25-mm wire with a
tons safe working load of 4½ tonnes. If he reeves this wire will fall in a three-fold purchase used to advantage his purchase will heave with a
tons stress of roughly 13 tonnes, which is suitable for the heavy wire. His pur-
tons chase blocks should have safe working loads of 15–20 tonnes.

4½-in If his big wire is 35-mm in circumference it will have a safe working
tons load of 10 tonnes.. Used with the same winch, a smaller purchase is
2½-in necessary, e.g. a two-fold or double luff tackle rove with 20-mm wire
tons as a fall. The wire has a safe working load of 3⅛ tonnes and is suitable for the winch. Used to advantage on this winch, the purchase will
tons create a stress of roughly 10 tonnes, which suits the wire hawser. This
tons purchase should have 15-tonne safe working load blocks. Such a

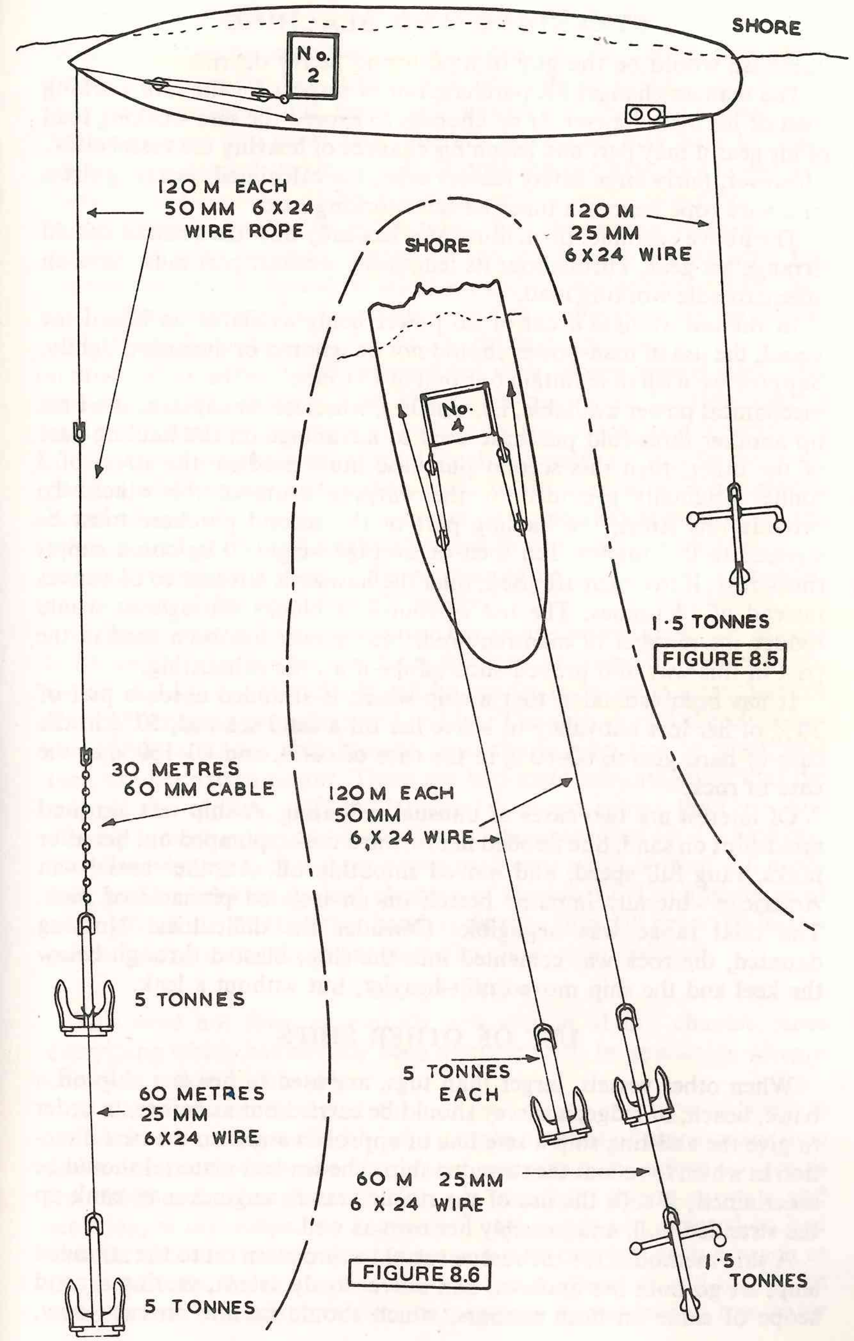


FIGURE 8.5

FIGURE 8.6

tons purchase would be the guy of a 60-tonne heavy derrick.

The seaman changes his purchase out of respect for the safe working load of his main hawser. If he chooses to exceed the safe working load of his gear it may part and lessen his chances of heaving the vessel clear. However, fairly large safety factors exist, the calculated breaking stress of a wire rope being six times its safe working load.

The above example, then, illustrates basically how the seaman should arrange his gear. Throughout its length the weakest part must have an adequate safe working load.

In the unfortunate event of no power being available on board the vessel, the use of man-power should not be ignored or dismissed lightly. tons Suppose we wish to maintain our pull of 13 tonnes on the hawser with no mechanical power available, i.e. winches, windlass, or capstan. If we set up another three-fold purchase used to advantage on the hauling part of the other, then this second purchase must produce the stress of 3 tons tonnes originally provided by the warping drum of the winch. To provide this stress, the hauling part of the second purchase must be tons 11 stone stressed to 0·7 tonnes. Ten men of average weight 70 kg could supply tons this stress; if five men are used, then the hawser is stressed to $6\frac{1}{2}$ tonnes tons instead of 13 tonnes. The use of four-fold blocks throughout would reduce the number of men required. Man-power has been used in the past in this way and proved successful—if a little exhausting.

It has been estimated that a ship which is stranded needs a pull of 30% of her lost buoyancy to heave her off a sand sea-bed, 50% in the case of hard gravel, 60–80% in the case of coral, and 80–150% in the case of rock.

Of interest are two cases of unusual refloating. A ship was aground amidships on sand. She flooded her forward tanks, pumped out her after tanks, rang full speed, and moved smoothly off. Another vessel—an American—literally impaled herself on an isolated pinnacle of rock. The tidal range was negligible. Consider the difficulties! Nothing daunted, the rock was cemented into the ship, blasted through below the keel and the ship moved off—heavier, but without a leak.

USE OF OTHER SHIPS

When other vessels, larger than tugs, are used to heave a ship off a bank, beach, or ledge, a survey should be carried out as before, in order to give the assisting ship a safe line of approach and also the best direction in which to refloat the stranded ship. The sea-bed material should be ascertained; if soft, the use of the rescue vessel's engines may bank up the stranded hull, and possibly her own as well.

A safe method is for the rescue vessel to turn stern on to the stranded ship, let go both her anchors, and move slowly astern, veering a good scope of cable on both anchors, which should lie fine on each bow.

Wires may then be passed across to the beached ship, either by making contact between the two vessels with boats or by firing a rocket line. The wires are hove taut, made well secure, and the rescue vessel then begins heaving into short stay. The beached vessel may have to heave on her own ground-tackle as well. Should she not have any rigged and there is the possibility of her refloating with a rush—something which is the exception rather than the rule—then the towing wires must be capable of being instantly slipped. When making the towing wires fast around bitts a turn should be taken around the bollard nearest the fair-lead before belaying the wire. This avoids an undue stress on the farther bollard which might cause the bitts to lift from the deck.

A vessel of D.W. 10000 tonnes fitted with 70-mm special steel cable tons $2\frac{3}{4}$-in and an electric windlass of 48 kW power can, when heaving, exert a maximum stress of 29 tonnes on each cable, and therefore it is preferable tons to pass the towing hawsers around hatch coamings or deck houses (well padded with timber) rather than bitts. In the case of a ship stranded broadside-on, the towing wire was passed up one hawse pipe, down the other, round again, and finally shackled to its own part. This proved a secure arrangement. Again, the wire could be shackled to a stranded ship's cable if she were similarly beached.

If the assisting ship decides to use her engine power alone her Master must decide whether to tow from forward or from aft. If the beach shoals rapidly and is rocky it will be unwise to move in stern first for fear of damaging propellers and rudder. The ship should therefore approach the stranded ship bow-on, pass the towing wire or wires, and then use her astern power. There are two main advantages in that the ship, if she strikes, will be damaged forward rather than aft, and the ship is more easily kept in position while an onshore wind is blowing. The disadvantage is that stern power used over a soft bottom will probably lead to banking up and choking of machinery. The advantage of towing from aft, on the other hand, is that the ship will generally have a greater ahead thrust from her propeller than when reversed.

BEACHING

This does not form an entirely new section of this chapter, since everything which has already been discussed will be applicable when it comes to refloating the ship.

If a ship is in imminent danger of foundering any type of beach is welcome. Assuming the ideal, i.e. a certain amount of preparatory time and a choice of beach, the best type is one which has a firm surface, is free from rocks, has a gentle slope, is free from strong currents and scouring, is not subject to heavy surf, and is not too exposed to bad weather. Fortunate indeed is the seaman who can find such a beach at the right time. Tidal range is another factor; there should ideally be *some* so that overside or bottom damage can be repaired at low-water times without the aid of divers.

When beaching it is again ideal to do so at high water or on a falling tide so that the ship settles slowly, rather than to drive her hard ashore and strain the bottom plating. Further, it is possible to some extent to control the degree to which she is beached, by discreet use of the engines before her keel closes with the sea-bed. There is, of course, the danger of banking up and also drawing sand into the machinery, so much will depend upon the nature of the bottom.

A damaged ship losing buoyancy rapidly, if beached, may well be able to refloat at a later high water after repairs have been done, compartments pumped dry, and her buoyancy restored.

If beaching bow-on with a trim by the stern, a beach with a slope steeper than that of her keel will enable her stern to be kept buoyant

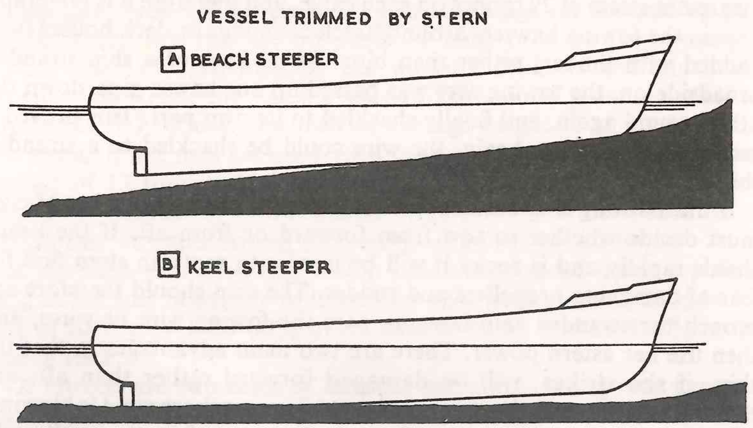


FIGURE 8.7

while her fore end is grounded. Fig. 8.7 (*a*) shows this condition. If her keel has the steeper slope, then her stern will touch first, as shown in Fig. 8.7 (*b*). Trimmed by the head, she will, whatever the slope of the beach, take the ground forward. One of the dangers in beaching end-on is that cross-winds or currents may swing the ship rapidly into a broadside position on the shore, making refloating very difficult. Fig. 8.7(b) might prevent this occurring.

A vessel may be beached bow-on or stern-on. Whichever method is chosen, ground-tackle should be rigged to keep her seaward end steady, and to stop her from driving farther ashore. Equally, she should be secured to the shore to prevent her coming off unexpectedly. If beached stern-on she has the advantage of presenting her stronger, finer end to the forces of onshore sea and weather. Further, her anchors are ready for easy laying and later heaving; they can be carried out direct from

the hawse pipes and stressed by the windlass. In fact, her anchors and cables could well be laid out while making her approach to the beach. Provided the beach is firm and free from rocks, the propellers and rudder will be unharmed, but her impact, of course, must be as gentle as possible. Stern suctions may be choked in this position, however.

If beached bow-on her vulnerable, more buoyant, end is exposed to sea and weather. To keep the stern quiet, ground-tackle must be laid out from aft. This is laborious when done after beaching, but the vessel could well be anchored from aft as she makes her approach (see Chapter I).

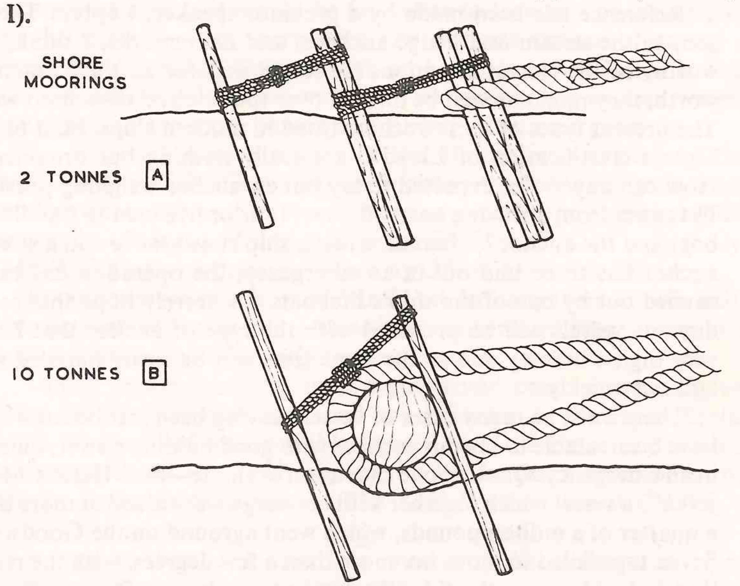


FIGURE 8.8

The seaman has a natural instinct by which he strongly avoids allowing his propeller and rudder to come into close proximity with objects such as wharves, piers, and other vessels. The suggestion that he should beach stern-on may well disgust him, but on close consideration the advantages are many.

Fig. 8.8 shows two methods whereby a vessel may secure her head-lines to the shore to prevent unexpected refloating or being driven off shore by a gale.

The stakes may be of metal. If wooden, a timber having a natural elasticity is preferable, e.g. lifeboat oars made of ash. They should be driven to a depth of at least 1 m and at an angle of 20 degrees to the 3 ft
vertical. Fig. 8.8 *(a)* shows a combination of stakes suitable for a stress of up to 2 tonnes. Fig. 8.8 *(b)* shows a heavy spar (a light derrick would tons

be ideal) secured between pairs of stakes along its length. The stakes on the seaward side must be exactly in line so that each bears a proportion
tons of the stress, which can be up to 10 tonnes.

In closing this chapter I am including extracts from a discussion held at the Institute of Naval Architects in 1950. This took place as the result of a technical paper submitted by Mr. H. L. Dove, M.I.N.A., on model anchor tests. I believe that the points made below will be of particular practical importance to the serving Officer.

'Reference has been made by a previous speaker, Captain Thomson, to the stream and kedge anchors, and his remarks, I think, are worthy of the closest attention. He stated that for all their practical worth, they might as well be thrown over the side and dispensed with. The present types of these anchors fitted in modern ships, built to the highest classification of Lloyd's, are really nothing but ornaments. How can anyone be expected to lay out an anchor weighing possibly
tons 1½ tonnes from a rowing boat with say, four or five men to handle the boat and the anchor? After all, when a ship runs ashore and a stream anchor has to be laid out in an emergency, the operation has to be carried out by one of the ship's lifeboats. I sincerely hope that some day . . . vessels will be provided with the type of anchor that has a very high efficiency and at the same time can be easily handled and laid out quickly.

'There must be many cases of vessels having been lost because they have been unable to lay out anchors with good holding power, quickly in an emergency. Quoting one case as an example—the "Helena Modjeska", a vessel which together with her cargo was valued at more than a quarter of a million pounds, which went aground on the Goodwins. Seven tugs failed to move her more than a few degrees, with the result that in lying across the tide, the sand scoured away from under the bow and stern, after which she broke her back. I am assured by friends at the Admiralty that half a dozen small but efficient anchors
tons of a weight measured not in tonnes, but in kilogrammes would have
hundredweights had far more effect than the seven tugs, and this vessel, being able to maintain steam to all her cargo winches, could probably have hauled herself off within a few hours.

'There is also another good example of the four-masted barque "Archibald Russell". This vessel, laden with grain, was completing a trip from Australia to Ipswich, and when entering Harwich harbour in tow, with a south-east breeze and light ground swell, suddenly took a very broad sheer and went ashore on Landguard Spit. Tugs failed to move her, and it was evident that she was pretty well hard and fast. Fortunately however, one of the Trinity House vessels, the "Alert", under the command of Captain Guy Jarrett, happened to be

in the vicinity, and Captain Jarrett, quickly weighing up the position, laid out his two bower anchors to the extreme length of the cables, connected up his heavy towing hawser, and literally launched the "Archibald Russell" *which came off so quickly that she ran past the* "Alert", *which had to cut her towropes.*

'So long as vessels run the risk of grounding due to fog, or other causes, so will it be necessary to provide them with anchors with the highest possible holding power, but of the lowest weight for easy handling, and irrespective of whether or not they bury too deeply for subsequent lifting. It would be far better to lose two or three lightweight anchors . . . if there were any possible chance of saving a vessel and her cargo, than to have on board heavy kedge or stream anchors with very low efficiencies . . . but which, due to their weight could not, in any case, be laid out quickly in an emergency.

'. . . it would seem a matter of the utmost importance and the responsibility of the Classification Societies to see that ships in these modern times are sent to sea with stream and kedge anchors which are really efficient and designed primarily for use in an emergency' (Mr. S. T. Cope, ex-Principal Mooring Officer to the Air Ministry).

'In commercial vessels, particularly oil tankers, there is little suitable equipment for handling these anchors (present type stream and kedge) quickly and effectively in the case of an emergency.

'Unlike bower anchors, these types would only be required, we trust, on very rare occasions, and any extension of the experimental work on modified and possibly lighter types of kedge and stream anchors with suitable holding power would be warmly welcomed by officers serving in these vessels' (Mr. A. F. Walker, then A.I.N.A.).

It is ironical that soon after this interesting discussion took place, new British ships were no longer required to carry anything more than three heavy bower anchors. An additional requirement of two light anchors with great holding power, such as the A.C.14 or the Stokes–Danforth, would, I am sure, be welcomed by most Masters.

CHAPTER IX

EMERGENCIES

ABANDONING SHIP

If all efforts to save a damaged vessel prove to be unsuccessful she will be abandoned. This must be carried out in as orderly a manner as possible, maintaining complete discipline, silence, strict adherence to orders, and immediately controlling any evidence of panic or insubordination, using *force* if necessary. All members of the crew and passengers will be required to exercise self-control, courage, and unselfishness. Failure to observe all these factors may result in unnecessary loss of life. Public address systems should be fully utilised.

In all probability, the last persons to abandon the vessel will be those engaged in last-minute damage control. When they leave their posts all machinery should be stopped and watertight doors and hatches tightly closed. On passenger ships, officers should be identifiable.

Boats should be lowered with as many people aboard as possible, and should then quickly clear the ship's side and lie off ready to embark the remaining complement from the water. This will avoid a dangerous waiting period alongside the ship, during which the boat is liable to be damaged and foul her falls.

Except in rough weather, the boats should secure themselves together in groups, each group being towed well clear of the wreck area by a power-driven boat. As soon as this is achieved, one or more of these power craft should cruise the area to pick up swimming survivors. If unable to carry any more persons the craft can provide the swimmers with floating wreckage so that they can support themselves until such time as the other boats can embark them. Swimmers should group themselves together and support each other. The group is then more easily detected than individuals.

When leaving a ship directly into the water it is preferable to jump in feet-first rather than to dive. When wearing a life-jacket, the height from which the leap is made should be kept to a maximum of about 20ft. 6 m, otherwise the impact of the jacket on the water is likely to cause stunning or a broken neck. If a leap is unavoidable from a greater height the arms should be crossed over the chest with the hands clamped tightly down on the shoulders to keep the jacket in place. At all times

the best method of entering the water is to lower oneself on a line or ladder.

In a strong wind it is preferable to leap from the weather side rather than the lee side, since in the latter case the rate of drift may well prevent the swimmer from getting clear and he may be overcome by the ship. On the weather side there are two possible hazards: the man may be hurled back against the ship by the sea, or he may find fuel oil extending well upwind. In such a case he has two alternative methods for negotiating the oil: He can swim underwater, surfacing now and then for air, but when he does so, he must spring from the water with his eyes tightly shut and use a rapid breast-stroke motion to thrust the oil away from his face. The second method entails swimming quickly through the oil on the surface with a rapid breast-stroke motion, the head being held high with the mouth closed. In the case of burning oil the former method is the only practical one. When about to commence such an underwater swim heavy clothing should be discarded, since it will remain buoyant for at least a quarter of an hour. A life-jacket should be similarly discarded.

A swimmer must move away from the ship as quickly as possible, since when it founders there is violent local suction, together with the surfacing, with great force, of air and wreckage.

When a ship is listed it is preferable to leap from the ends. If it is made from the high side the man is likely to strike underwater projections or the hull plating, while on the low side the man may be struck by masts, funnels, ventilators, or samson posts, etc., if the vessel capsizes before he is clear.

Procedure within the Boats; Preservation of Crew and Passengers

The importance of previous training cannot be too strongly emphasised, since this is a direct factor in reducing fear and shock. Even in the case of passengers, their regular attendance at previous boat drills will have given them a certain amount of confidence and familiarity which will materially assist in reducing panic. The passengers should not be mustered in such a way as to regard boat drill as an amusing weekly or fortnightly show. Their active participation will be of value to both themselves and the crew.

Occasionally in port, the crew should lower boats and pull clear of the ship. The same operation performed at an anchorage during a slight swell or moderate sea will do much to impress upon all concerned the difficulties of clearing a vessel in heavy weather. At boat drills a brief word on first aid, use and maintenance of lifeboat stores, and conduct in an open boat is most advisable, but regrettably rarely practised.

Ideally, a man should abandon ship dressed in warm clothing covered with oilskins and wearing boots or shoes. The clothing will not only keep