Part 3. Pages 14–17 are for entries concerning the annual thorough examination of gear exempted from annealing.

Part 4. Pages 18–23 are for entries concerning the annealing of gear. Page 24 contains some recommended minimum factors of safety namely:

tons Metal parts of lifting machinery: 5 for S.W.L. 10 tonnes or
tons less; 4 for S.W.L. over 10 tonnes.

Wooden structures: 8.
Chains: 4½.
Wire rope: 5.
Fibre rope: 7.

Test certificates, etc., are attached to the Register by means of gummed slips provided within the inside back cover. The Register is designed for eight years' service. When a new one is put into use the old one should be preserved for at least four years.

The following are arbitrary expressions for finding the breaking stresses of:

Fibre Rope

Manila $\frac{2D^2}{300}$ Polypropylene $\frac{3D^2}{300}$ Terylene $\frac{4D^2}{300}$ Nylon $\frac{5D^2}{300}$

(where D is the diameter in mm and the result is in tonnes).

Chain

Grade 2 Stud $\frac{30D^2}{600}$

(where D is the diameter of the bar forming the link in mm and the stress is in tonnes).

Wire Rope

(a) 6 strands, 12 wires per strand $\frac{15D^2}{500}$

(b) 6 strands, 24 wires per strand $\frac{20D^2}{500}$

(c) 6 strands, 37 wires per strand $\frac{21D^2}{500}$

(where D is the diameter in mm and the result is in tonnes).

In the foregoing expressions the result is approximate and usually errs on the safe side. In arriving at the safe working load, the breaking

stresses are divided by 5 or 6, the safety factor. The results are a useful guide in the absence of more precise information. The same applies to the figure of 10% chosen for frictional effect in purchases. The figure applies more to fibre rope than wire rope. When employing wire or synthetic rope, a figure of 6% is more realistic.

In the past, a safety factor of about 2·5 has often been suggested for use with ropes which are used only occasionally. A wise seaman will reject this notion. Appreciating how rapidly a rope can deteriorate with misuse, the fact that a rope is used only occasionally is irrelevant. With so many materials being used for rope, with widely differing stresses, it is not surprising that one type of rope per ship is recommended for safety.

PATENT DERRICK SYSTEMS

When cargo is handled using one derrick only, the rig is known as a swinging derrick, shown in Fig. 15.16. For heavy loads, a more sophisticated rig is used, shown in Fig. 15.15. The swinging derrick requires four winches and it will be seen from the figures that heaving on the guys will not only increase the thrust at the heel of the derrick but also the stress in the span or topping lift. For this reason, guys are sometimes secured to the load itself. The amount by which the derrick can be swung out of the centreline is limited, because the guy must not make too small an angle at the derrick head. If the angle is too small, then the guy loses control. All these disadvantages of the swinging derrick are partially overcome in the design of the Hallen derrick.

The Hallen Derrick (Fig. 15.3)

The boom is stepped on a mast, Y-mast or bipod mast, the basic requirement being a good spread of cross trees. The two guys are secured to the cross trees using swivel-outriggers which are stayed vertically and horizontally. These outriggers cannot swing inboard past the centreline and this maintains a good controlling angle between guy and derrick. In Fig. 15.3 the left-hand outrigger has moved to the right as far as it can and lies in the centreline. The other outrigger has swung outboard, following the derrick, and the outrigger stay—shown dashed—is slack. The plan view shows how the controlling angle is obtained, the derrick having been swung opposite to the direction in the perspective drawing. The guys also double as topping lifts; if both guys are hauled or slacked together, the derrick will top or lower. Three winches are used, two for the guys and one for the lifting wire or purchase, all operated by a joystick control. Limit switches are used to prevent over-topping and over-swinging but these may be adjusted to allow for alteration in the working range and for vertical stowage.

Fig. 15.3 shows only basic principles—in practice, the Hallen may be a heavy-lift derrick. Instead of using two gun tackles for the guys (as shown) the falls may be endless, running through further blocks on the centreline, which therefore gives a traditional topping lift. This type is known as the Hallen Universal derrick and superseded the **Hallen D-Frame** derrick which is also shown in plan view. A large steel bracket is welded to the mast in the centreline, making a D-shape to an observer facing athwartships. Here, the guys do not use outriggers but are attached to heavy, sprung pendants which bear against the D-frame when the derrick is swung, again maintaining a good controlling angle on the guys.

The Hallen derrick is best suited to cargoes such as containers, logs, steel rails, sawn timber and heavy lifts, and is not generally chosen for handling small, general cargo. The derrick can be made ready in a few minutes and employs only one winchman. The guys can carry 75% of the load, so there is good safety aloft. It does the job of a crane, with lower capital expenditure and a higher safe working load compared with current ship cranes. It will swing to 75 degrees from the centreline and work efficiently at only 15 degrees above the horizontal.

Where it is not desired to use outriggers or D-frames, a suitable system is the Velle derrick.

The Velle Derrick (Fig. 15.4)

This is shown in schematic form, with the derrick lowered to the horizontal and the lifting purchase hanging free. The reader is therefore looking along the derrick boom, which is shaded.

A yoke is fitted across the head of the boom, giving it a T-shape. The guys, which also act as topping and lowering units, are secured to the yoke with four short, steel-wire hanger ropes, one of which—for the sake of clarity—is shown dashed. The topping/lowering ends of the falls are made fast to half-barrels on one winch, being wound in the same direction so that the wires are run on or off the winch at uniform speed. The slewing ends are wound on to the half-barrels of another winch in opposite directions, for obvious reasons. A third winch is used for hoisting. The plan view shows how the yoke maintains the controlling angle of the guys at the head of the boom. The use of

divergent cargo runners drastically reduces swing and rotation of the load. Winches are remotely controlled using a joystick duplex controller, all levers returning to neutral on being released.

The Stuelcken Derrick (Fig. 15.5)

This heavy-lift derrick is fitted to well over 200 ships. A safe working
load of 275 tonnes is not uncommon. While a traditional heavy derrick tons
may take eight hours to rig and require up to six winches, with extra
stays on the masts, the Stuelcken is rapidly brought into use, affords
easy sea stowage and employs only four winches. It is mounted on the
centreline between two unstayed Samson posts in the shape of a V,
and can therefore be swung through the posts to serve another hatch.
One hoisting winch and one span winch are placed in each post, all
four winches being operated by one man, using two levers—one for each
post. Bearings, swivels, sheaves and the gooseneck are maintenance-free
for up to four years, producing only about 2% friction. The winches
have two ratios, using full or half loads. The span tackles are independent,
the hoisting fall is endless. Revolving suspension heads are fitted
on the posts and swinging-through takes about ten minutes. In the
double-pendulum block type, half the cargo tackle may be anchored
to the base of the boom. The fall still passes through the two purchases
but because one end is anchored, the hook speed is doubled. The safe
working load is naturally halved. Typical dimensions of a 275 tonne ton
Stuelcken are: length 25·5 metres, diameter 0·97 metres, diameter of 83 ft 6 in 3 ft 2 in
posts 3·4 to 1·5 metres, posts 18 metres apart (upper end) and 11 ft 1 in 4 ft 11 in
8·4 metres apart (lower end). Using full SWL of 275 tonnes, a hook 58 ft 11 in
speed of 2·3 metres per minute is obtained. With one end of the lifting 27 ft 6 in tons
purchase anchored, the figures become 137 tonnes and 4·6 metres per 7 ft 6 in
minute. By varying winch ratios, combinations of 100 tonnes (treble tons 15 ft
speed) and 68 tonnes (quadruple speed) can be used. The double- tons
pendulum block type of Stuelcken is swung through by detaching the tons
union table, allowing the lower blocks to swing free each side of the
boom. The derrick is then slowly topped until nearly vertical. A bullrope
is used to ease the derrick through the vertical until the span tackles
have taken the weight on the other side. The union table is re-secured
and the derrick is ready to work the other hatch.

Fig. 15.5 also shows a fork-type Stuelcken, using single-pendulum blocks. This is swung-through by detaching the cargo hook and hauling the lifting purchase until both blocks meet and seat in the fork. By the time this occurs, the lower block is above the top block, as shown. The derrick is topped and swung through as before and the lifting purchase extended to serve the other hatch.

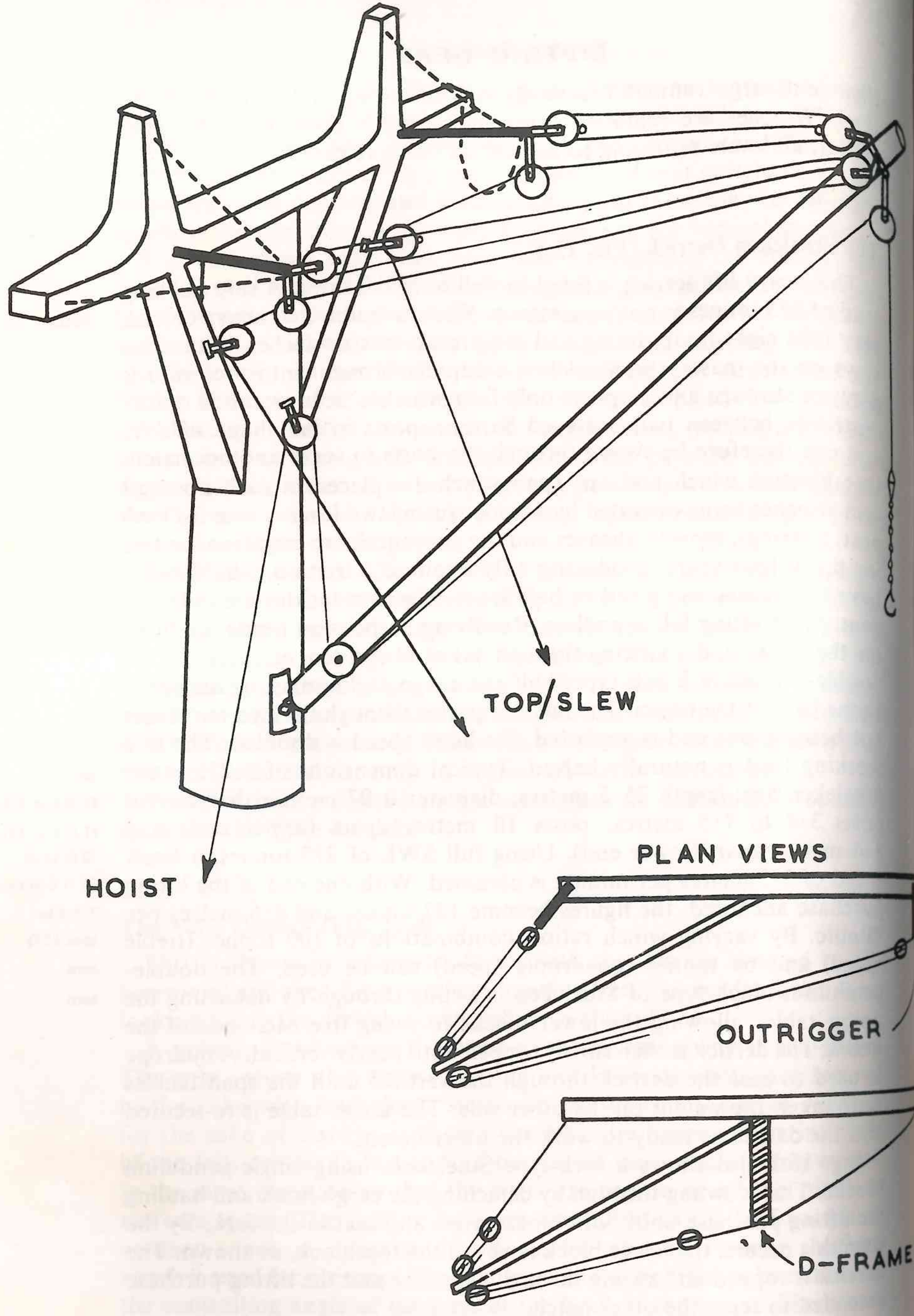


FIGURE 15.3 HALLEN DERRICK

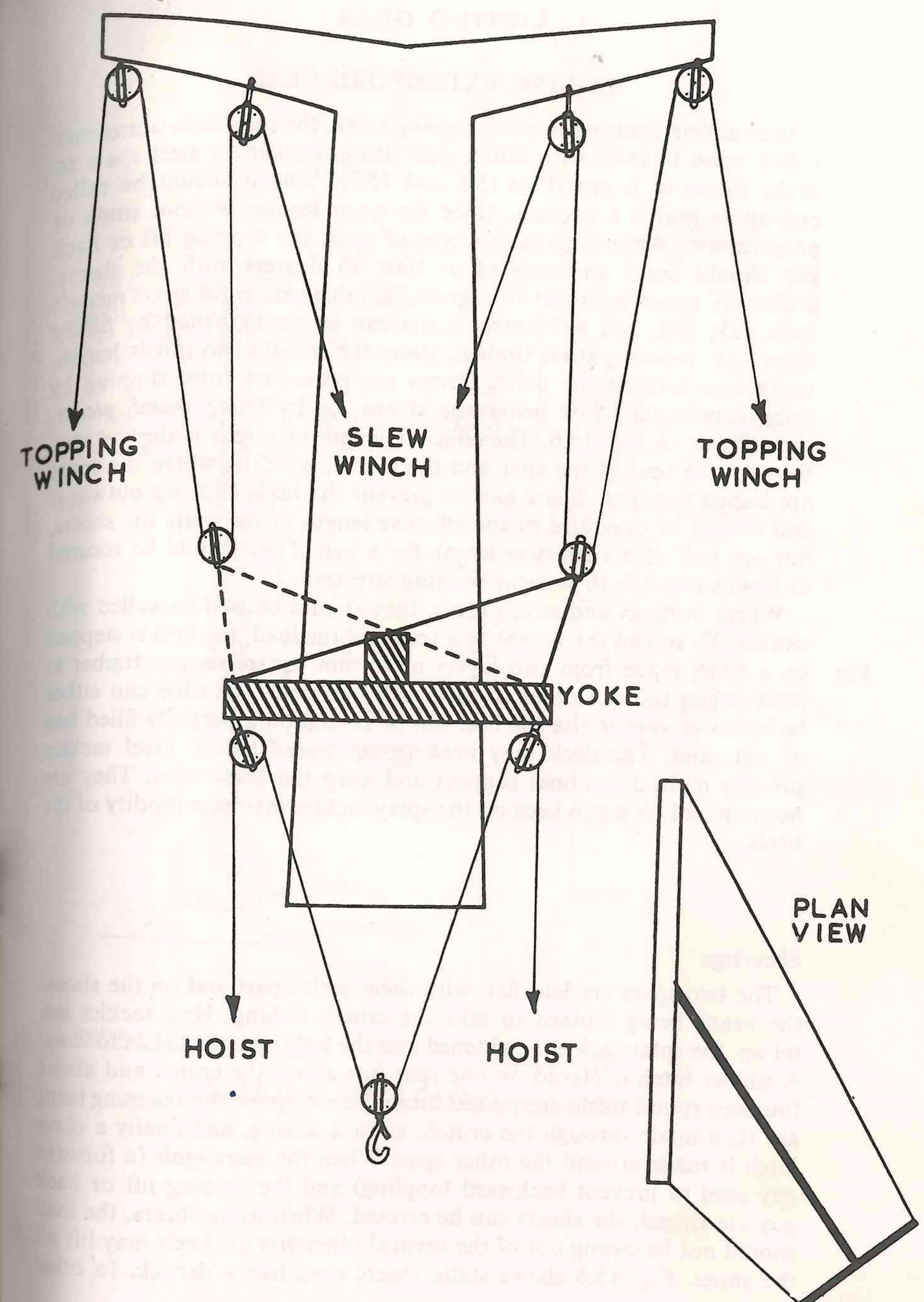


FIGURE 15.4 VELLE DERRICK (SCHEMATIC)

RIGGING EXTEMPORE GEAR

In complete contrast to the foregoing work, the seaman is sometimes called upon to improvise lifting gear using wooden or steel spars to make sheers or a gyn (Figs 15.6 and 15.7). Why it should be called extempore gear is a mystery, since the word means 'without study or preparation'. When rigging this type of gear, the topping lift or back guy should make an angle of at least 45 degrees with the sheers, preferably between 60 and 90 degrees. Suitable woods for spars include teak, oak, elm, ash and beech. Spars can be strengthened by *fishing* them—i.e. securing stout timbers along the middle two-thirds length, using wire lashings or bolts. Strops are prevented from slipping by using rope collars just below the strops, or by fixing *thumb pieces*, shown inset in Fig. 15.6. The effective length of a spar is the distance between the heel of the spar and the *crutch*, which is where the spars are lashed together. *Splay tackles* prevent the heels slipping outwards and should be one-third of the effective length of the spars for sheers, but one-half of the effective length for a gyn. They should be secured as low as possible to prevent bending stresses.

Where lashings and strops cross, they should be well parcelled with canvas. To spread the weight of a spar and the load, the heel is stepped
3-in on a shoe, made from two layers of 75-mm square-section timber at right angles to each other to form a lamination. The shoe can either be hollowed out or else the heel can be placed on a partially filled bag of wet sand. The deck may need to be shored below. Heel tackles provide multi-directional support and keep the heels rigid. They are not required on a gyn because the splay tackles maintain rigidity of the heels.

Sheerlegs

The two spars are laid flat, with their heels apart and on the shoes, the heads being crossed to take the crutch lashing. Heel tackles are set up, the splay tackle is tightened and the lashing is passed as follows. A timber hitch is placed on one spar just above the crutch and about fourteen round turns are passed around both spars. Six frapping turns are then made through the crutch, as in a seizing, and finally a clove hitch is made around the other spar. When the *martingale* (a forward guy used to prevent backward toppling) and the topping lift or back guy are rigged, the sheers can be erected. When using sheers, the load should not be swung out of the vertical otherwise the heels may lift off the shoes. Fig. 15.6 shows static sheers used like a derrick. In other

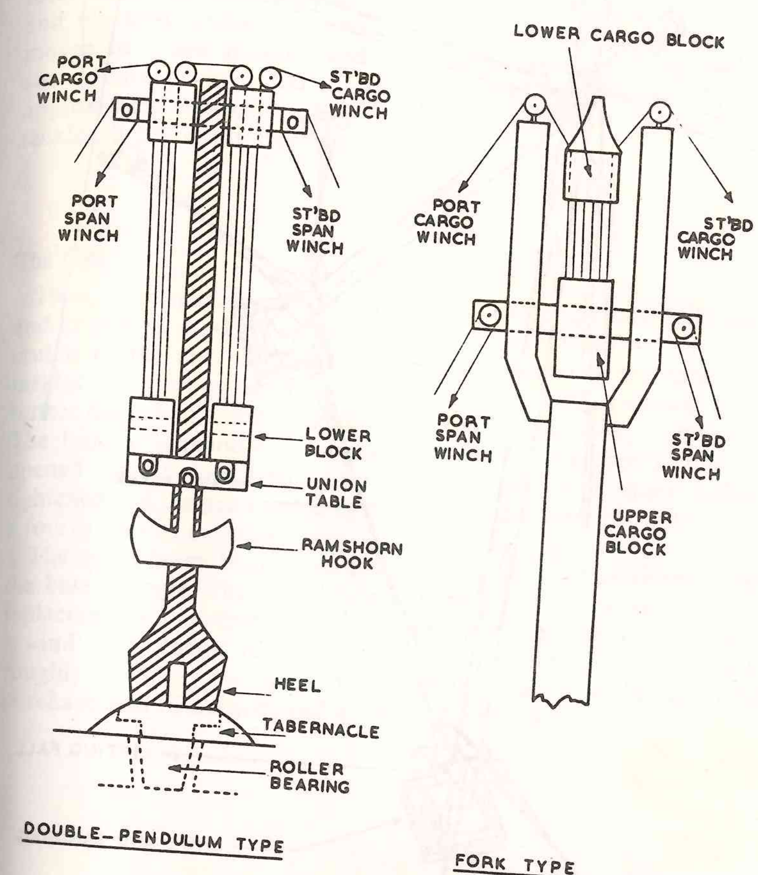


FIGURE 15.5 STUELCKEN DERRICKS

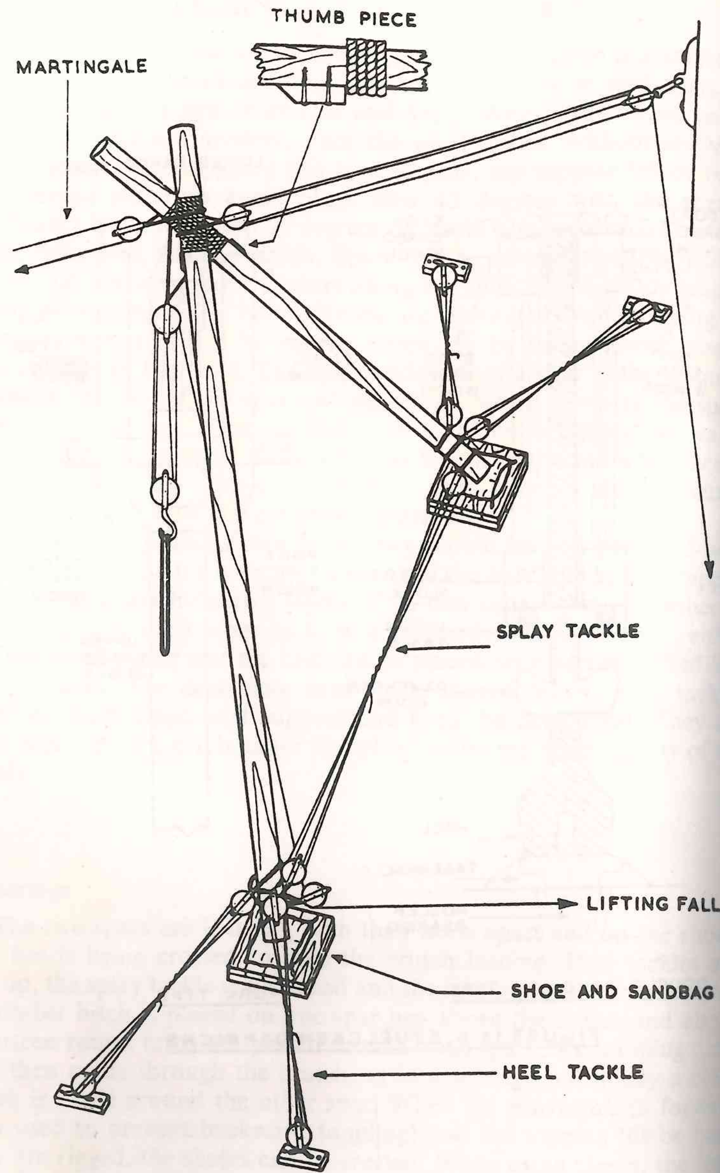


FIGURE 15.6

cases, on smooth ground or on a deck, the sheers can be rigged with very long forward and back guys, and equally long heel guys—two to each heel—leading in opposing directions along the line in which it is desired to shift the load. These are walking sheers and are used as follows. The sheers are tilted 20 degrees towards the load, which is lifted clear. The sheers are then tilted 40 degrees in the opposite direction and the load landed. By heaving on the heel tackles the sheers are moved to a new position and the process repeated. They are being swung-through rather like a Stuelcken derrick. If W is the load lifted, approximate stresses are 0·6W in the back guy, 0·3W in the heel tackles, 0·5W in the splay and 0·8W in the spar.

The Gyn

Here, three spars are set up as a tripod, two being crossed like sheers and known as *cheeks*. The third spar, or *prypole*, is lashed beneath the crutch of the cheeks. The only purchases required are three splay tackles and a lifting purchase. The lashing is passed as shown, using a timber hitch, half a dozen figure-of-eight turns and finally a clove hitch. The lashing is made not too tight, otherwise the cheeks cannot be opened out at their heels. Once opened, the cheek splay tackle is tightened and the gyn erected by heaving on the other two splays, using a fourth spar as a central lever.

The gyn is laterally unstable and the load must not be swung outside the base triangle. The gyn is primarily used for lifting an object and replacing it in the same position, for example the intermediate shaft of a windlass to enable re-bushing to be carried out. Estimated stress is roughly 0·4W in the spars, 0·6W in the spar used for the lifting purchase lead (if needed) and 0·3W in the splays.

DECK CRANES

While the ship's derrick is considered by some to be very adaptable, flexible and versatile, others say the same applies to a ship's crane which, while entailing a greater capital investment, does leave the deck entirely clear of guys and other rigging. (This is the great advantage too of the Hallen, Velle and Stuelcken derricks, which are often referred to as derrick-cranes).

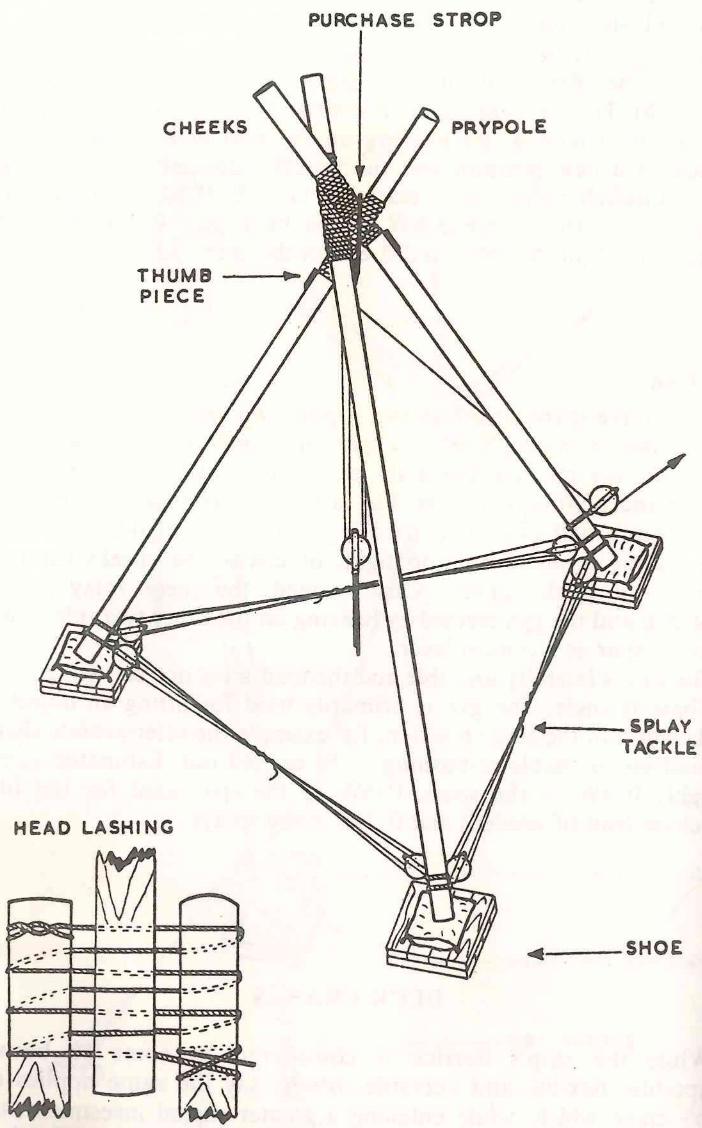


FIGURE 15.7

The deck crane provides protection from the weather for the wires and machinery and much of the servicing can be done inside the pedestal and tower. The hydraulic crane offers compact motors, reliability, minimum maintenance and security against overloading. One three-phase electric motor will drive four separate pumps and each motion of the crane will have its own pump system. If the system pressure should fail, brakes are automatically applied. Cut-outs can be fitted for maximum hoist, outreach and plumbing depth. Grooved drums often have 'FULL' and 'EMPTY' sensors.

The simple 3 tonne SWL deck crane of the 1950s is now dwarfed by the modern type with safe working loads up to 60 tonnes or more, which can be provided with remote control, *level-luffing* whereby the load remains at a set height even though the jib is topped, fittings to work containers, adaptation for grab-work, and explosion-proofing for use on tankers. Deck cranes may also run along rails, either on or clear of the hatchways, where they can be clamped in suitable working positions.

Twin cranes can be used for very large unit loads. The two cranes are mounted on the same pedestal but the two towers or *crane houses* can operate independently, i.e. in *single mode*. By locking them together, heavy loads can be handled. *Team cranes* are mounted on separate pedestals, usually at opposite ends of the hatch. The falls can be connected to one spreader, the cranes electrically interconnected and the system controlled either remotely from the deck or from one cab. Again heavy loads can be handled rather like the derrick Yo-Yo gear in Fig. 15.11. Twin cranes can be teamed to give even greater flexibility.

Control systems for cranes should be given high priority in the ship's maintenance programme.

Under existing Docks Regulations (1934), cranes are the only lifting devices which may be overloaded, *in exceptional cases*. (See page 383) Perhaps for this reason they are required to be thoroughly examined annually, compared with the four-yearly examination for derricks.

DERRICK RIGS

The Union Purchase (Fig. 15.9)

This is occasionally referred to as *married gear*, although its original title was the *yard and stay*. In the days of sailing ships the whips were rove through blocks secured to the yardarm and the mast stay. The name 'yard' is still used for the outboard derrick. In the figure the whips are connected to a union swivel. Although not shown, this unit has three swivels, one each for the whips, and a third for the hook. If only a swivel-

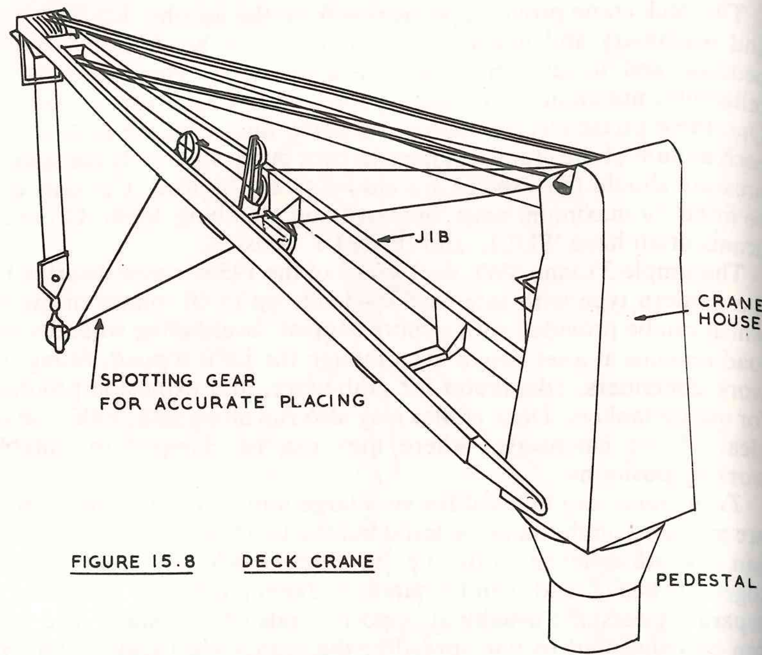


FIGURE 15.8 DECK CRANE

lugged hook is available the runners are crossed through a shackle and then shackled to the swivel hook.

The rig is used for light loads of up to about 1½ tonnes. The derricks are secured in the plumbing positions, one over the quay and the other over the hatch, by means of slewing guys. These guys are omitted from the drawing. Standing, or lazy guys, are fitted to the outboard sides of the derricks to assist in absorbing the strong side-stresses. The load is lifted on one whip and hove across the deck on the other, slacking away on the first one. The angle between the whips should never exceed 120 degrees, since at this optimum angle the stress in each whip is equal to the load. Complete co-ordination between the two winchmen is essential. It is possible, through misjudgement and indifferent rigging, to overload the gear by *more than* 100%. For this reason the safe working loads of the derricks should be cut by 67% when *double-derricking*.

Doubling a Whip (Fig. 15.10)

This converts a single whip to a double whip and creates a mechanical advantage. Sufficient wire must be available to reach the farthest part of the worked compartment. If the second spider band shown in the draw-

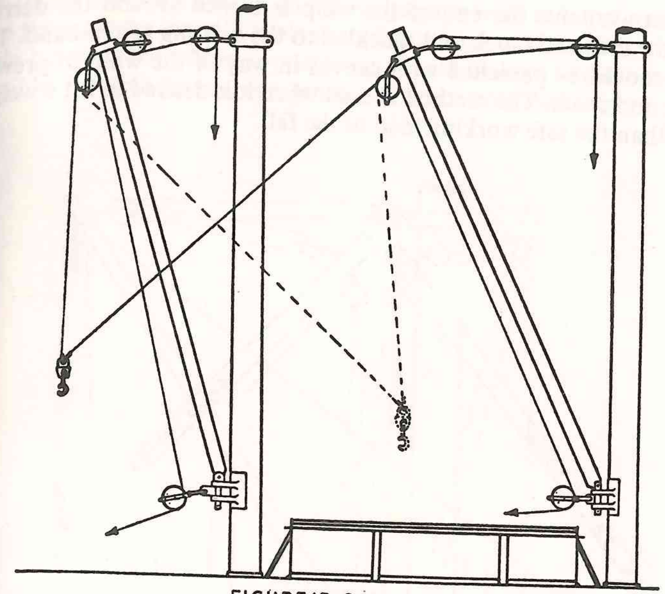


FIGURE 15.9. UNION GEAR

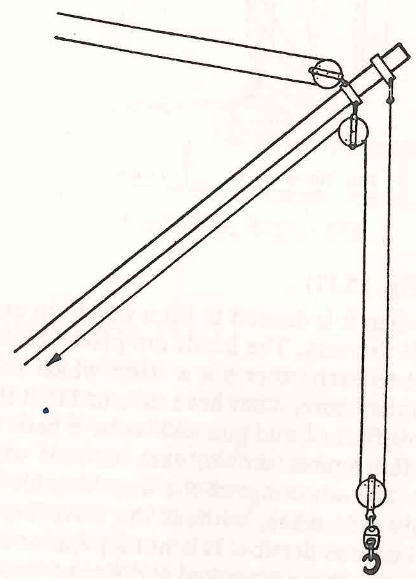


FIGURE 15.10 DOUBLING GEAR

ing is not available the end of the whip is turned around the derrick just below the head block and shackled to the existing spider band. The derrick should be parcelled with canvas in way of the whip to prevent slipping and chafe. The method is used when it is desired to lift a weight greater than the safe working load of the fall.

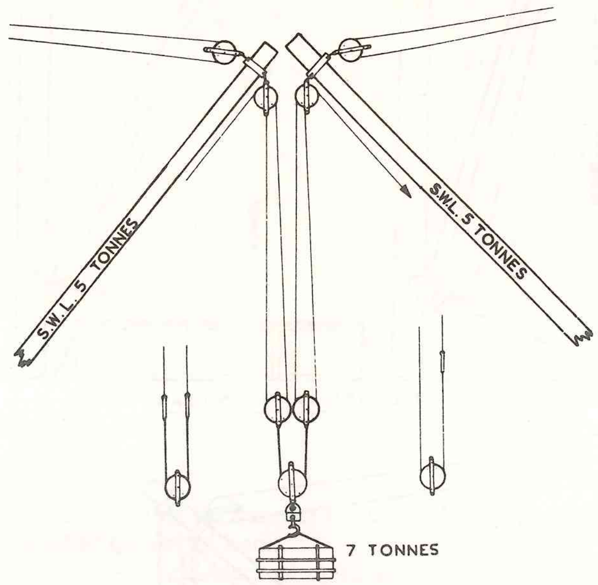


FIGURE 15.11 YO-YO GEAR

The Yo-Yo Gear (Fig. 15.11)

This rig is used when it is desired to lift a weight in excess of the safe working load of the derricks. The heads are placed close together, and the whips shackled to each other via a strop which passes through a travelling block. In the figure, it has been assumed that the safe working load of the fall is insufficient, and gun tackles have been rigged as lifting purchases. Using the figures shown, each derrick will experience a stress of $3\frac{1}{2}$ tonnes. The advantage of the travelling block is apparent if one winch suddenly fails when, without the travelling block, the full load would prevail on one derrick. It is not a popular rig among stevedores, because if the winches are worked at different speeds the travelling block is abutted by the lower block of one purchase, the slower-working

tons

one. To avoid using a strop on the whips, one whip is sometimes simply rove through the travelling block and shackled to the other whip. The angle between the whips or purchases should be kept as close to zero as possible. For this reason, the derricks must be very accurately guyed.

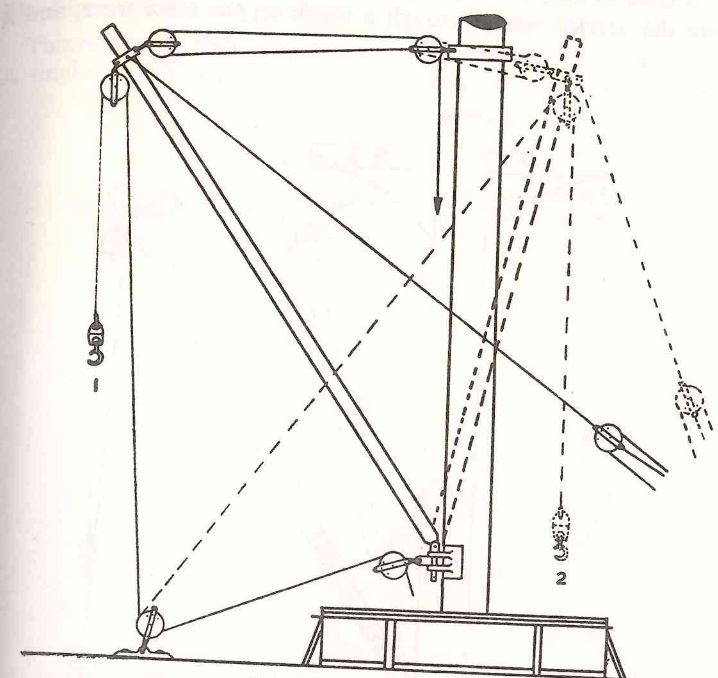


FIGURE 15.12 WING LEAD

The Wing-lead Derrick (Fig. 15.12)

This rarely-seen rig provides a very speedy method of working cargo. The whip is rove through the headblock from the hook, down to the deck, and through a block at the ship's side, and thence to the winch via the heel block. The load is lifted from below in the position (2) and raised clear of the coaming. The inboard guy is then slackened and the stress in the whip, together with its side lead, swings the derrick to (1). The derrick is then re-plumbed over the hatch by heaving on the inboard guy. The thrust in the derrick is increased in this rig compared with the traditionally-rove whip, and loads must therefore be light. The rig could be used for loading provided the wing-lead was shifted to the right-hand side of the coaming. The guy will then be rigged on the shore side of the derrick.

The Backweight or Deadman Rig (Fig. 15.13)

This is used to load or discharge with a single derrick. A lazy guy is led from the derrick head, through a block on the cross trees, and is

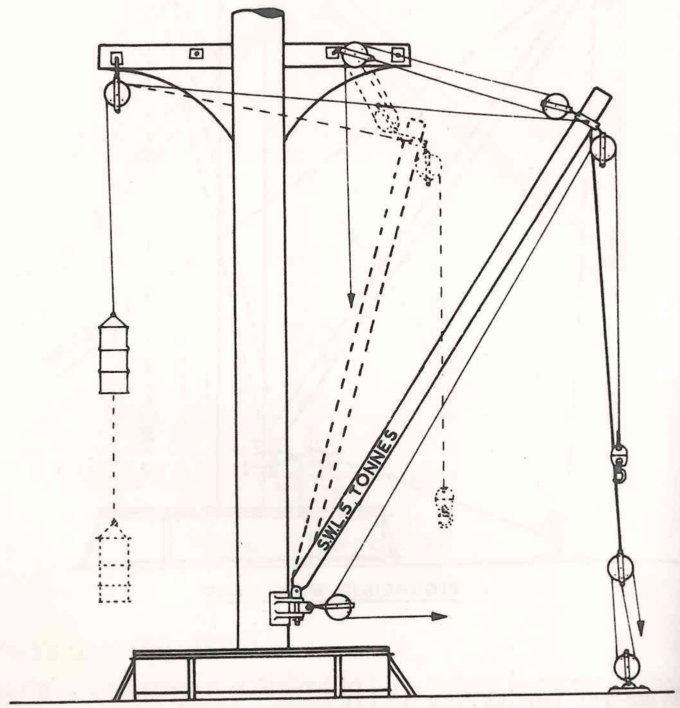


FIGURE 15.13 BACKWEIGHT RIG

then shackled to any suitable weight, such as a large drum of concrete or water. The derrick is plumbed overside by heaving on the *steam guy*, i.e. the one on the right-hand side of the drawing, which is led to a winch. The deadman is then rising. As soon as the steam guy is slacked the deadman descends and swings the derrick inboard, the swing being controlled by the steam guy. It provides a quick method of working

light cargoes. It is popular in certain parts of the London docks for discharging timber cargoes. The backweight is a danger to persons on deck, and where another derrick is available it is plumbed overside and the lazy guy rove through its headblock. The deadman then operates overside.

The Liverpool Rig (Fig. 15.14)

This is used for light cargoes such as bagged goods and sacks of hides. A single derrick is plumbed overside and secured with standing guys

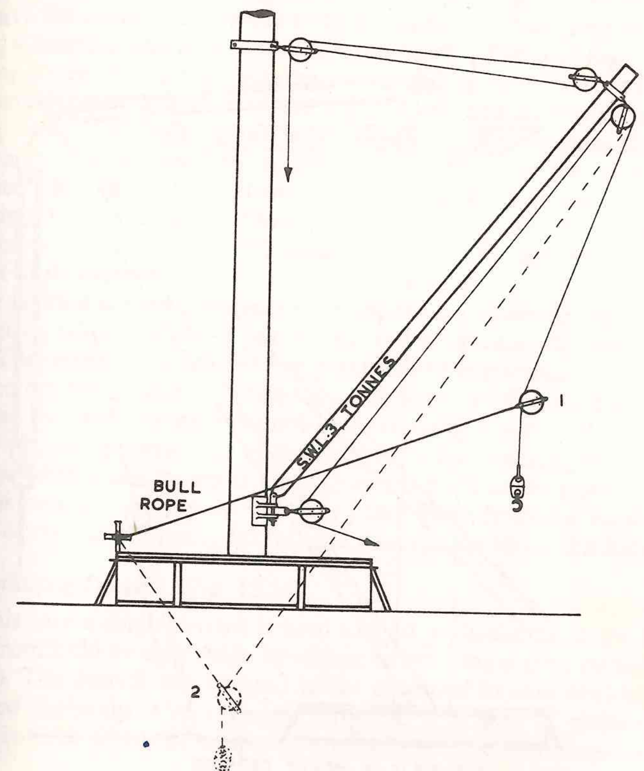


FIGURE 15.14 LIVERPOOL RIG

(not shown). The whip is led through a travelling block which is secured, by means of a 24–32-mm fibre bullrope, to a portable bollard clamped to 3–4-in
the hatch coaming. When the whip is slack the bullrope-operator heaves

on the rope and belays the line so that the block is in (2). The hook is lowered, the load lifted and raised. As it clears the coaming, the bullrope is slacked and the load is veered across the deck (1). When the load is plumb under the derrick head the bullrope is all slack. With an experienced man using the bullrope the method provides a very rapid discharge of cargo.

The Heavy or Jumbo Derrick (Fig. 15.15)

tons These derricks have safe working loads often in excess of 100 tonnes. The basic principles are shown in the drawing. A sheave is built into the

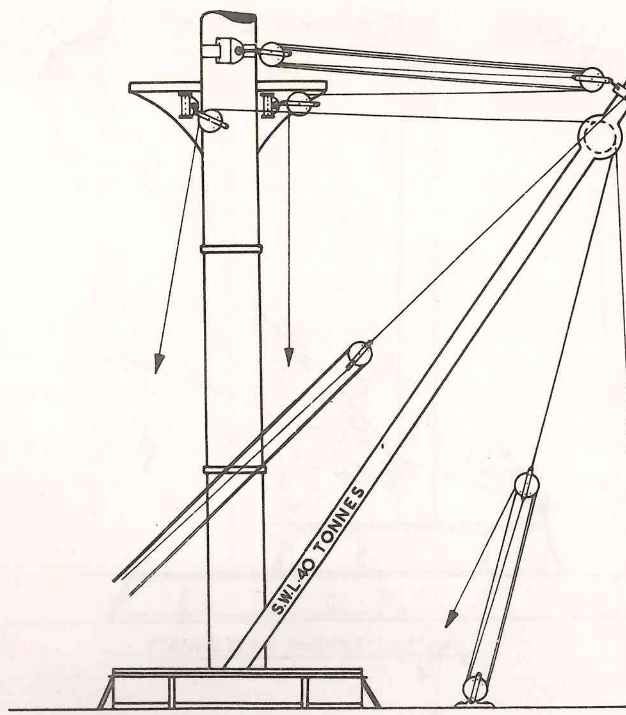


FIGURE 15.15 HEAVY DERRICK

derrick so that the lifting purchase can be used to advantage. A lead block on the cross trees enables the topping lift to be similarly used. The gain in mechanical advantage also reduces the thrust on the derrick, the head purchase block, the spider band, the gooseneck, and the topping-

lift mast shackle. The stresses in the falls are also reduced. Both guys are winch controlled. During the use of this type of derrick the mast is rigged with extra stays.

When preparing the derrick for use all the wires and blocks should be carefully examined, particularly the sheaves for free rotation. The derrick is stowed against the mast and secured at its head either by chains and wedges, or a steel clamping-band, or both. Sometimes the top lifting-purchase block is left in position and a canvas hood shrouds the block and the derrick head.

A gantry, or a gallows, is usually fitted to the mast just above the derrick head. A block is hung off here and a gantline is rove through it to heave the topping lift blocks to their positions. With these secured in place, a heaving line is rove through the blocks. The topping-lift fall is bent on to the end and the heaving line is used to reeve the wire fall. The guy pendants are shackled to the spider band and their purchases are set up tight. The topping lift is then hove as tight as possible and a breaking-out wire passed round the derrick head above the spider band. The derrick is then detached from the securing band or chains, and the breaking-out wire stressed. The derrick then moves away from the mast, and very soon the topping lift becomes completely taut as it takes the weight of the derrick.

The derrick is then lowered to the horizontal position, controlling it with guys, when the lifting purchase is more conveniently secured and rove. The derrick is tested for free rotation at the gooseneck.

If, before the derrick is broken out, the topping-lift blocks abut each other so that the purchase cannot be hove tight, a wire will have to be rigged on the opposite side of the derrick to the breaking-out wire, so that the derrick can be eased away from the mast under control. Without this easing wire, the derrick may jump away from the mast to the extent of the slack topping-lift fall and damage the block shackles.

The Swinging Derrick (Fig. 15.16)

In this case a single derrick is used to load or discharge cargo, swinging it from hold to ship's side by means of two steam guys (winch controlled). The derrick can be used to the extent of its safe working load provided the whip is of sufficient strength. If a load of more than 3 tonnes is to be lifted the whip will normally require doubling. tons

Precautions when Handling Heavy Lifts

All gear involved, including strops and eyebolts, should be carefully examined beforehand. The stability of the ship must be checked so as to make sure that the rise in the centre of gravity of the ship will not produce a condition of negative metacentric height. In this connection, free-surface effects may have to be reduced.

The vessel should be on an initial even keel with moorings taut and manned. Barges not in immediate use must be cast off. Preventer stays will be rigged on the mast.

If loading the weight on deck the latter may require shoring from below. The guys should be rigged at 30 degrees to the deck and making a broad angle with the derrick. Winches will have to be checked and manned with reliable persons.

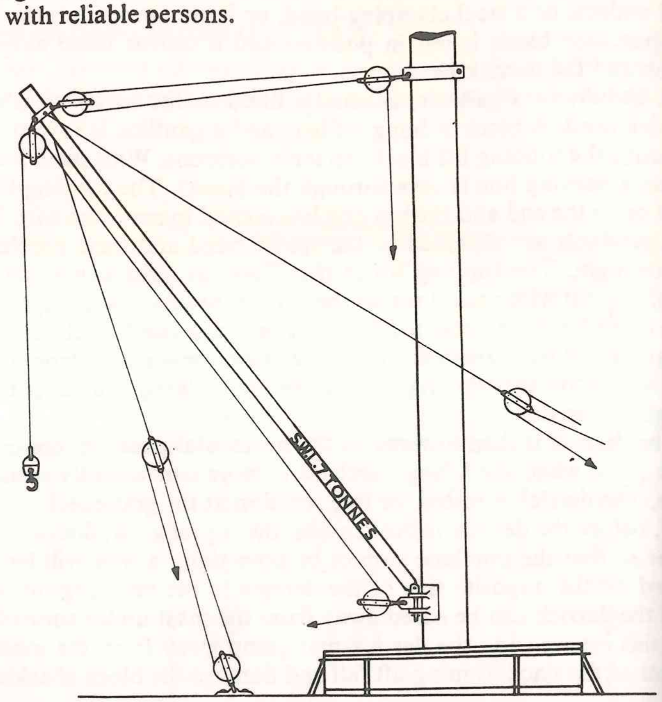


FIGURE 15.16 SWINGING DERRICK

The load must be plumbed by the derrick head and slung under the supervision of a competent person. Light lines are often secured to the load to act as steadying lines.

When discharging, the critical moment occurs when the load is just floated clear of the deck or tanktop, for the centre of gravity of the load is then virtually at the derrick head and the centre of gravity of the ship rises in proportion. If the stability of the ship becomes negative the vessel will fall over to an angle of loll. The load is then preferably landed, and the stability of the ship improved. If this is impossible lighters are sometimes secured to that side of the ship which will be the high side when the load is swung out of the fore-and-aft line.

As the load moves from the fore-and-aft line, the vessel will acquire an increasing list, whether or not her stability is negative.

When lowering the load into a truck on the jetty, due allowance must be made for the fact that at the instant when the load is landed the ship will rapidly right herself and cause a sudden lateral drag upon the truck. To prevent this, the topping lift must be instantly slacked down together with a rapid veering of the lifting fall.

When loading the weight, the same reasoning applies. As soon as the weight is taken, the ship will heel due to a lateral movement of the ship's centre of gravity. This is also the critical moment of the operation as the centre of gravity of the load virtually rises to the derrick head. As the load is swung inboard, the heel decreases.

The following is an extract from a pamphlet issued by the Chain Testers' Association of Great Britain and is designed to be of help to all persons engaged in the use of lifting machinery:

DO

(1) Know the weight being lifted and allow for the purchase weight.

(2) Select lifting tackle of adequate strength and see that it is properly marked; no chain or rope should be used for any load exceeding the safe working load.

(3) See that end links, rings, or shackles are riding freely on any hook on which they hang.

(4) Use wood or other packing to protect the sling from any sharp edges on the load.

(5) Avoid shocks due to (*a*) the load slipping or (*b*) snatch in starting. The stress on all gear is much greater if the load is applied suddenly.

DO NOT

(1) Use an excessively pitted, corroded, or worn chain. (Condemn it and cut it up.)

(2) Use a chain in which links are locked, stretched, or do not move freely.

(3) Join chains by bolting or wiring links together.

(4) Shorten chains by tying knots in them (use an adjuster or keep an adequate supply of slings of suitable length).

(5) Drag a chain from under a load or drop it from a height.

(6) Hammer a link to straighten or force it into position.

(7) Carry idle slings on the hook at the same time as a loaded sling.

Multiple Leg Slings

The Association recommends a standard normal practice of marking and certifying these slings with the safe working load, at 90 degrees between legs. Above this angle the safe working load decreases rapidly.

If all the legs cannot be loaded equally, use a sling strong enough to support the load safely on those legs which may have to carry it.

Endless Chain Slings

These must be used with care to avoid possible overloading or damage to links by bending too sharply. The Association recommends as a standard normal practice the marking and certifying of these slings with a safe working load equal to 1½ times the load on the single chain.

Wire Rope Slings

These should never be bent sharply, allowed to come into contact with hot metal, or to become rusty.

Fibre Ropes

These must be examined frequently for external chafe, cutting, internal wear between strands, and deterioration of fibre. Wet or damp ropes should be kept in a well-ventilated store and not dried rapidly in a boiler house, or left to dry out on the open ground.

CHAPTER XVI

ROPE AND CANVAS

FIBRE ROPE

THE process of manufacture entails combing selected fibre into long ribbons known as sliver, which are later twisted up into yarns. These yarns are then twisted into strands, three or four of the latter being finally laid up into the finished rope.

The primary object of twisting fibres together in a rope is that by mutual friction they may be held together when a stress is applied to the whole.

The essential features of a good rope are carefully selected and blended high-grade fibre, careful spinning into yarns of uniform size and strength, forming the yarns into solid circular strands with all yarns parallel, the strand being even, smooth, and having the correct degree of twist, and laying three or more of these strands into rope at the correct angle to suit the required working conditions.

Standard Lay implies a rope with that angle of lay which experience shows combines pliability, strength, and ability to withstand chafe to the best advantage for all general work.

Soft or *Long Lay* implies a rope in which the angle of lay is less than normal, the angle of lay being that between the axis of the strand and the axis of the rope. The pliability and, to some extent, the breaking stress are increased, but the elasticity is reduced. It is more liable to absorb water and lose its shape, but is very necessary for work such as sailmaking.

Hard, *Firm*, or *Short Lay* implies a rope in which the angle of lay is greater than normal. The effect is to increase the ability of the rope to retain its shape under load, and to reduce the absorption of water. Both the pliability and the breaking stress are, however, reduced, but the elasticity is increased.

Right-hand lay means the final laying up of the strands, regardless of the rope's construction, in the same as a screw-thread. In the trade it is described as a Z-*twist*. Left-hand lay is the reverse and is described as an S-*twist*. These are illustrated in Fig. 16.1 together with the construction of rope. It will be noticed that the fibres and the strands have the same twist, but the yarns have a reverse twist, i.e. in a right-handed rope the fibres are twisted together right-handed, the yarns are twisted left-handed, and the strands are laid up right-handed.

Three-stranded rope is referred to as *plain lay*. Seamen refer to it as a hawser-lay if it is right-handed, but the members of the rope trade find that it is frequently confused with cable lay so that when ordering it is preferable to use the term 'plain lay'.

Four-stranded rope is sometimes called *shroud lay*. It has a bigger bearing surface compared with plain lay. Its weight is greater and its strength less. The four strands are laid round a central fibre heart or core. Both three- and four-stranded ropes are normally laid up right-handed.

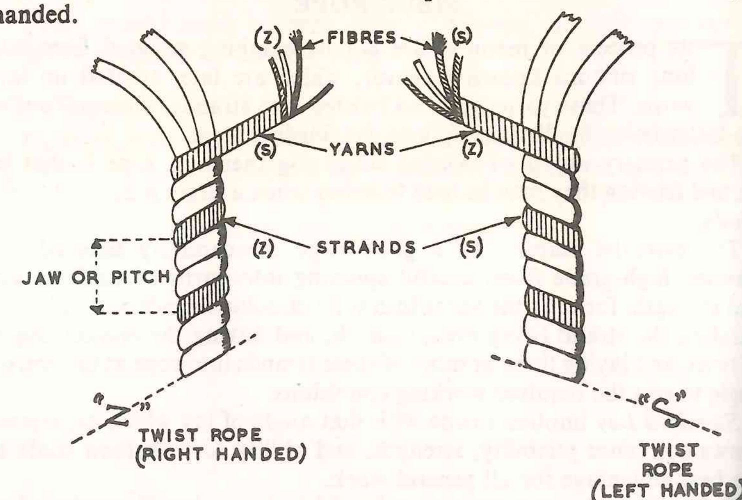


FIGURE 16.1

Cable or *Water Lay* is made by laying together three ropes each of three strands. The characteristic features are its greater pliability and elasticity compared with plain lay of equal size. The weight is slightly less and the strength is substantially reduced. Cable-lay rope has a good
120 fathom resistance to water penetration. If three 100-m ropes are laid into
100 fathoms cable lay, the resulting rope would be about 83-m long. It is normally composed of three right-handed ropes laid up together left-handed. When required, however, it can be manufactured with a reverse lay. It is frequently used as a towing spring attached to a length of wire rope. It is essential that the two lines should have the same lay, otherwise the fibre line will tend to unlay itself. Since wire rope is invariably right-handed, it follows that most cable-laid towing springs also have a right-handed lay.

Warp-lay rope is the same as cable lay except that the first and final lays are very hard. Warps are often supplied twelve stranded, i.e. four

primary ropes each having three strands are laid up together. For some work, the warp lay may even have fifteen strands.

Unkinkable Lay is not illustrated, since it appears the same as plain lay at first sight. This type of rope, specially made for lifeboat falls, has the yarns spun with the same twist as the strands instead of as in ordinary rope. This tends to eliminate the tendency of orthodox rope to kink and twist when working in multiple blocks.

Plaited mooring ropes of natural or synthetic fibre are highly flexible and almost undamaged by kinking. They have a lower stretch and ultimate extension than laid ropes of a similar size, but are nearly as strong.

This type of rope is found to develop an extremely good grip on winch drums and capstan barrels. Some plaited ropes consist of four left-handed strands and four right-handed strands laid up in pairs. In similar service, the life of a plaited rope may be double that of a plain-lay rope. It is particularly useful when the rope is liable to twist or turn in use. Natural-fibre plaited ropes are treated with water-repellent in manufacture.

Hard-fibre Ropes

1. Manila. This is made from *abaca* fibre, which comes from a plant belonging to the banana family. Its colour varies from ivory white to darkish brown. The production of this fibre constitutes the most important industry in the Philippines. It is available in various grades, the inner fibres of the leaf being much finer than those removed from the outer edge.

As a rope it is smooth, glossy, strong, flexible, very durable, easy to handle, and has a very high resistance to sea-water rotting. It is the most common natural fibre in use at sea. The following figures relate to the finest-quality manila rope:

Three-stranded, 48-mm diameter, weight 352 kg per 220 m coil:
Breaking stress 17·5 tonnes.
Four-stranded, 48-mm diameter, weight 349 kg per 220 m coil:
Breaking stress 15·6 tonnes.
Nine-stranded cable lay, 48-mm diameter, weight 309 kg per 220 m coil:
Breaking stress 10·5 tonnes. (If plaited, this size of rope has a breaking stress of 17 tonnes.)

Manila rope will stretch about 25% of its length.

2. Sisal. This fibre is taken from *aloe* leaves, in the pineapple family. East Africa and Java are the main producing centres. During the war, when manila was extremely scarce, sisal was in wide use in this country and at sea. Very few failures were reported, and in fact it is a fibre of very consistent strength, a very good sisal being of equal strength to medium-grade manila.

As a rope it is an attractive creamy-white colour, very brittle, glossy, and generally swells more than manila when wet. It is not a smooth rope, and its hairy surface promotes considerable discomfort after prolonged handling with the bare flesh. The following figures are for best-quality sisal:

Three-stranded, 48-mm diameter, weight as manila:
Breaking stress 14·7 tonnes.
Four-stranded, 48-mm diameter, weight as manila:
Breaking stress 13·2 tonnes.
Nine-stranded cable lay, 48-mm diameter, weight as manila:
Breaking stress 8·9 tonnes. (If plaited, this size of rope has a breaking stress of 14 tonnes.)

Sisal rope is not generally considered suitable for marine work where manila is available.

3. Coir. This is the fibre of the *coconut* and is removed after the shell has been water-soaked for many months. It comes mainly from India and Ceylon, and is unique in that it is imported from there not as a fibre but as a yarn, already spun by the natives. It is very elastic, red in colour, rough to handle, floats very easily, and is extremely resistant to sea-water rotting. It is often called *grass* or *bass line*. It is principally
16 and 22 in circumference used as towing and harbour springs, varying between 128 and 176 mm in diameter as a cable-laid rope. It is about one-half the weight of manila and roughly one-sixth as strong. The following figures are for best-quality coir:

Three-stranded, 48-mm diameter, weight 203 kg per 220 m coil:
Breaking stress 3·05 tonnes.
Nine-stranded cable lay, 48-mm diameter, weight 153 kg per 220 m coil:
Breaking stress 2·03 tonnes.

As a cable-laid rope, coir will stretch between 60 and 100%. As a three- or four-stranded rope, its elasticity is about 45%.

Soft-fibre Ropes

1. Hemp. Originally the bulk of this fibre came from Russia. Nowadays it is exported from India, Italy, the Balkans, and New Zealand. The hemp produced in New Zealand and St. Helena is not as strong as manila, and is mainly used for the cores of wire ropes.

Italian hemp is generally regarded as the best-quality hemp, having a strength one-fifth greater than top-grade manila. It has largely been

superseded by manila, and is now found at sea as boltrope, small cordage, and high-grade twine.

Indian hemp is equally water-resistant as Italian hemp, and Bombay hemp is now of greatly improved quality as a result of strict Government grading.

Bolt-rope is spun from soft hemp and gives a special soft lay for easy handling and non-stretch qualities. It is a tarred rope. A 48 mm tarred bolt-rope made of soft hemp weighs 420 kg per 220-m coil and has a breaking stress of 12 tonnes (*three stranded*). If supplied untarred, the weight is reduced by 25% and the strength increased by 20%.

2. Jute. This is mainly used for hessian manufacture and the cores of wire rope. It is weaker than hemp.

3. Flax. This is used for sail and tarpaulin canvas. It is ideal for use as a sewing-twine due to its high resistance to abrasion.

4. Cotton. This fibre makes an excellent rope for use as a power drive. At sea it is generally found as an ornamental rope, particularly on gangways. It is very soft rope and easily soiled.

Synthetic-fibre Ropes

1. Polypropylene rope is the lightest synthetic rope, 60% stronger than manila. It stretches 40%, absorbs only 0·1% water and melts at 165°C. A 48 mm polypropylene rope will break at 27·5 tonnes.

2. Polythene is about twice as strong as cotton. As a rope, its strength lies midway between manila and nylon. It absorbs only 0·01% of water and will float almost indefinitely. It has made coir obsolescent for this reason. It melts at 135°C and shrinks about 4% at 60°C. It is unaffected by most industrial chemicals and micro-organisms. It offers good resistance to sunlight and abrasion. Size for size it is 7 times stronger than coir. A 48-mm polythene rope weighs 252 kg per 220-m coil and has a breaking stress of 22·4 tonnes.

3. Nylon and Terylene. Ropes made of these fibres are immensely strong, soft, and pliable. They are waterproof and their surfaces dry very quickly. They are equally flexible when at extremes of temperature and when wet or dry. They are pest- and corrosive-resistant. They are virtually impervious to rot and mildew and have a low fire risk. Due to their low melting-points, small cordage may have the ends of the strands sealed by momentarily holding them in a flame. This avoids whipping. nylon is generally more elastic than terylene, but both are good in this respect.

When splicing these ropes at least four tucks should be made, due to the slippery surface of the fibres. For this reason knots should be avoided, as they tend to slip. They are not so easy to handle, compared with, say, manila, due to their very smooth surface.

The resistance of these ropes to abrasion is extremely good. The outer yarns, if abraded, form a *fuzz* of fibre which effectively prevents further abrasion. This means that the internal yarns of a used rope are not affected in strength, and there is no high inter-yarn and inter-strand abrasion, such as is often seen with sisal and manila.

The main danger points with these fibres are that nylon is attacked by strong acids and terylene by strong alkalis.

Nylon absorbs about one-third of the moisture taken in by a hemp rope, while terylene absorbs only a twentieth of this latter amount.

A 48-mm three-stranded nylon rope weighs about 330 kg per coil of 220 m and has a breaking stress of 42 tonnes. The reader should compare this with the stresses given for best-quality manila rope. Strength for strength, a nylon rope of about 30 mm may be substituted for a manila rope (best quality) of 48 mm diameter.

1-in The following figures are of interest: Considering 8-mm ropes, each of three strands, terylene has a wet strength of 100%, Italian hemp has a wet strength of 80%, while the figure for best sisal is 90%. The com-
2000 lb 1340 lb parable breaking loads are 1020 kg for terylene, 607 kg for Italian
1030 lb hemp, and 480 kg for sisal.

Nylon and terylene ropes are in wide use as *tails*, i.e. lengths of synthetic rope joined to mooring lines to act as shock absorbers. It is essential that both ropes have the same lay. The use of these tails effectively cushions the ropes to which they are attached and saves them from
6 fathoms progressive damage. The tail will usually be about 12 m in length, fitted to the shore end of a mooring line, and its eye will be protected
6-in from bollard-chafe by means of a leather parcelling. A 48-mm mooring
4½–5 in circumference line will need a tail of 40 mm in diameter.

Waterproofing

This service is available from rope manufacturers at a small extra cost. It increases the life of the rope, prevents the entry of sea-water impurities, reduces kinking, hardening, and swelling. It affects neither the weight nor the breaking stress of the rope and provides an added advantage in that when the rope is discarded it may easily be sold to paper mills.

Preservation of Natural-fibre Ropes

Most fibre ropes are oil-spun, a small amount of lubricant being introduced at the time of manufacture to soften and oil the fibres. Excessive internal friction is thereby reduced, increasing the life of the rope. A dry-spun rope is stainless but non-waterproof.

The original methods of tarring a rope with Archangel tar increased the weight of the rope by 12½% and considerably decreased the breaking stress. Modern methods, using pure pine tars, Archangel tar, rot-proofing, and waterproofing compounds in conjunction, increase the weight

by only 5% and decrease the breaking stress by only 5%. The Gourock Ropework Company immersed three ropes into a tank which was bacterially rich. After two months of immersion, ordinary sisal showed a strength loss of 58%, old-fashioned tarred rope showed a loss of 23%, while the most-up-to-date tarring protected the rope to such a degree that only 5% strength loss was experienced.

Any strength losses due to tarring are more than offset by the prolonged life of continually submerged ropes.

If a very dry rope is required rot-proofing is possible by a process known as *tanning* or *barking* with 'Cutch Chrome'. It should be noted that straightforward tarring, used without a water-proofing compound, does not render a rope water-repellent.

The Care of Ropes

On an average-sized merchant ship there may be as much as 9 miles of fibre rope, weighing 15 tonnes. When one considers that a 220-m
coil of high-grade manila rope, 72 mm in size, may cost £850, there is tons 120-fathom
one very good reason for giving ropes every attention, quite apart from 9 in
the safety aspect. Polypropylene is the same price.

The common causes of rope failure are excessive stress (which damages fibre more quickly than any other cause), abrasion or cutting on a sharp object, exposure to alkalis, acids and rust removers and bad storage with inadequate ventilation, particularly in the case of ropes stored away in a wet condition.

Rotting very often commences on the inside of a rope and is difficult to detect unless the lay is open. If fibres are able to be rubbed loose or if there is much dust within the lay it is a sure sign of dry rot. If the interior of the rope is much darker than the outside it is a sign of dampness, while a grey powdery substance indicates mildew and poor ventilation.

The care of ropes has already been mentioned in Chapter XV; they must be stored away when *dry*, and either hung on wooden pegs, galvanised hooks, or stowed on gratings. They should be turned on these gratings every so often so that the weight of the coil is taken on a different part of the rope. The storeroom should be dry and airy, and away
from weather. The ideal temperature is between 10° and 20°C, while 50° 70°F
the relative humidity most favourable to long life is between 40 and 65%.

Ropes, if dried artificially in extreme heat, will become dry (i.e. the lubricant will dry out) and brittle. On deck in port ropes should again be stowed on gratings and protected from sunlight, rain, and frost. The freezing of ropes is detrimental to their life, for the minute ice particles cut through the fibre.

After use, ropes should be cleaned and dried. After immersion in salt water they should ideally be hosed down with fresh water.

Kinks cause permanent injury to a rope. Knots cause kinks, and therefore splices are better. A short splice is stronger than a long splice. The safe stress on a rope should be regarded as about one-sixth of the breaking load. A sudden jerk may increase the stress up to eight times its value. Before making a splice it should be ascertained that there is no 'turn' left in the rope, which, when stressed, will continually pull at the splice.

A right-handed rope should always be uncoiled by taking away that end of the coil which enables the turns to be taken off anti-clockwise, i.e. the coil is unwound left-handed. The reverse applies to left-handed ropes. Naturally therefore, a right-handed rope is coiled down so that the turns *form* clockwise; the reverse is true for left-handed ropes.

Ropes should never be subjected to bad nips; if this is unavoidable the nip must be frequently freshened. The diameter of rollers should be ten to twelve times the diameter of the rope which is to be passed around them. The same figures apply to bollards and warping drums. A capstan or drum that will only revolve clockwise should be used only for a right-handed rope.

In Fig. 16.1 the term *jaw* is used. This refers to the pitch of the rope and is the distance along one complete spiral of a strand. A soft-lay rope will have a longer jaw than a hard-lay rope. When a rope is badly stretched so that it suffers permanent elongation the inside of the strands is quite clearly visible from the exterior of the rope, which is said to be *long-jawed*, for the pitch has extensively increased.

Whenever some line is cut from a coil, either the length removed or the length remaining should be marked up near by.

Miscellaneous Cords and Twines

Small Cordage is usually referred to at sea as small stuff. Some of the more common ones are listed below. The size of small stuff is often referred to by the number of threads or yarns. A three-stranded rope having three yarns in each strand would be known as nine-thread line. Generally, small cordage can be ordered by length in coils of 220, 110 or 55 m.

Houseline is made from Indian hemp and is 3-ply, i.e. three yarns twisted together. It is usually tarred and sold in balls by weight, usually of about 110 m to the kg.

Marline is similar to houseline but is 2-ply. Both marline and houseline are used for serving and whipping ropes.

Hambroline is a small tarred hemp used as a boltrope or very heavy servings. As a yacht lacing it is untarred Italian hemp. It is sold three-stranded in 55-m hanks, and runs at 6, 7 or 8 mm diameter.

Spunyarn is a tarred, soft hemp comprising two, three, or four threads

twisted together. It is mainly used for serving and covering wire ropes and standing rigging. According to the number of threads it is sold either by weight or by length in coils.

Oakum is a mass of oily fibre made from tow or old ropes which have been picked to pieces. It is usually bought in small bales and ordered by weight. It is chiefly used for caulking deck seams, and is rolled into a long thread for this purpose. Three threads are necessary to caulk a new deck, while one or two threads are usually used to renovate an established wooden deck. The oakum is hardened down into the seams and then *payed* with molten pitch to seal the seam.

Tarred Cordage is made from soft hemp and used for general deck purposes, nine-thread line being popular as a heaving line. It is made in various sizes from nine to twenty-one threads, the corresponding circumferences being 7–15 mm. It is often referred to as ratline.

Dressed hemp lines include 4- and 5-mm line for boat lacings, awning lacings and cod-line. It has a fine finish and is strong but light. It is obtained in 55- or 110-m coils and may also be sold in 8 or 10 mm sizes for signal halliards or plaited loglines.

Leadlines are made from high-grade cable-laid hemp. The final lay is usually left-handed. Hand leadlines are about 8–10 mm in diameter and supplied in 55-m coils. The heavier deep-sea leadlines are about 12 mm in diameter and supplied as 220-m coils.

Patent loglines are made of polythene (low absorption) or untarred Indian or European hemp, in coils varying from 73 to 220 m. The line is usually plaited and may have a copper-wire core. The size is from 10 to 12 mm.

Twine, 3-ply for seaming and 5-ply for roping, is made of flax or hemp. It is sold in 0·28 kg balls. Other twines made of polypropylene are used for general lacing work.

Signal halliards. Polythene is ideal, in 73-m coils, owing to its low water-absorption.

Bends, Hitches, and Knots

The use of these may locally reduce the strength of a rope by as much as 40–60%, and this should constantly be borne in mind when working with rope, upon which the safety of life may depend.

The terms used in this work are:

The ***Bight***, which refers to the middle part of the rope between the ends, and also to a loop made from the rope. A rope suspended between two points is said to hang in a bight.

The ***Standing Part*** is the part of the bight nearest to the eye, bend, or hitch. It is also that part of a tackle fall which is secured to the block.

The ***Running End*** is that part of a rope which leads through a fairlead, which moves through pulleys, or which first comes away from a coil.

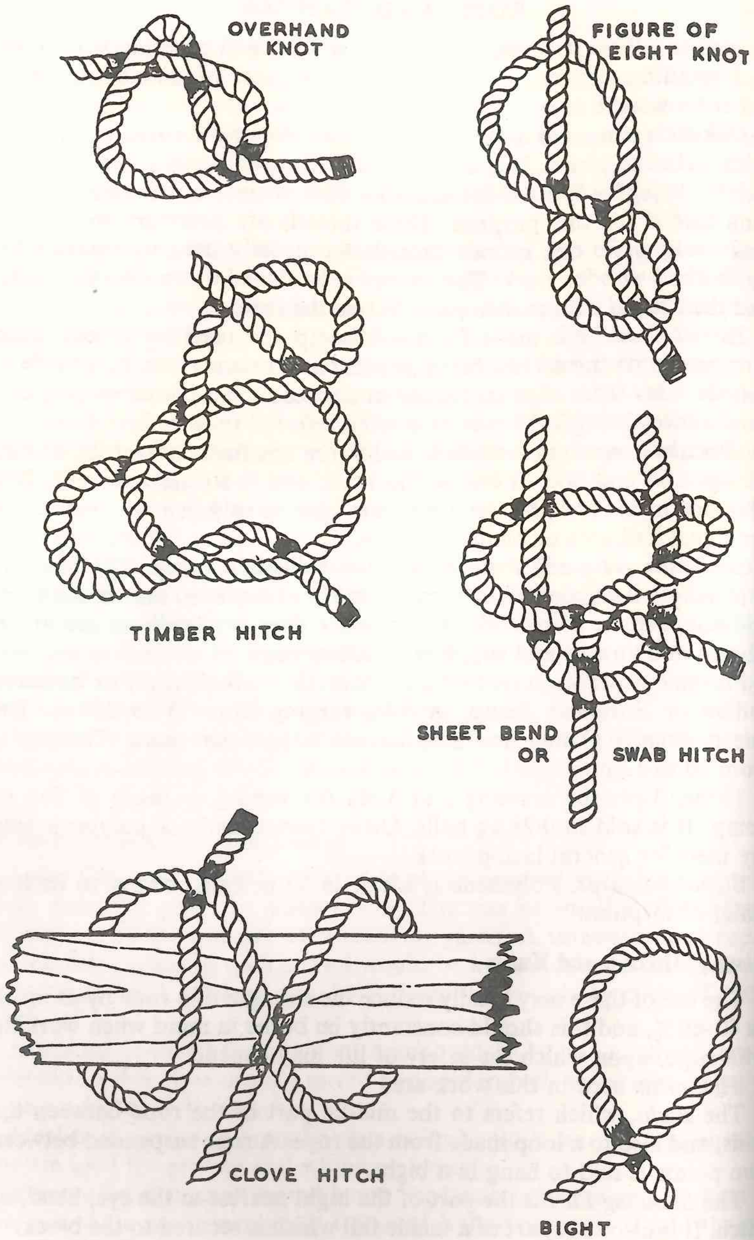


FIGURE 16.2

The *End* of a rope is the short length at the extremities of a rope. It also refers to the very short piece left after making a knot, bend, or hitch. The *Bare* or *Fag End* is the extreme end of a rope.

In Fig. 16.2 the following are illustrated:

The *Overhand Knot* which may be put into a rope so that a person can grip the line without his hands slipping. It is the basis of several bends and hitches, and is, in fact, a half-hitch.

The *Figure-of-eight Knot* is put into a rope to prevent it from unreeving through a block.

The *Timber Hitch* is often used to secure a line to a spar or a bale. If it is desired to tow or drag the object, or perhaps to hoist it, it is kept steady by passing a half-hitch round the object at a distance from the timber hitch and close to the forward or upper end.

The *Sheet Bend or Swab Hitch* is used for joining two ropes together or to secure an end to an eye. If it is made around both sides of a hook it is called a *Midshipman's Hitch*. If in the figure the end is again passed around the eye and finally tucked under the standing part, the result is a double sheet bend.

The *Clove Hitch* forms a quick means of securing a rope to a spar, rail, etc. It tends to slip under a side pull.

In Fig. 16.3 the following are illustrated:

The *Reef Knot*, which is used to join together two ropes of equal size. It consists of two overhand knots. The ends must be crossed opposite ways each time, i.e. left over right—right over left, or vice versa. If the overhand knots are made the same way each time a granny knot results, which usually either slips or, paradoxically, jams hard. If the lines are of unequal size, or if the reef shows signs of slipping, the ends may be stopped back on to the standing parts.

The *Bowline* forms an excellent method of introducing a temporary eye into the end of a rope. It is extremely reliable.

The *Rolling Hitch* has an extra turn compared with the clove hitch. This makes it suitable for withstanding side stresses, and it is therefore often used for stoppering-off a rope.

The *Half-hitch* is probably the most well-known hitch of all. It provides a very quick means of securing a line. It does not slip or jam, provided *two* half-hitches are made and preferably after passing a round turn around the spar, rail, etc. The end may be stopped back on to the standing part.

The *Marline-spike Hitch* is useful for securing a long object within the bight of a rope. It may be used to send gear aloft to men working in the rigging.

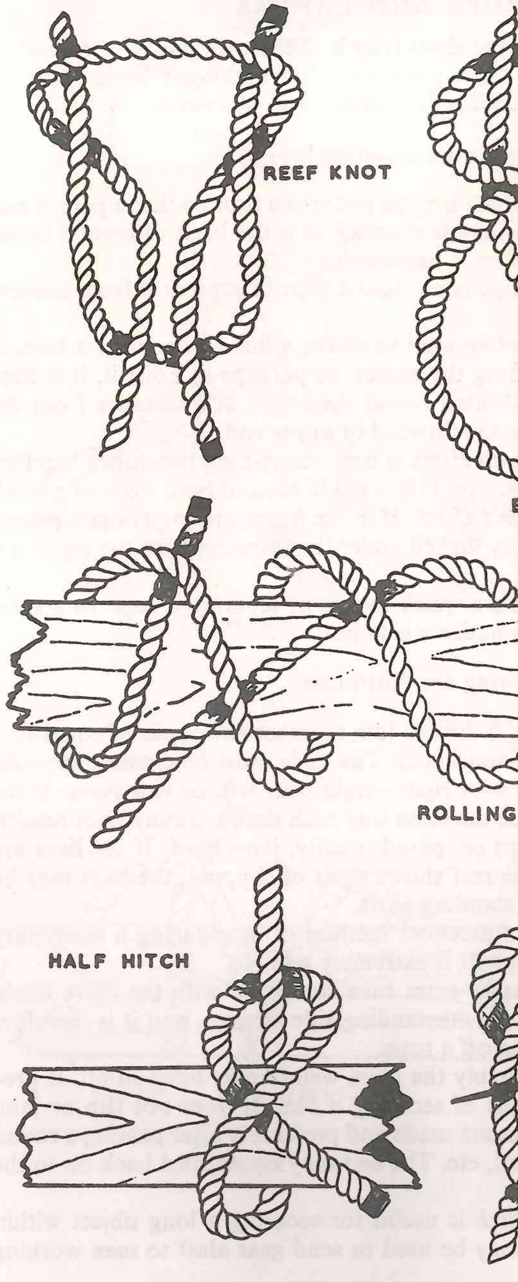


FIGURE 16.3

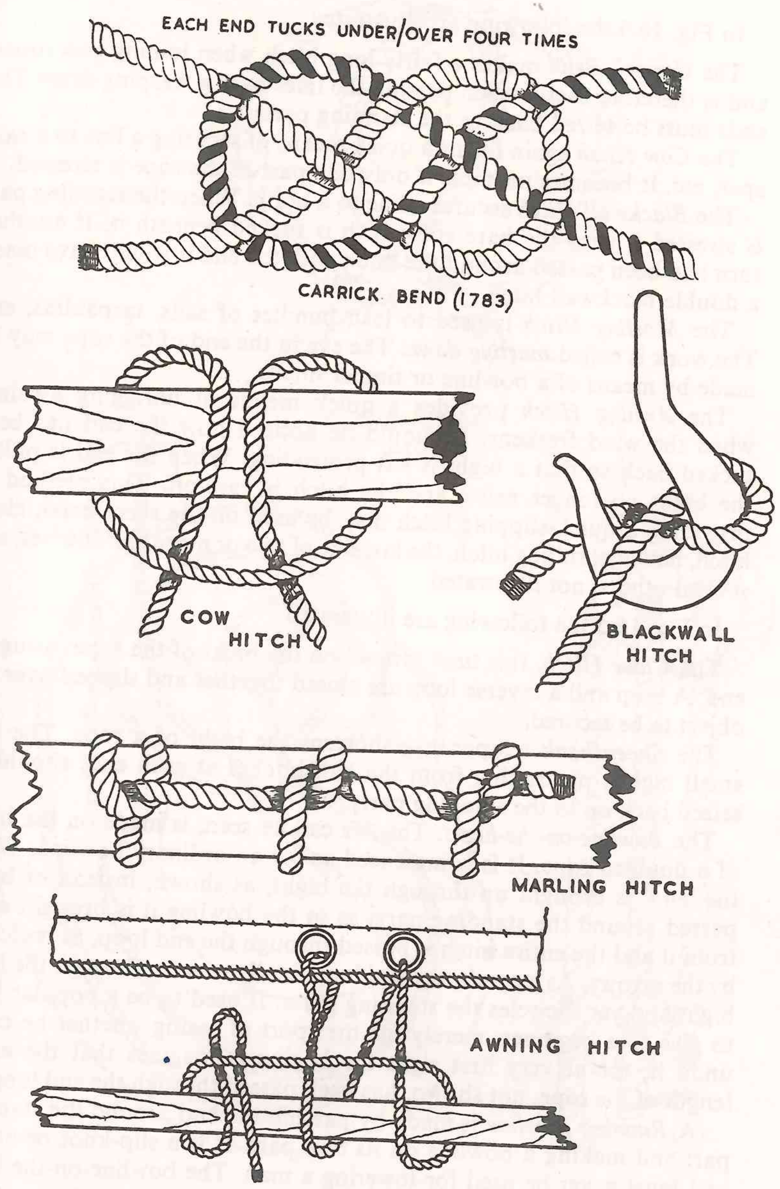


FIGURE 16.4

In Fig. 16.4 the following are illustrated.

The *Carrick Bend* makes a fairly long hitch when joining two ropes, and is therefore useful when passing the lines over a warping drum.The ends must be seized back to the standing parts.

The *Cow Hitch* again forms a quick means of securing a line to a rail, spar, etc. It becomes unstable if only one part of the rope is stressed.

The *Blackwall Hitch* secures a line to a hook. When the standing part is stressed it jams the bare end which is tucked beneath it. If another turn had been passed around the hook with the end it would have made a double blackwall hitch.

The *Marling Hitch* is used to lash bundles of sails, tarpaulins, etc. The work is called *marling down*. The eye in the end of the rope may be made by means of a bowline or timber hitch.

The *Awning Hitch* provides a quick means of unrigging awnings when the wind freshens. It should be noticed how the end has been tucked back so that a bight is left protruding. When the end is pulled the bight no longer exists and the hitch is cast off. This method of providing a quick-slipping hitch may be used on the sheet bend, clove hitch, bowline, rolling hitch, the last one of two or more half-hitches, and several others, not illustrated.

In Fig. 16.5 the following are illustrated:

The *Clove Hitch*, this time formed on the bight of the rope, using no end. A loop and a reverse loop are closed together and slipped over the object to be secured.

The *Sheepshank* temporarily shortens the bight of a rope. The two small bights, protruding from the half-hitches at each end, should be seized back on to the standing parts.

The *Bowline-on-the-bight*. This, as can be seen, is made on the bight of a doubled rope. It is commenced as for an ordinary bowline. When the 'end' is brought up through the bight, as shown, instead of being passed around the standing parts as in the bowline it is brought *away* from it and the entire hitch is passed through the end loop, as indicated by the arrows. As a result, the end loop finally runs up through the large bight and yet encircles the standing parts. It used to be a popular knot to give to a beginner, merely for the sport of seeing whether he could undo it, for at very first sight the beginner imagines that the entire length of the rope, not shown, has been passed through the end loop.

(A *Running Bowline* is made by passing the end around the standing part and making a bowline on its *own* part. It is a slip-knot or noose, and must never be used for lowering a man. The bowline-on-the-bight is used for this, and the two big bights hanging below the knot are adjusted to different sizes. The small bight is passed under a man's arms, and the larger one under his buttocks.)

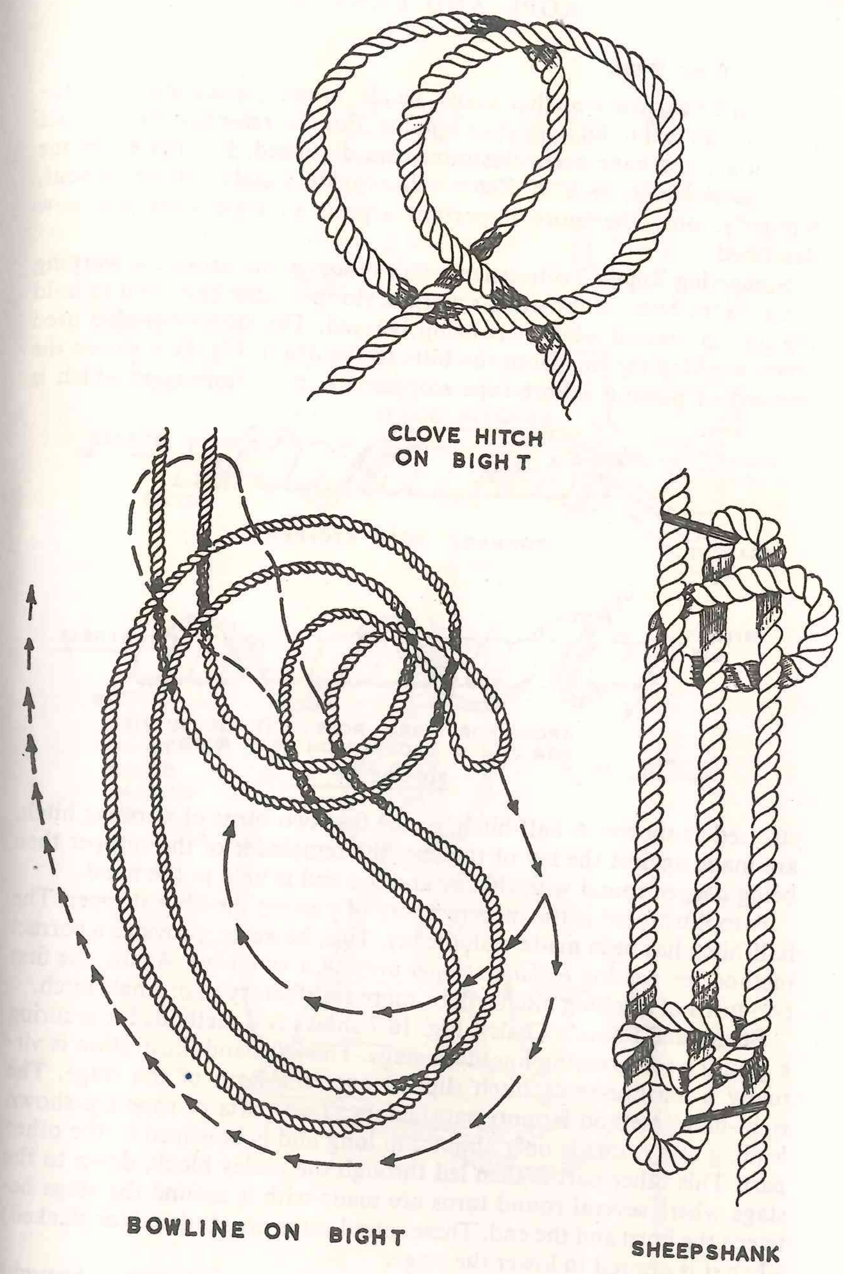


FIGURE 16.5

General Rope Work

It will be appreciated that knots, bends, hitches, and ropework provide enough text to fill a separate volume. For this reason, only the most common types have been illustrated and discussed. For more curious readers, *Ashley's Book of Knots* will provide suitable entertainment. Similarly, only the more important aspects of rope work are now described.

Stoppering Ropes. Tó transfer a taut mooring line from the warping drum to the bitts, or for similar work, a stopper must be passed to hold the line in tension while it is being belayed. The stopper is also used when working the line from the bitts to the drum. Fig. 16.6 shows the method of passing a fibre-rope stopper around a fibre rope which is

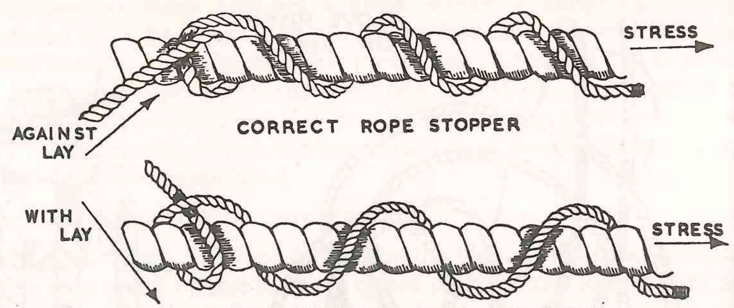


FIGURE 16. 6

stressed as shown. A half-hitch, or the first two turns of a rolling hitch, are made against the lay of the line, the remainder of the stopper then being *dogged* round with the lay and the end is held in the hand.

Also illustrated is the incorrect way of passing the fibre stopper. The half-hitch has been made with the lay. This, however, provides a correct method for passing a *chain stopper* around a *wire rope*. Again, the first two turns of a rolling hitch will be more satisfactory than a half-hitch.

Stages and Bosun's Chairs. Fig. 16.7 shows two methods for securing a gantline (or lowering line) to a stage. The left-hand illustration is virtually a marline-spike hitch slipped over the horn of the stage. The right-hand method is more satisfactory. Two parts of rope are shown
6 ft leading away; one is only about 2 m long and is bowlined to the other part. This other part is then led through the pulley block, down to the stage where several round turns are made with it around the stage between the horn and the end. These round turns are rendered (or slacked) when it is desired to lower the stage.

Also shown is a bosun's chair. Here, the running part is brought

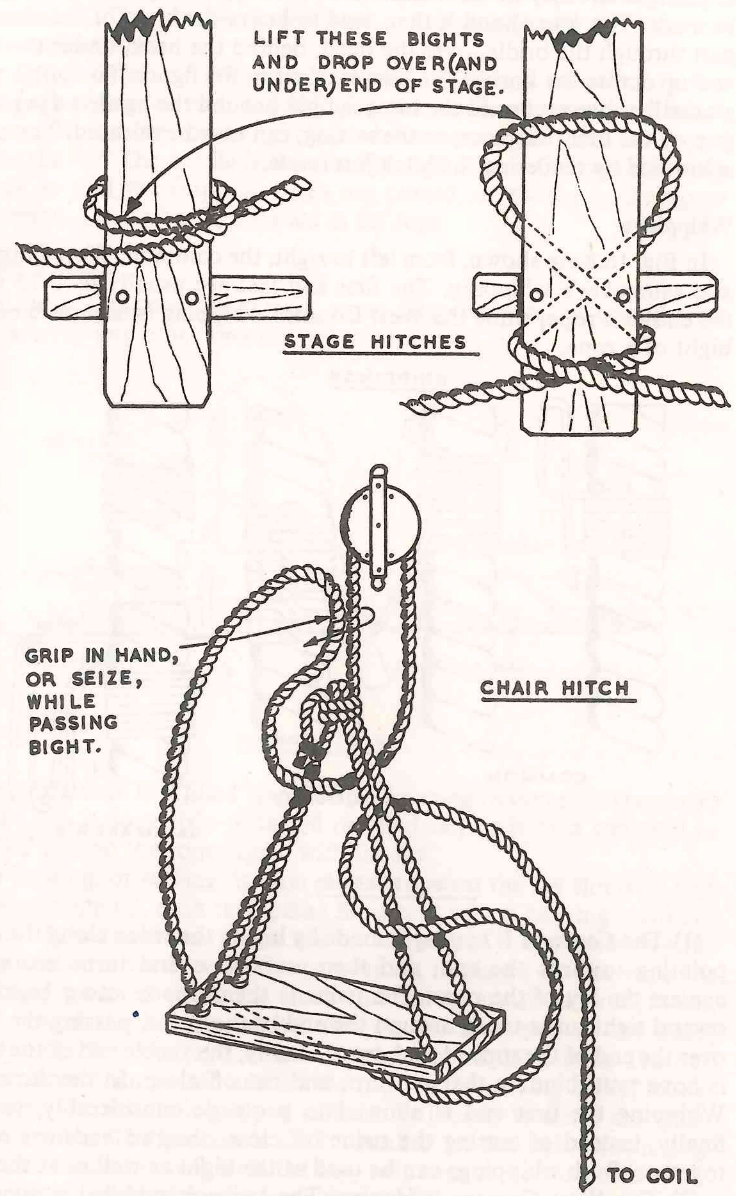


FIGURE 16. 7

through the chair bridle and held firmly against the standing part by gripping it strongly in one hand. Alternatively, a temporary seizing can be made. The other hand is then used to heave the bight of the running part through the bridle, over the head, behind the back, under the feet, and up across the knees. The part marked in the figure 'To coil' is then gradually hove taut until the hitch is tight around the bridle's apex. The grip on the first two parts, or the seizing, can now be released. The chair is lowered by rendering the hitch just made.

Whippings

In Fig. 16.8 are shown, from left to right, the common, West Country, and sailmaker's whipping. The first and last are usually used to whip the end of a rope, while the West Country whipping is used to bind the bight of a rope.

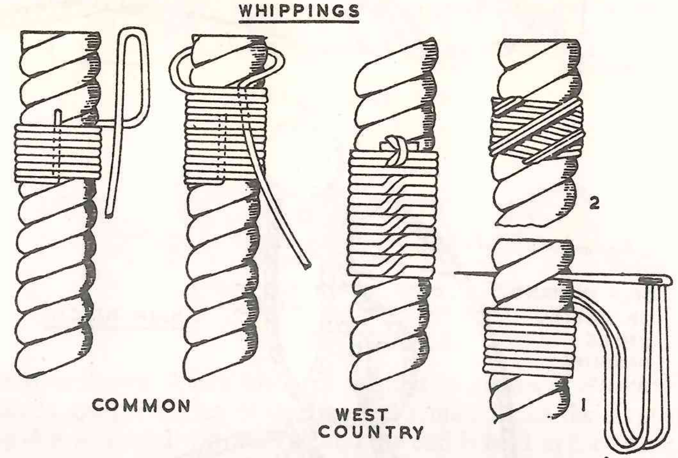


FIGURE 16.8

(1) The *Common Whipping* is made by laying the twine along the rope, pointing towards the end, and then making several turns around it, *against* the lay of the rope. The twine is then looped into a bight and several tight turns taken around the end of the twine, passing the bight over the end of the rope at each turn. Finally, the visible end of the twine is hove taut, binding the last turn, and cut off close. In the American Whipping the first end is allowed to protrude considerably, so that finally, instead of cutting the twine off close, the two ends are reefed together. Both whippings can be used at the bight as well as at the end.

(2) The *West Country Whipping*. The twine is middled around the

rope, its ends brought up to the other side and half-knotted (overhand knot). The ends are then taken to the other side of the rope and again half-knotted. The process is repeated continuously and the ends are finally reef-knotted.

(3) The *Sailmaker's Whipping* is started by sewing into the heart of the rope, burying the end, and bringing the needle out on a long length of twine. The needle now hangs clear while several tight turns are passed *against* the lay. The needle is then finally used to sew the twine through strands so that the frapping turns are passed, as shown in the upper illustration. The end is then buried in the rope.

Serving a Rope

Fig. 16.9 demonstrates how a rope, fibre or wire, is bound with spunyarn (or any other small stuff) to protect it.

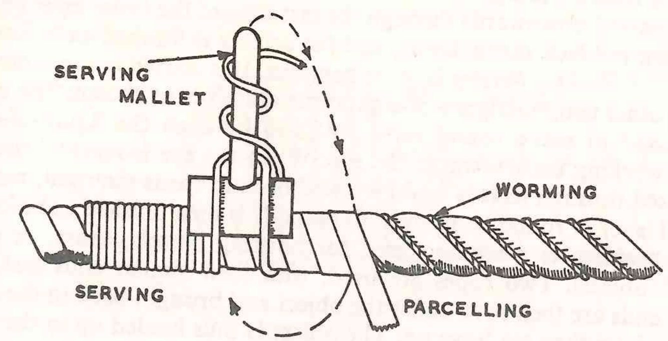


FIGURE 16.9

The strands are first filled by passing a *worming* (a very small cordage) with the lay. A long strip of tarred or oiled canvas is then wrapped or *parcelled* around the rope, again with the lay.

The binding, or serving, is then started, *against* the lay similarly to a common whipping, each turn being hove taut with a heaving mallet or by hand. When sufficient turns are on to prevent a slip occurring the serving mallet is used to finish the work. It is placed on the rope (its head being grooved to fit the line) and the spunyarn is brought up, passed round the handle, back down on the near side of the head, dipped under the rope, and is then dogged around the handle. The ball of spunyarn is then passed around the rope as the serving mallet makes each turn. The handle is gripped sufficiently loosely to allow the spun-yarn to render. The process is easily recalled by the well-known doggerel: 'Worm and parcel with the lay, turn and serve the other way.' The serving is finished in the same way as a common whipping.

Seizings

Fig. 16.10 shows:

(1) The *Flat Seizing* to bind two ropes together, e.g. at the steps of a pilot ladder. The seizing is threaded through its eye as shown, and several round turns are made loosely around both ropes. The end is then passed back towards the eye under all the turns and rove again through the eye. It is then passed back, after all the turns have been hove taut, to make a pair of frapping turns around all parts. Finally, the end is clove-hitched around all parts. The end may either be buried, back-spliced, or knotted.

(2) The *Round Seizing* is commenced in the same way. Once the first layer of turns has been hauled taut, the end is used to make a second layer of round (riding) turns. At the right-hand side of the seizing the end is passed downwards through the last turn of the *lower layer* (which is shown in black throughout), and the seizing is finished as before.

(3) The *Racking Seizing* is more complex. It is started in the same way as the other two, but figure-of-eight turns are taken as shown. The end is then used to make round turns to fill-in between the figure-of-eight turns working back towards the eye. When the eye is reached the end is passed through it. It is again worked back towards the right, making a final layer of round turns over all parts. It is then finished as before.

Parbuckling is a method used for hoisting barrels, spars, or other round objects. Two ropes are used, with their similar ends fast. The other ends are then rove under the object and brought back to the other ends, where they are hove on. The object is thus hauled up in the bight of the two ropes.

Mousing a Hook is done to prevent an eye from slipping or jumping out of it. A flat seizing is passed around both parts of the hook, once the eye has been dropped over the bill of the hook.

Racking a Tackle is a term used to describe a method whereby a tackle may be held in tension while belaying or loosely handling the hauling part. All parts of the fall are merely gripped tightly together in the hands. If this is not possible the hauling part, where it leaves the sheave, may be jammed between the swallow of the block and the adjacent part of the fall. This is called *choking the luff*, and is detrimental to the rope.

Eyes may be made in hawsers either by splicing, in which case it is known as a *soft eye*, the outer curve of the eye most distant from the splice being known as the *crown* of the splice, or by passing the hawser around a thimble (a pear-shaped piece of galvanised steel, grooved to take the line), and seizing it to its own part. This makes a *hawser eye*. A thimbled eye, on the other hand, refers to an eye splice made around a thimble.

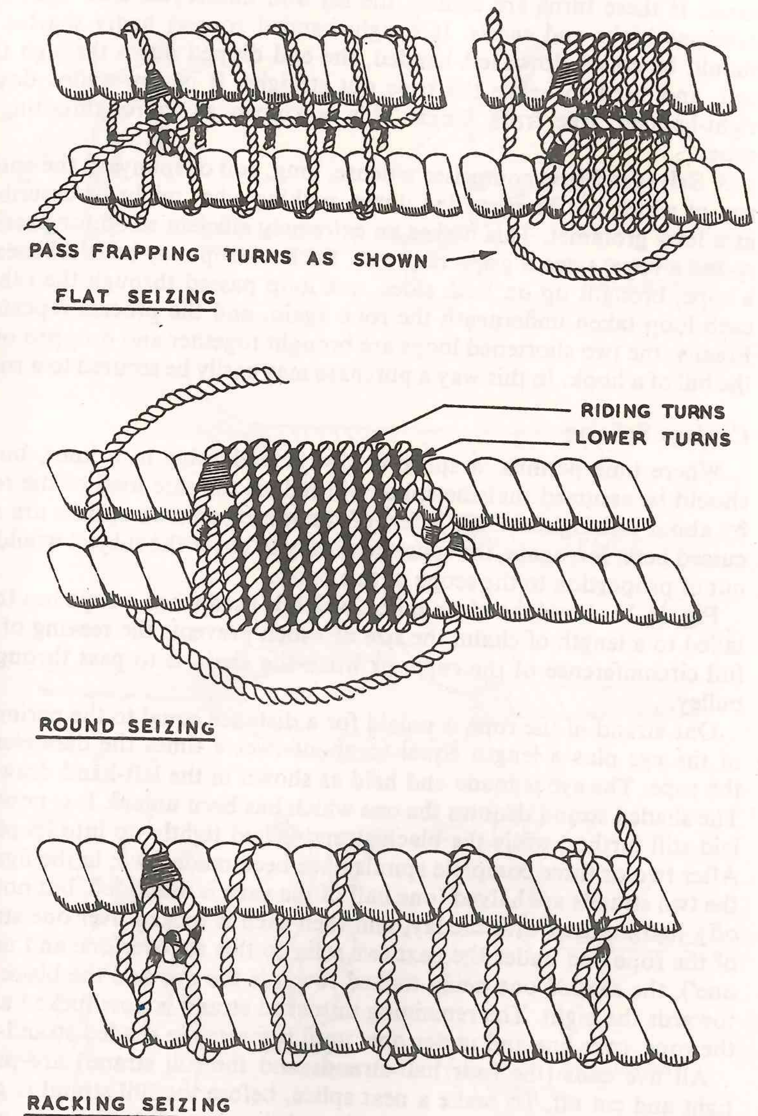


FIGURE 16.10

Thoroughfooting a Rope. A fibre rope has the ability to absorb several turns. If these turns are against the lay and numerous, then the rope develops kinks and *snarls*. If a right-handed rope is badly snarled it should be coiled down left-handed, the end dipped down through the coil, and used to heave the rope out straight. It is now coiled down right-handed, free from kinks. This is known as thoroughfooting a rope.

A Selvagee Strop comprises a dense, long, coil of spunyarn the entire run of which has been marled down, making what might be described as a long grommet. This makes an extremely efficient strop for passing round a rope, since it grips very well. Such a strop may be laid beneath a rope, brought up on both sides, one loop passed through the other, each loop taken underneath the rope again, and the process repeated. Finally, the two shortened loops are brought together and dropped over the bill of a hook. In this way a purchase may easily be secured to a rope.

Cordage Splicing

Where time permits, a splice is always preferable to a knot, but it should be assumed that the splice will reduce the safe load of the rope by about one-eighth. Only a few of the more common splices are discussed here, for, again, the space necessary to cover the subject would be out of proportion to the scope of this book.

Fig. 16.11 shows the *chain splice*, which is used when a rope has to be tailed to a length of chain, the size of which prevents the reeving of the full circumference of the rope, or when the chain is to pass through a pulley.

One strand of the rope is unlaid for a distance equal to the perimeter of the eye plus a length equal to about twelve times the diameter of the rope. The eye is made and held as shown in the left-hand drawing. The shaded strand denotes the one which has been unlaid. It is now unlaid still further, while the black strand is laid tightly up into its place. After two or three complete spirals have been made (two, in the figure), the two strands are halved (one half of the yarn is discarded, but not cut off), half-knotted with the lay, and then each is tucked over one strand of the rope and under the next (we refer to this as 'over one and under one'), the shaded one being tucked towards the eye and the black one towards the bight. The remaining untucked strand is now tucked along the rope, over one and under one, until it meets the shaded strand-end.

All five ends (the four half-strands and the full strand) are pulled tight and cut off. To make a neat splice, before the full strand is given its final tuck, it too may be halved, and the general result is a tapered splice. The ends of strands should really be dogged together, but this will be explained later.

The *cut splice* is also illustrated and forms a quick method of joining

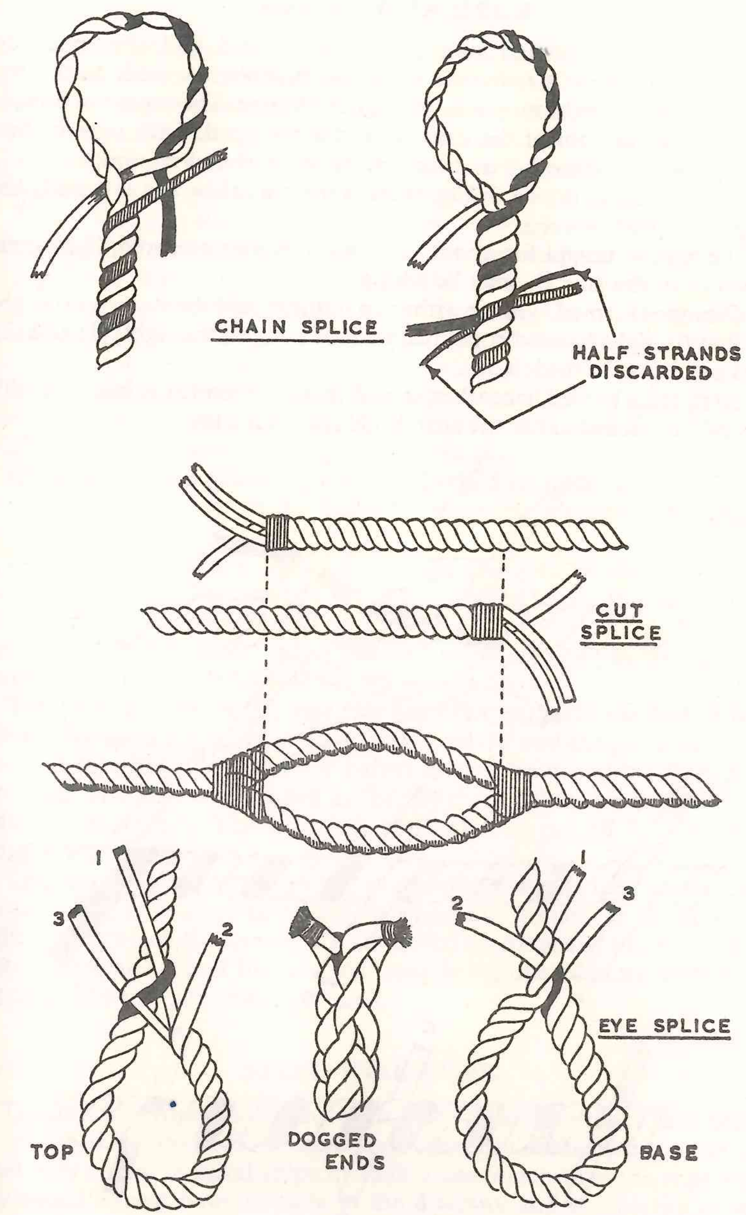


FIGURE 16.11

two lines when a short or long splice is not desired, and when knotting will cause too great a reduction in the permissible safe load. Naturally, it also serves to make an eye in the bight of a rope. The ropes are unlaid, whipped at the root of the strands, and overlapped. Each rope is then eye-spliced into the other and the splices are served, if required.

The final splice drawn in Fig. 16.11 is the *eye splice*, and is usually the beginner's first exercise.

The rope is unlaid for about nine times its diameter and, if desired, the root of the strands may be whipped.

The eye is formed, with or without a thimble, and the strands arranged so that (in right-handed rope) two strands hang to the right, (1) and (2), and one hangs to the left, (3).

First, (1) is tucked beneath a strand (black), then (3) is laid over this strand but tucked under the next, both against the lay.

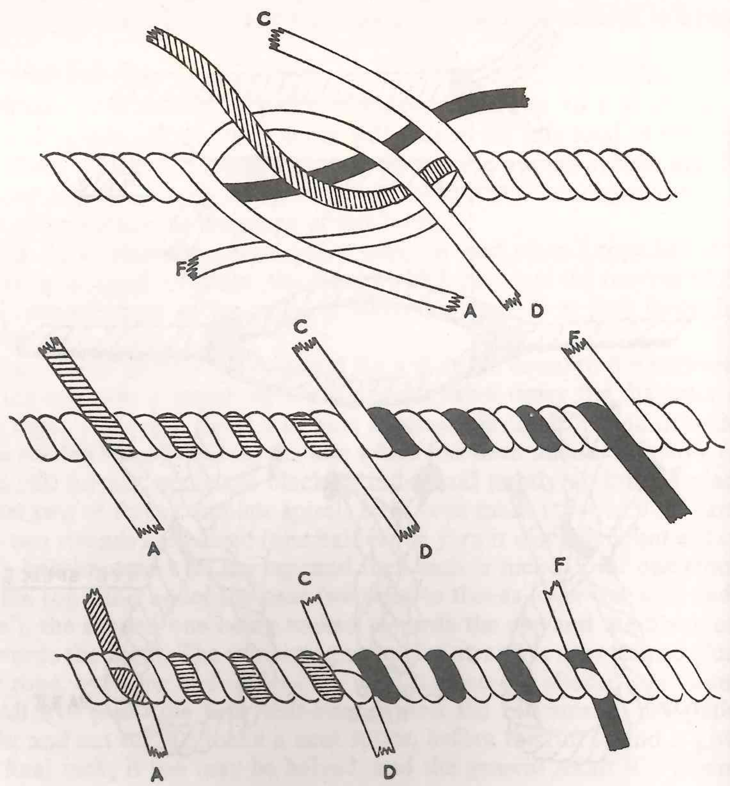


FIGURE 16.12 LONG SPLICE

The strands are pulled well through and into the 'lay' of the rope. The splice is then turned over and viewed from its base. One strand is clearly seen to be unoccupied, so (2) is tucked beneath it against the lay from right to left. All strands are then tucked over one and under one for about two or three full tucks. They are then halved and two further tucks made, after which the ends are dogged.

This is done, as shown in the figure, by halving each strand-end and whipping half of one strand to the half of the next adjacent strand.

Fig. 16.12 shows the *long splice* by which means two ropes are joined without in any way affecting the size of the join. The ropes are unlaid for about twelve to fifteen times the diameter, or even more if the splice is to suffer a considerable stress. The ends are married, that is, each strand of the right-hand rope is placed between a pair of strands from the left-hand rope, as shown in the upper part of the drawing.

(C) and (D) are then half-knotted with the lay.

(F) is now unlaid and the black strand is laid into its place for several complete spirals (three in the figure), in a similar manner to the chain splice.

(A) is also unlaid and the shaded strand laid into its place for three complete spirals. The strands are then situated in three pairs, equidistant. It should be noted that each strand of a pair meets the other end on, i.e. where they meet, they share one strand-groove; in the figure I have shown them side by side for the sake of clarity.

The half-knotting of (C) and (D) has been left until the last in the figure. To finish the splice, each strand is halved and the pairs are half-knotted together, the discarded halves having been omitted from the drawing. The ends are finished as for the chain splice, i.e. tucked over one and under one. The bare ends can either be cut off flush or else dogged together.

The *short splice* is not shown. It is stronger than the long splice, but more bulky. It is commenced by marrying the strands, as in the long splice, after which the strands are all tucked over one and under one for about three and a half tucks, a half-tuck being one executed with half strands. The ends are usually dogged.

STEEL WIRE ROPE

The first wire rope was produced in 1834, while fibre ropes have been in existence for over 5,000 years. The Admiralty authorised the use of steel wire ropes on naval ships in 1838, since which time the rope has developed almost bewilderingly in the diversity and complexity of its forms. Its terms of reference have been exactly reduced by science, metallurgy, and chemistry to a set of known values and characteristics.

A modern wire rope consists of a number of strands laid around a central *heart*, which may itself be a steel strand, steel wire rope, or be a strand or rope of vegetable or synthetic fibre. Each strand in turn is composed of a given number of individual wires again laid round a central wire or fibre *core*, the wire core in this case usually consisting of one single wire.

The steel is produced as cast ingots or billets, which are then reduced to rods by repeated rolling. The rods are then drawn, and progressively annealed and cold-worked until they become wires of the correct diameter.

Before the wires are laid into strands, and then the rope, ancilliary processes are undertaken to minimise corrosion. Most engineering ropes are *black*, i.e. they are ungalvanised, while except for certain classes of cargo runner, most shipping and fishing ropes are galvanised. Galvanising of the wire is always done before the strand is built and indeed, modern galvanising is so efficient that very often some of the wire-drawing stages are done after galvanising. The present-day electrolytic galvanising entails little or no loss of strength or ductility in the wire.

When a wire rope or strand has a fibre heart the latter must be adequately protected against penetration by moisture, which tends to lead to corrosion in the heart of the rope or strand, and this, in turn, could lead to a rapid breakdown in service. All hemp (or vegetable fibre) cores are immersed for long periods in baths of heated lubricants so as to give complete saturation of the fibre. When the strand (or the rope) is being formed, and the wires or strands laid over the core, the pressure is such that surplus lubricant is squeezed out, and this ensures lubrication of every part of the strand or rope at the completion of manufacture.

In the case of synthetic-fibre main hearts no lubrication is necessary to prevent water penetration so far as the hearts themselves are concerned, since nylon, terylene, polythene, etc., are all completely immune from micro-biological attack. In such a rope, however, the strand cores would still be of hemp and would be treated as described in the foregoing paragraph.

During the forming of the strand, and subsequently the rope, the wires are continually fed with heated lubricants so that the rope is finally wound on to its drum or reel in a fully lubricated condition.

Construction of the Rope

The number of wires in a strand is determined by the fact that 6 wires of equal size will just comfortably fit around a single wire core of the same size and that a further layer or *gallery* of wires of the same size laid on the 7-wire strand will naturally hold 12 wires. Such a strand would therefore have either 7 or 19 wires. A further gallery (which contains 18 wires) brings the total to 37 wires, and yet another (containing 24 wires) brings the total to 61 wires.

When a fibre strand-core is used the total number of wires does not follow a natural build-up system, but in practice usually totals either a single layer of 12 wires around the core or a total number of 24 wires laid as an outer gallery of 15 wires and an inner gallery of 9 wires.

It is possible to lay another gallery of 18 wires over the single layer of 12 wires and achieve a rope with 30 wires laid around a fibre core.

It can be seen then that there is a very wide variety of wire ropes available to the shipping industry alone, quite apart from mining and engineering projects.

The degree of flexibility of a steel wire rope is governed by the number of wires in the strand; the greater the number of wires, then generally the greater is the flexibility. Further, flexibility is increased by the introduction of a fibre strand-core at the expense of strength. On the other hand, both strength and flexibility are gained if the wire is built up from a very large number of small-gauge wires.

A wire which has each strand consisting of twelve wires laid over a fibre core may be more flexible than one which has twenty-four wires laid over a similar core in two galleries, assuming equal sizes of ropes. This is due to the fact that the core in the first rope is relatively larger than that of the second rope. So when we state that flexibility is directly proportional to the number of wires in each strand we are comparing ropes the strands of which have two or more galleries.

A wire rope is referred to by the use of two numbers: the first indicates the number of strands, and the second refers to the number of wires in each strand. Marine ropes invariably have six strands and may be summarised as follows:

Rope construction	Strand construction	Usual purpose
6 × 7	6/1	Standing rigging
6 × 12	12/Hemp	Deck ropes; running rigging
6 × 19	12/6/1	Cargo runners; topping lifts and pendants; towing lines; mooring lines
6 × 24	15/9/Hemp	
6 × 30	18/12/Hemp	As for 6 × 24
6 × 37 6 × 61	18/12/6/1 24/18/12/6/1	Where high flexibility is required

It should be noticed that strands having even numbers of wires are those fitted with fibre cores. The fibre heart of the rope not only forms a cushion for the strands so that under stress they can bed themselves into their natural positions but it also acts as a store for the lubricant (which should periodically be applied while in service), and squeezes this into the wires when the rope is flexed or stressed, thus minimising friction between the wires.

Other types of wire rope include flexible copper wire rope for use in the vicinity of magnetic compasses, e.g. as awning jackstays, seizing wire, which is usually between 6 and 10 mm in diameter consisting of one strand of 6/1 construction, and what are known as extra special flexible steel wire ropes (ESFSWR) in which the term 'extra special' refers to the quality of the steel.

The Lay of the Rope

There are five main types of lay in wire rope:

(1) *Right-hand ordinary lay*, in which the strands are laid up right-handed but the wires are twisted together left-handed.

(2) *Left-hand ordinary lay*, in which the strands are laid up left-handed but the wires are twisted together right-handed.

(Notice that these correspond to the plain lay of fibre ropes.)

(3) *Right-handed Lang's lay*, in which both wires and strands are laid up right-handed.

(4) *Left-handed Lang's lay*, in which both wires and strands are laid up left-handed.

(Notice that Lang's lay follows the principle of unkinkable fibre-rope lay. In a steel wire rope, Lang's lay gives wearing qualities far in excess of those of ordinary lay. When wear takes place in ordinary lay a flat is worn on the wires *across* their axes. The same wear applied to Lang's lay wears the wires *along* their axes, with the result that ordinary-laid ropes eventually have individual wires worn through and sticking up along their lengths, while Lang's laid ropes wear down evenly and eventually appear like bars of polished steel.

Unfortunately a Lang's laid rope tends to rotate much more in service, compared with the ordinary lay, and its use is therefore restricted to conditions where both ends of the rope are secure or where the rope travels in guides or on rails, such as in lifts, mines, excavating, etc. Were it not for this, then Lang's lay would undoubtedly be in universal use. It is rarely found in use on ships.)

(5) *Cable-laid wire rope*, which is very large and highly flexible. This is made in exactly the same way as cable-laid fibre rope, and a 36-strand wire rope composed of 6, 6-stranded ropes would be described as 6 × 6/19's or 6 × 6/24's, etc. The six ropes are invariably laid around a fibre heart.

Preformed Wire Rope

This used to be referred to as true-lay wire rope. Anyone who has handled an ordinary type of steel wire rope will know only too well its

tendency to spring open and unlay itself when cut. A preformed rope has none of this tendency, and remains quite inert after being severed. The actual operation is performed merely by shaping each strand of the rope, before laying-up, into a helix of the same size and pitch that it would naturally have formed when laid into rope.

'Spring Lay' Wire Rope

This is an extremely flexible yet tough rope made of tarred sisal and galvanised wires. It has a great resistance to damage by sea-water and weather.

Its construction is 6 × 3 × 19, i.e. 6 ropes each containing 3 sisal strands and 3 strands of 19 wires, the individual strands and the whole rope having central fibre cores. It is very easily handled and coiled. It is ideal for mooring ropes and towing springs. Its strength is about three times that of first-grade manila of equal size, and four times that of high-grade sisal of equal size. It resists shock loads.

General Remarks on Wire Rope

Wire rope resists bending and does not absorb turns so easily as fibre rope, with the result that it easily kinks and snarls. When this happens a kink which is about to develop should never be pulled out, otherwise the rope is long-jawed and permanently damaged. The kink, which appears as a loop or bight in the wire, of small diameter, is removed by grasping the rope on either side and pushing the hands together so that the diameter of the kink is enlarged. As soon as this is done, the kink—provided the wires are not permanently bent or damaged—will suddenly untwist itself.

Wire should never be subjected to sharp nips, such as altering its direction of lead by passing it through shackles, eye-bolts, or over plate edges. This will permanently damage the wire, the effect being known as *crippling*. When securing wire to a drum or bollard the diameter of the latter should be at least twelve times the rope diameter. The diameter of a roller around which a wire rope is to be passed should be at least ten times the rope diameter.

Wire rope should be stowed on reels or coiled down when not in use. When winding a new rope on to a drum it is best to start the first layer as follows:

If over-winding on to the upper side of the drum, anchor the wire on the left and run the wire on from left to right.

If underwinding on to the lower side of the drum, anchor it on the right-hand side of the drum and wind on from right to left.

This applies the same principle as that used with fibre ropes, i.e. that right-handed ropes must be uncoiled left-handed. These instructions are reversed if left-handed wire rope is being run on the barrel or drum. The directions are assumed to be for a person facing the drum and watching the wire fed towards him.

Ropes in store should be placed on gratings and turned every so often to alter the weight/contact point of the coil and also to stop drainage of lubricant.

Before putting a rope into service the grooves of drums and sheaves should be carefully examined to see that they are of the correct size for the rope in question, in proper alignment, and in good condition.

A wire rope should always be put into service by uncoiling it either from a drum or reel, under tension, or by unrolling the coil along the deck. If the rope is on a drum a spindle may be passed through the central hole, jacked up at both ends, or suspended from a cargo runner by means of a two-legged bridle, and the wire rope pulled carefully off. A drum without a central hole should be placed on a turntable and cross-battens lashed over the top of the wire to prevent turns jumping off. The rope should never be pulled from a coil loosely or thrown off a reel, otherwise serious kinks will form.

In service the wire should be frequently cleaned, examined, and lubricated. Many excellent rope lubricants are available, but the rope must be cleaned and dried before application of the oil. The rope should constantly be checked for internal corrosion, fractured wires, excessive wear, and rotting of cores. Several broken wires close together in one strand constitute a far greater danger than the same number distributed throughout the length of the rope.

Whenever possible wire rope should not be subjected to a bend and sudden reverse-bend. When it leads from a pulley to a drum the angle of lead should not exceed 5 degrees from the plane of the sheave.

The coiling of more than one layer of wire on a drum is detrimental to the rope, but is difficult to avoid. Dead layers which are never off the drum *should* be avoided. The higher the speed at which a wire rope, or any rope for that matter, is worked, the greater is the wear. It is more economical to increase load rather than speed.

The grooves of pulleys and drums should support one-third of the rope circumference in a true circle. The groove diameter should be 5% greater than the rope diameter. When a rope is placed on a grooved
$\frac{1}{16}$ in drum the laps should clear each other by about 1·5 mm. Worn grooves will prevent this.

When coiling a rope down, right-handed ropes are coiled right-handed; the free end should be able to revolve, because many turns may develop during coiling. If the end cannot be rotated the coil will have to be composed of several *Frenchmen*. These are occasional right-handed turns but with the uncoiled length emerging from *below* the last

turn instead of above it (see Fig. 16.13). They remove the twists quite effectively. When a right-handed rope has been belayed left-handed and strained it develops a left-hand set, i.e. it resists right-handed coiling, and only the use of 'Frenchmen' will enable it to be coiled down.

A coil should be stopped all round with yarns when not in use, to prevent the turns from jumping. A 'Frenchmen' coil will tend to throw off the turns more vigorously, if disturbed, compared with an ordinary coil.

Wire rope is about five times as strong as high-grade manila rope, depending upon the steel used. Greater comparison figures are possible of course. It stretches very little and may be considered non-elastic; it does in fact part very easily when subjected to a shock load. It should not be assumed that the wires in a rope are in one length—frequently, in a long rope, they are welded together to give the required length, but these joins are well staggered.

Cutting Wire Rope

Two whippings of marline or rope-yarn should be placed on the rope,
each one commencing about 2·5 cm away from the point of sever and 1 in
continuing for about 5 cm. It is most important to work *away* from 2 in
the cutting point when whipping, so that the latter is not loosened when the rope is cut and the strands spring apart.

The 5 cm space left for cutting is now placed on a hard surface, such 2 in
as the mooring bitts, and hammered once or twice to flatten the upper wires. This gives a good keying surface for the cold chisel which is finally used to sever the strands. Several designs of wire-cutter are available, and they give a neater finish than a cold chisel.

When cutting a length off a coil the length remaining or removed should be marked up locally.

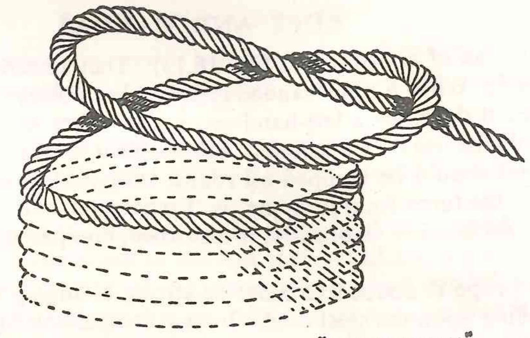
Bulldog Grips

These are shown in Fig. 16.13. They are used to form an eye in a wire rope when splicing is not possible for any reason. They must never be used for joining two hawsers, simply by clamping the ropes together.

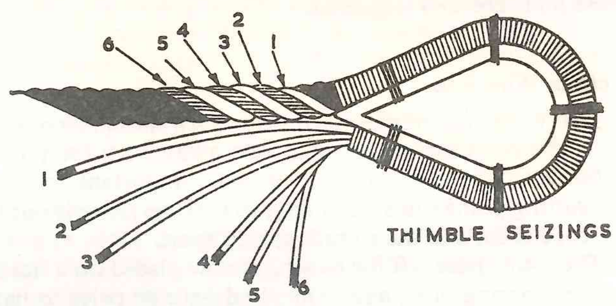
The base-plate of the grip must always be fitted under the working part of the rope, with the U-bolts over the dead end.

Three grips should be used on ropes up to 24 mm in size, four grips 3 in
on ropes between 24 and 32 mm in size, and five or more on ropes over 3 and 4 in
32 mm in diameter. They should be spaced at distances equal to 4 in
nine times the diameter of the rope.

They are extremely useful fittings, but they do, however, tend to crush and mark the rope.

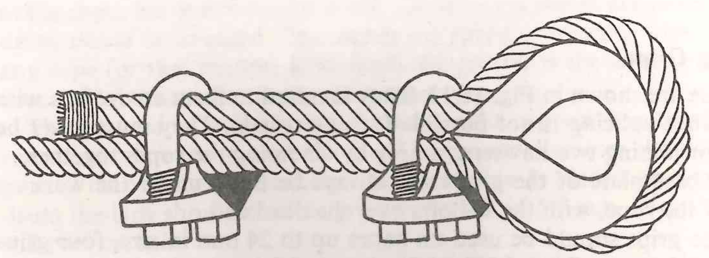


COILING A RIGHT-HANDED "FRENCHMAN"



THIMBLE SEIZINGS

NUMBERING ENDS & STRANDS (WIRE EYE SPLICE)



BULLDOG GRIPS

FIGURE 16.13

Inspection of the Rope

Distortion of the rope by kinking, crushing, crippling, etc., is likely to reduce the strength of the rope by as much as 30%. A rope in which the heart is protruding should be discarded.

Wearing of flats across the wires, giving them a bright appearance, does not affect the strength of the rope unless it is very pronounced. Sometimes the entire rope is seen to be flattened, such as a cargo runner continually being wound on to a drum in two or three laps. This indicates distortion of the strands, which is serious.

Broken wires should be examined to ascertain whether wear or corrosion has caused the breakdown. Reference should be made to Chapter XV to study the Docks Regulations stipulation on this point.

A wire rope should be frequently opened up with a marline spike; a dry, powdery heart or core indicates dry rot, and the rope should be either discarded or, if considered wise, lubricated.

At sub-zero temperatures the steel wires will become brittle and the rope may part without warning. Further, the flexibility is reduced. However, the wire will regain its normal characteristics under normal temperatures.

Splicing Wire Rope

This is done along the same lines as fibre-rope splicing, but greater skill is required due to the extreme resilience of the wires. The galvanising may be damaged during the process and before being parcelled and served, splices should be dipped in Stockholm tar or other preservative.

The strength of the rope may be considered to be reduced by about one-eighth by a good splice, but considerably more by a bad splice. Great care must be exercised to prevent tearing the strands or cores with the marline spike.

A long, tapered spike should be used and carefully inserted in the rope, avoiding the heart. The tucking end of a strand is inserted in the same direction as the spike, pulled beyond it, and then back into place. Strands should be tucked some distance away from where they last emerge, otherwise a bad nip is caused and the strands open, exposing the cores, quite apart from the fact that the wires are kinked. The marline spike can easily be worked back along the lay and the strand set carefully into place. It is far better to tuck too far away from the splice than too close to it.

In wire splicing a half-tuck may be either a tuck executed with halved strands or a tuck done with alternate strands, so that three ends emerge one tuck farther along the rope than the other three. Both types of half-tuck produce a tapered splice, which is highly desirable.

Short Splice

This is a bulky splice, and many seamen prefer to do a cut splice, in the belief that it is stronger and more easy to execute.

A whipping is put on each rope at a distance from its end equal to about thirty-six times the diameter. The end of the rope is already whipped presumably, close to the point where it was cut from a coil.
6 in Place another whipping about 15 cm away from the end one and cut the latter. The strands then unlay themselves for this distance of roughly
6 in 15 cm. Each end should be whipped with sail twine, bearing in mind that all whippings must work away from rope or strand ends. The wire rope can now be unlaid all the way to the main whipping ($36 \times D$ mm from the end).

The rope ends are married, so that a strand of one rope lies between two strands of the other and the ropes are hove together, so that the whippings nearly touch. Seize the strands of one rope on to the other rope, so that the other set of strands can be tucked without the operator being hampered by a dozen unruly strands.

We now see, therefore, two wire ropes butted together. The strands of the right-hand rope, say, are seized on to the left-hand rope. The strands of the left-hand rope are free to be tucked into the right-hand rope.

Cut the whipping on the right-hand rope and tuck the left-hand rope's strands into it as for a fibre-rope splice, i.e. each tucking end passes over the strand to its left and under the next strand.

After the first round of tucks pass a seizing round the splice to prevent the ends from easing back and becoming unspliced.

If the tucking ends have fibre cores, cut them out and lay up the strands again. Make three or four more rounds of tucks. Stopper back about a third of each strand and tuck the remaining two-thirds once again. Now halve each tucking end, stopper one-half back, and tuck the other.

With a mallet, flatten all tucks, working towards the bight of the rope, and finally cut off all ends.

Repeat the process on the other (left-hand) rope and finally serve the splice all over.

By reducing the tucking ends twice, a well-tapered splice is obtained.

Eye Splice (Fig. 16.13)

Many wire ropes nowadays are spliced by the 'Talurit' system, in which the eye is formed, with or without a thimble, and the dead end laid along the standing part, as in the case where grips are to be used. An alloy collar is slid over both parts, close up to the neck of the eye, and closed very tightly in a powerful press.

When splicing an eye the tucking ends should be of length equal to eighteen times the rope diameter, so that the strands are pliable to handle, do not kink easily, and can be pulled well tight.

The success of the splice depends upon the first round of tucks; if the ends are badly tucked initially the splice appears to be long-jawed.

Right-handed splicing merely involves laying each end around the same strand four or five times. The tucks are made with the lay; the splice is quick and easy, but is of no value if the rope is likely to rotate in service.

Left-handed splicing (over-and-under splicing) is more efficient, and the splice appears as though it is a plaited rope, giving very strong adhesion. It is a strong splice, three tucks of which are probably equivalent to about five right-handed tucks.

Locking splices, having possibly more than one lock in the splice, are always the strongest. Two ends are tucked under one strand so that they cross, i.e. they are tucked in opposite directions. Generally only one lock is made, and in the first round of tucks.

The Docks Regulations stipulate that eye splices shall consist of at least three full and two half tucks, all against the lay; any other splice may be used if it is equally or more efficient.

Before commencing the splice the length of the ends should be measured off and a serving put on the rope. If a thimble is to be used the serving is continued for the full length of the eye, measured by placing the thimble on the rope and turning it over once.

The thimble is then seized at the middle of the serving, the eye is formed, and the two parts seized at, and to, the neck of the thimble. A
temporary whipping is put on the bare end, about 15 cm from it, and 6 in
the extreme-end whipping is severed. The strands are whipped, the temporary whipping removed, and the strands unlaid to the thimble.

The first tuck is often made on a hard surface, such as the mooring bitts, after which the eye is hung up at chest-level for completion of the splice.

In the descriptions following the reader should imagine himself looking at the wire rope, from the crown of the eye towards the neck. The tucking ends are lying on his left hand and the standing part is to his right. The tucking ends, when allowed to lie in their natural lay, are numbered from 1 to 6, counting from the right-hand top end to the left-hand bottom end.

The strands of the rope are numbered from 1 to 6 along the rope away from the eye (Fig. 16.13).

The Left-handed Lock Splice (Boulevant)

Tuck No. 1 end through number one strand, towards the right.

Tuck No. 2 end through number two strand, towards the left. With the spike still beneath number two strand, bring No. 6 end upwards, but beneath Nos. 3, 4, and 5 ends, and tuck it under number two strand towards the right; this forms a lock.

Tuck No. 3 end through number three strand, towards the left.

Tuck No. 5 end through numbers four and five strands, to the left.

Drop number five strand from the spike and tuck No. 4 end through number four strand, also to the left.

The splice is finished off as in fibre-rope, tucking over one and under one, i.e. left-handed.

The Naval Splice

Tuck No. 1 end through number one strand, to the left.
Tuck No. 2 end through number two strand, to the left.
Tuck No. 3 end through number three strand, to the left.
Tuck No. 4 end through number four strand, to the left.
Tuck No. 6 end through numbers five and six strands, to the left.
Tuck No. 5 end through number five strand, to the left.

The splice is finished off as before, and in both splices the strands may be reduced as described in the short splice to give a finely tapered result.

CANVAS

This is made from either hemp, cotton, jute or flax, or even a blended mixture of these materials. British canvas is predominantly manufactured from flax, while the bulk of American canvas is derived from cotton.

The threads running along the length of the roll or *bolt* of canvas are known as *warp* threads, while those running across the width of the bolt are called *weft* threads. The edge of the canvas does not fray due to the
1 in continuous weft, and is called the *selvedge*. Approximately 2·5 cm from each selvedge a coloured thread is woven parallel to the selvedge, and is called the *seam line* or *selvedge stripe*. This acts as a guide when sewing two cloths together.

If the canvas is cut, a *raw edge* is formed and fraying occurs.

2 to 3 ft The width of the canvas varies from 0·6 to 1 m. It may be obtained flame-proofed and also waterproofed. This latter process is achieved either by means of wax impregnation or by chemicals. The former method does not give lasting protection, as the wax is affected by strong sunlight and cracks with continual folding. Tarpaulin canvas is often a coarser material, manufactured from second-grade flax, and is cheaper. It is available in the natural shade, or in brown or green.

Merchant Navy canvas is provided in seven grades numbered 0–6, the lower figure representing the stouter canvas. In the trade, canvas is

referred to by weight, i.e. so many grammes per square metre. Duck canvas is a very light cotton material, and is used for fine work.

Canvas is liable to stretch considerably along the warp but very little across the weft. The same applies to shrinkage, and although a dyeing process initially shrinks the material, further shrinkage occurs continuously. To prevent this, canvas is often painted so that the paint fills in the spaces between the threads, and this also tends to prevent stretching. Naturally, the application of paint causes a certain amount of shrinkage. If it is desired to obtain a very taut canvas it is laced up tight, damped with fresh water, and painted while still moist.

Canvas Work

Sewing is done with flax sewing twine previously impregnated with beeswax to prevent kinking of the twine and to secure a more watertight seam. Some sailmakers prefer to run their twine through beeswax themselves, but it may be obtained already treated. The beginner tends to space his stitches too far apart, and they are then referred to as *Homeward Bound Stitches* or *Dog's Teeth*. For fine work, up to six stitches to 2·5 cm are used, but four to 2·5 cm is approved for normal work.

The sailmaker usually allows 2·5 cm in 30 cm run of cloth for 1 in per ft
shrinkage (boat covers, tarpaulins, etc.) and the same amount for stretch in the case of awnings. When sewing, the bottom cloth gradually shortens relative to the top cloth, and due allowance must be made for this.

When sewing, a sailmaker's hook is used to hold the canvas firmly against the pull of the stitching, and acts as a sailmaker's third hand.

Fig. 16.14 shows the flat and round seams—the latter being the quicker of the two. The round seam is made on the inside of the work and then well rubbed down to make it flat. Both are shown joining two cloths. The sailmaker's hem is known as *tabling*, and strengthens the edge of a cloth when eyelets are to be inserted. It is always used when sewing rope to canvas, as shown. *Herringboning* is used to repair a cut or tear, and draws the two edges together. This method of stitching is also used when sewing canvas around rails; a normal stitch would cause the seam to spiral around the rail, giving an amateurish appearance.

Canvas is invariably sewn with doubled twine, but it is considered sharp practice to knot the twine when commencing. The professional method leaves the twine unknotted, and as the first stitch is made, about 4 cm of twine-end is left protruding. This is then tucked in the seam 1½ in
pointing in the sewing direction and is sewn over with the next few stitches. When a length of twine is used up the needle is cut away, leaving about 2·5 cm of twine protruding from the canvas. The last 1 in
half-stitch is unpicked and the new length of twine passed through the

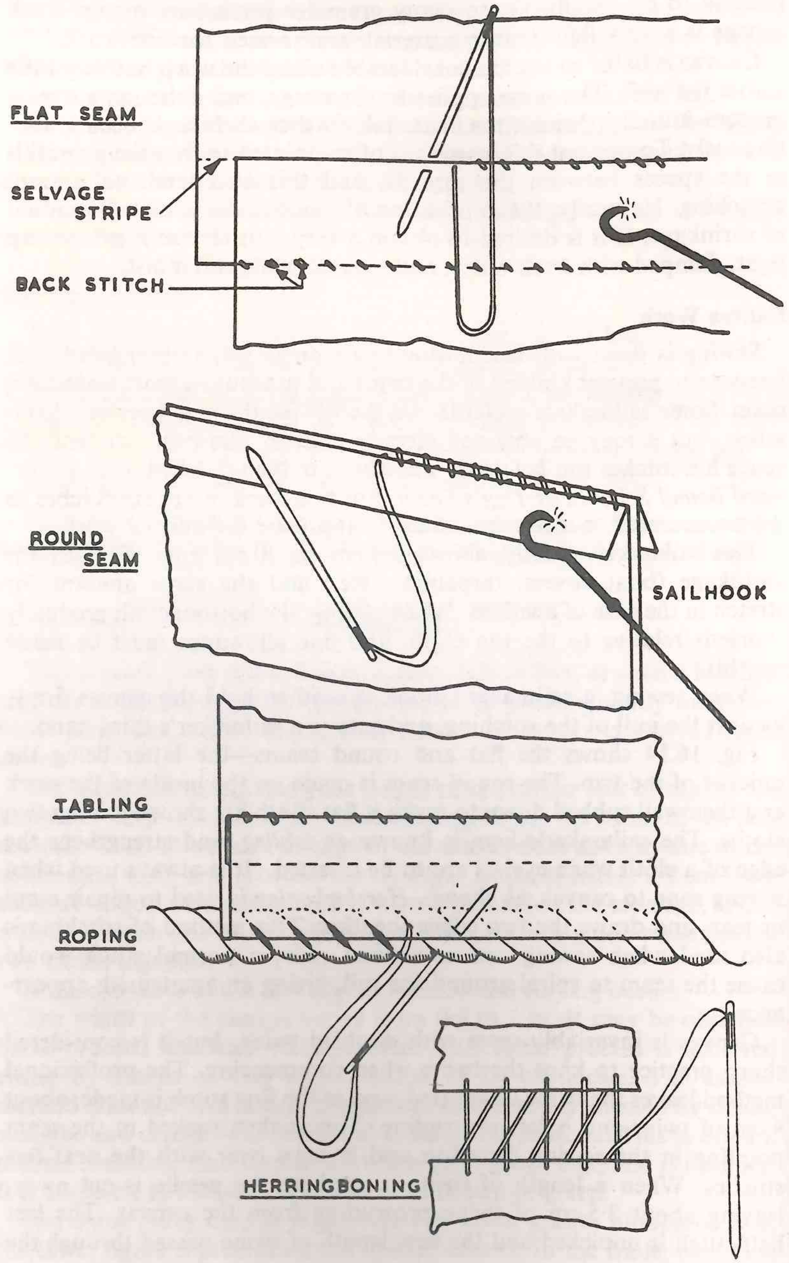


FIGURE 16.14

vacant stitch-hole. The twine is drawn through so as to leave 4 cm protruding. There are now two twine-ends protruding inside the seam. They are twisted together, laid along the sewing line and sewn over with the next few stitches. 1½ in

In the flat and tabling seams in the figure the end stitches are seen to be doubled. This is because the seams have been finished with two or three back-stitches, working the needle back along the seam, before cutting off the twine.

A person sewing canvas uses a *palm*, which is a broad leather strap secured across the palm of the hand by means of a thumb-hole. The centre of the palm has a metal cup, which is used similarly to a lady's thimble, i.e. to push the needle through the canvas. A roping palm has a stouter cup and also a thumb guard. Sail needles are numbered, Nos. 10 and 11 being commonly used for roping, the finer No. 14 for sewing. Nos. 15 and 16 are sufficiently fine for working duck canvas.

Brass eyelets are in two parts, a male and a female. A punch and die are used, suitable for the size of eyelet. The hole is made in the canvas by means of a piercing tool and widened with a fid. The male eyelet is placed in the die, the canvas placed over the male, the female over the canvas, and the punch is then used to tap down the protruding male flange, locking the female part in place.

CHAPTER XVII

DECK APPLIANCES

LEADLINES, both of the hand and deep-sea variety are no longer required on new tonnage. Neither are mechanical sounding machines but I am including detail of these devices partly because seafarers may encounter them on older ships and also for historical interest.

(1) THE HAND LEAD

This consists of a length of 8–10 mm diameter cable-laid rope, the final lay usually being left-handed. It is manufactured from dressed hemp. When making a leadline it must not be marked until the rope has been stretched and this is done by soaking it thoroughly in fresh water and setting it tight using a small purchase. The slack is taken up periodically as the line lengthens.

An eye is then spliced in one end, slipped through the strop of the lead, passed over the base of the lead and hauled taut to form a cow-hitch. The line is next carefully measured and marked. The depth measurements can be taken either from the base of the lead, known as *lead-in* or from the strop of the lead, called *lead-out* which gives the *benefit of the lead*. In the latter case, all soundings read from the line are greater by an amount equal to the length of the lead. The markings may be in either metres or fathoms. Both are included in the following table:

Metres	Fathoms	Mark used
1, 11 and 21	–	One tail of leather
2, 12 and 22	2	Two tails of leather
–	3	Three tails of leather
3, 13 and 23	13	A piece of blue serge
4, 14 and 24	–	Green and white bunting
5, 15 and 25	5 & 15	A piece of white linen
6, 16 and 26	–	Green bunting
7, 17 and 27	7 & 17	Red bunting
8, 18 and 28	–	Blue and white bunting
9, 19 and 29	–	Red and white bunting
10	10	A leather washer
–	20	Piece of cord with two knots
20, 30 and 40	–	Leather washer with 2, 3 or 4 leather strips.

Where a piece of material is inserted into the line, the position is called a *mark*. In a metric line every metre has a mark. In the fathom line however there are only 9 marks, the other 11 numbers between zero and 20 being known as *deeps*, which can be recognised by a knot in the line itself. The type of material used for marks is optional. The original reason for the different qualities was so that leadsmen could identify them in the dark, some using their lips to differentiate for instance between serge and bunting. The marks and deeps must always be called by the leadsman in such a way that the whole number is at the end and therefore more likely to be heard. Thus,

5¼ fathoms is called as 'And a quarter *five*'
8 fathoms is called as 'By the deep *eight*'
10 metres is called as 'By the mark *ten*'
11½ metres is called as 'And a half *eleven*'
12¾ fathoms is called as 'And a quarter less *thirteen*'

Years ago, this is how one would have seen soundings taken using a 3 Kg lead on a 45 metre line.

The leadsman operates on a small platform projecting over the ship's side, called the *chains*. To take a sounding on the starboard side (the weather side normally being used so that the ship does not drift over the lead), he would stand facing forward holding the coil in his left hand and the last few metres of line, with the lead hanging down, in his right hand. A half turn is taken round the palm of the right hand. He then commences to *heave* the lead back and forth, finally releasing it on a forward swing so that it enters the water well ahead of him. He heaves in the slack after the coil has run away a few turns, and dumps the lead up and down on the bottom as the chains move over the line. He notes the mark on the line at the water's edge and gives the appropriate call.

Some seamen, when the lead is swinging forward with their arms straight, quickly bring their elbows into their sides and, provided the swing has been carefully judged, the lead describes a circle above their heads. It is spectacular and undoubtedly gives the lead a much greater cast ahead of the chains.

The base of the lead is hollowed out into a *score*, which is filled with tallow if a sample of the sea-bed is required. The tallow is then found to have sand, shells, gravel, or whatever the sea-bed consists of, adhering to it. This process is known as *arming* the lead.

(2) THE DEEP-SEA LEAD

This is made from larger line and uses a lead weighing about 13 kg. **28 lb**
It is scored in a similar way and armed when desired. This line is at least
220 m long and is marked at every 5 fathoms with a cord having **120 fathoms**

one knot in it. At 20, 30, 40 fathoms and so on, a piece of cord is used having one knot in it for every 10 fathoms, i.e. two, three, and four knots respectively. The lead is marked in this way to 120 fathoms, using a piece of leather with one hole in it at 10 fathoms, and a piece with two holes in it for 100 fathoms, i.e. a hole for each nought.

This lead is hove along the weather side by placing the lead forward and with several crew members ranged along the ship's side, each holding a few coils in his hands. In some cases the Officer in charge will stand where the lead is expected to touch bottom.

The lead is cast overboard and the coils run away, each man warning the one abaft him that the lead has not yet touched. The traditional warning is 'Watch there, watch'. The ship is stopped while heaving the deep-sea lead.

(3) THE SOUNDING MACHINE

The Kelvin Hughes sounding machine may be hand-driven or controlled by an electric motor. It is equipped with a drum on which is
300 fathoms wound 550 m of seven-strand galvanised steel wire. This wire is secured
2-fathom at its outboard end to a 4-m length of hemp line. This line carries a brass sheath or tube which is perforated and fitted with a cap. Supplied
24-in with the machine are 100 sounding tubes, which are 60-cm hollow glass rods open at one end, and coated on their insides with silver chromate. The tubes therefore appear to be red.

One such tube is placed into the brass sheath, open end downwards, and the cap is placed on the sheath. The sounding wire is then allowed
24-lb to run to the sea-bed under the influence of an 11-kg cast-iron sinker which has an arming score similar to sounding leads. While the sinker is descending a hooked metal rod called a feeler is held bearing very lightly upon the wire. Immediately it is felt that the wire no longer presents an upward resistance to the feeler the wire must be checked.

The sinker is now hove-in, the glass sounding tube is removed and held against a boxwood scale graduated in metres. Sea-water will have been forced into the glass tube to an extent which is dependent upon the depth to which the tube was lowered. Further, the action of the salt water will have changed the coating in the tube to white silver chloride. With the tube held in the boxwood scale therefore the dividing line between red and white coatings enables the depth of water to be read.

It is most important to check the wire as soon as the sinker touches the sea-bed; if the tube is allowed to fall from the vertical the sea-water already in it will be able to move farther up the tube and a false reading will be made.

The wire can either be lowered using a sheave built on to the rail aft or by means of a sounding boom which is swung out perpendicular to

the ship's side. In this latter case the wire runs through a travelling sheave which may be hove out to the end of the boom. The speed of the ship should be reduced when making a sounding.

The following are the maker's instructions for operating a motor-driven machine:

'Attach sinker and stray line to machine. Place glass tube in guard sheath and replace cap. Place the sinker over the ship's side and let wire out gently by easing the handwheel in the running-out direction with the bolt in the lower position. Snatch the wire into the block of the carrier. Run the carrier out to the end of the boom and belay. Lower sinker until nearly touching surface and hold in this position. Set pointer to zero.

'Place the loop of the feeler pin over the right wrist and gently press the feeler pin on to the wire. Smartly rotate the handwheel one half-turn only in the running-out direction and watch the pointer as the wire runs out. Release the handwheel and catch the starting switch handle in the eft hand.

'At the instant the wire slackens off, read the number of metres of wire out as indicated by the pointer. At the same time put the starting switch handle over about half-way and then gradually over to the "on" position to heave in at full speed. When the pointer shows 20 m 10 fathoms
the switch handle should be eased back gradually so that the motor stops before the swivel reaches the carrier block. Read off the exact depth on the glass tube with the scale provided.

'Use a pad of oiled canvas to guide the wire on to the drum while heaving in.'

In later models, the tube was plain glass but constricted, and worked on the principle of a clinical thermometer. Water was forced into the tube at depth but could not get out until the tube was shaken. It did not, therefore, matter if the tube fell on its side because there was no internal coating to be affected.

The sounding machine is now obsolete but is included here, together with Plate 24, for interest's sake. Many ships which were fitted with the machine have now had it replaced with a second echo-sounder. The success of the sounding machine operation was perhaps too dependent upon human factors.

(4) THE SHIP LOG

From the earliest days when man ventured to sea in wooden boats, navigation, however crude, has been necessary.

Probably the earliest known attempt to estimate distance or speed at sea was made by the Romans, who used a type of waterwheel fixed to the hull of the galley which carried a drum inboard filled with pebbles. Every time the wheel revolved one pebble fell out into a tally box. By counting the number of pebbles in the box, an estimate of distance travelled could be obtained.

Of the early methods of estimating speed and distance, the best known are the Dutchman's Log and the Common Log. Both methods have been in use since the fifteenth century, and even today there is reason to believe that these methods are still practised.

The Dutchman's Log gives an accurate method of finding a ship's speed. Two points are chosen on the ship and the distance between them measured accurately. A small float or similar object is then thrown as far ahead of the ship as possible and timed accurately between the two marks. The success of the results depends on the accuracy of observation and timing.

The Common Log or Ship Log was first invented or used about 1578, and consisted of a piece of wood attached to a line and thrown overboard to lie like a 'log' on the water. The Common Log consists of a wooden quadrant called the log ship, weighted at the base to keep it upright. In the log ship are two or three holes; to one or two of the holes the log line is made fast, while in the other is a bone peg attached by a cord to the log line. When heaving the log, the log ship at the end of the line is thrown overboard, well clear and to windward of the ship, and
10 or the line paid out from the log reel on which is it wound. The first 20 or
20 fathoms 30 metres of the log line are called stray-line, and this is allowed to carry the log beyond the disturbed wake of the vessel. Where the stray-line joins the log line, a piece of bunting is inserted, called the *turnmark*. Beyond this mark, the line is marked with pieces of cord, each having a certain number of knots in it. Between these marks there is situated a piece of cord having one knot in it.

The distance apart of the marks is in the same proportion to the
feet 6 080 number of metres in a nautical mile (1 854) as the duration of the sand-glass used is to the number of seconds in an hour (3600).

The sandglass is inverted as soon as the turnmark runs over the rail. This glass is usually a 14- or 28-second timer. At the instant the sand-glass is run-out the cord nearest the rail is noted. The number of knots in the cord represent the number of knots of ship's speed, for they increase in number from the log-ship towards the vessel. The one-knot marks indicate half-knot speeds.

The line has to be quickly nipped as the sandglass runs out, and this is simplified by the use of a 'Burt's nipper', which is a device consisting of a handle and rollers through which the line is allowed to run. The operation of the handle causes the rollers to jam the line. This nipping action pulls the bone peg from the log-ship, allowing it to be easily hove-in.

The marking of this logline provides an excellent explanation for the use of knots as ship-speed units.

There are now three basic types of ship log:

(a) The Towing Log

In this design a streamlined gunmetal rotator having four pitched fins is towed by means of a patent logline having a wire heart. The rotator revolves at a speed proportional to the speed of the ship through the water and induces a constant twist into the line. The latter is connected to the register, which dissipates the twist within its mechanism, which in turn converts the number of rotations into nautical miles, indicated on the dial of the register.

The towing log has been in use for over 150 years—it is simple to use, and provided reasonable care is taken to see that the line is of the correct length and the rotator is not damaged, accurate results may be obtained. A damaged rotator should be discarded, for its pitch will undoubtedly be affected.

The most modern towing log is the Walker's 'Commodore' (see Plate 7), which was introduced in 1956 to replace the Walker's 'Trident' electric log. The register provides mechanical indication of distance run on the dial, remote indication of distance run on the chart-room receiver dial, a speed feed to true-motion radar installations, speed indication, and speed and distance recording.

The register, fitted with 4 m of five-core electric cable, requires no 15 ft
internal lubrication except at very long intervals of about 100,000 miles. The dial movement is grease-packed and requires no attention. The contact movement is a complete assembly providing reduction gears and electrical contacts. It causes an electrical pulse every tenth of a mile for distance-repeating on the chart-room receiver, and a pulse every 10 m yd
which is used either for speed feed to radar, or speed indication, or both.

The register employs the 'Cherub' rotator, which makes 900 turns to the nautical mile. The register is connected to a socket by means of a four-pin plug having an earth connection. The socket has a spring-loaded cap which must always be kept closed when the log is not in use, and it must never be painted, otherwise the cap may not seat properly.

Installation. The usual causes of error are either that the rotator is damaged, the line is of incorrect length, or that the rotator is towed in the propeller slipstream.

Both port and starboard mountings should be provided for the register and preferably with an outrigger bracket so that not only does the rotator clear the wake but also that the iron governor wheel, just abaft the register, does not foul the ship when the helm is hard over.

In a vessel over 120 m in length, with long, straight sides from the 400 ft
bridge position to the runaway aft, the log may be towed from a side boom, using a terylene logline. In this case a 'Viking' connector is

fitted at the outer end of the boom and transmits the turns from the line, through a fine copper aerial wire, to the register mounted in the wing of the bridge.

Before streaming the log the hands of the register and the chart-room receiver should be synchronised, by turning the hands in the opposite direction to that in which they normally revolve.

Speed Indication. For this the register is wired to the 'Commodore' switchcase, which provides feed for the radar, the bridge speed-indicator, and for the combined speed and distance recorder. This speed indication is accurate to within 2% if speeds are above 3 knots. The chart on the recorder, showing speeds from 3 to 23 knots, will suffice for about 4,000 miles.

Speed feed to radar from the log is much more efficient than a feed taken from the main propeller shafting, because no adjustments are necessary when varying engine revolutions in foggy or crowded traffic waters.

The Logline. The length used depends upon the ship's speed and the height of the register above the water level. The following lengths are recommended when streaming the log from astern:

40–50 fathoms For a maximum speed of 12 knots use 73–90 m.
60–65 fathoms For a maximum speed of 15 knots use 110–120 m.
70–80 fathoms For a maximum speed of 18 knots use 130–150 m.

New lines stretch considerably, and their length should be carefully checked after a short initial period of service. It is always preferable to use the maximum length of line, for the rotator, being deeper in the water, is less affected by rough weather.

When the length has been decided one end is rove through the shell of the rotator (a streamlined connector secured to the rotator by about
1 fathom 2 m of line), a figure-of-eight knot is made in the end of the line, and this is hauled tightly back inside the shell. The other end of the line is secured to a hook by means of a round turn, seizing the end back on to the standing part several times.

When using a new line, or one which has been stowed away for a considerable period, the hook end should be paid out astern until all kinks are removed. It can then be hauled in and coiled down ready for use.

When streaming the log the line is hooked into the eye of the register and the rotator passed overboard. When the line is nearly paid out the load must be gradually transferred to the register spindle. Some seamen prefer to pay out the bight of the line, fling the rotator astern, and then grip the line to the rail, finally transferring the load to the register. There is the possibility here that the line may part as it jerks tight astern; on the other hand, by streaming the rotator first the line tends to run

overboard with a rush, and may prove difficult to control. The former method is recommended by the manufacturers.

When *handing* the log, i.e. bringing it aboard, it is necessary to pass the hook end overboard and pay it out as the rotator is hauled in. When the rotator comes aboard the line may be hove-in free of turns.

If the log is streamed from abeam it can be handed without the line becoming badly snarled with undissipated twist by using one of the following methods: a grapnel may be cast across the line and slid down until it nearly touches the rotator. The latter can then be quickly plucked from the water. The other method uses a line having a thimbled eye in it through which the logline runs. The tripping line, as it is called, is made fast inboard. When it is desired to hand the log the tripping line is cast off inboard and passed aft along the ship's side until the thimbled eye touches the rotator, which may again be quickly withdrawn from the water. The use of such a tripping line tends to promote wear in the log-line in way of the thimble.

(b) The Electromagnetic Log

This device uses electromagnetism as its operating principle. The log transducer or sensor contains an energised winding which is supplied from a power transformer. This power, which is of the order of 50 volts at 0·7 amp, is used to produce an alternating magnetic field which is projected into the sea. An electric voltage gradient is therefore induced in the water as it flows through the magnetic field.

The voltage is then detected by electrodes on the outer face of the sensor and passed to the electronic unit for measurement. Since its value is only a few millivolts, even at full steaming speeds, it has to be processed to provide a suitable speed signal. It is also integrated with respect to time to provide pulses for recording distance travelled and for feeding to radar, satellite navigators, etc.

The log sensor. This protrudes through the ship's bottom plating by a distance of 28 mm, its face being flush with a bronze capping welded to 1 in
the shell plating. The siting of the sensor will be governed to a large extent by the availability of suitable space in the forward part of the ship. Because the sensor electrodes are so close to the shell plating, it is vital that the siting is chosen where a clear flow of water exists. It should be positioned within the first 15 metres of the ship's length and 50 ft
in a dry space. There must be 1·15 metres vertical clearance for removal 3 8 ft
of the sensor. If a bow thrust unit is fitted, the sensor is sited below the thruster tube or well clear of the thruster and as near the centre line as possible, bearing in mind that it should be well clear of lines of docking blocks. The situation becomes even more critical because the siting must not allow the sensor to leave the water in heavy seas or when at light draught.

The sensor should be accessible in case a fault develops. Under no circumstances should grease or paint be allowed to cover the electrodes. Should this occur it will be found impossible to zero the log correctly.

7 in Having chosen a suitable site, a 178 mm diameter hole is cut into the shell plating. Two sensors are provided with each log, one should remain boxed up as a spare.

To change a sensor it is only necessary to switch off the power, retract the sensor by means of the handle and lead screw and then close the sea valve completely. The removal of two bolts then enables the sensor to be replaced.

The electronic unit. This carries out all the electronic processing necessary to obtain speed and distance indication. It is intended for bulkhead mounting and should be placed where it will be accessible for servicing and calibration. It could be mounted on the bridge for ease of calibration but this will be costly due to the long run of cable between the unit and the sensor. This is special cable and for reasons of economy, it is preferable to keep the electronic unit near the sensor. The length of cable joining the unit to the bridge is not critical in any way.

Speed and distance repeaters. These can be located where required but are not watertight. An engine-room repeater is normally also supplied.

Electrical requirements. The log operates from 100/120 to 200/250 volts A.C. 50/60 Hz.

(The above information together with the diagram of the sensor assembly in Figure 17.1 was kindly provided by Thomas Walker and Son Limited.)

(c) The pitot log

This device makes use of a log tube measuring the static pressure of water and also the impact pressure as the ship moves. Differences in these two pressures cause a small beam to move. This movement is counteracted by an electromagnet. The current required to energise this magnet is therefore proportional to the ship's speed and may be used by the speed indicators and also the integrator for distance run. The log tube is raised by motor power in 20 seconds. Provision is also made for hand operation.

The tube is easily replaced at sea and provision is made for blowing silt out of the tube either with water at a pressure of 2·8 kg/ cm^2 (30–50 lb/in^2) or by using air.

Speed and distance indicators are fitted in the wheelhouse, chartroom and engine-room.

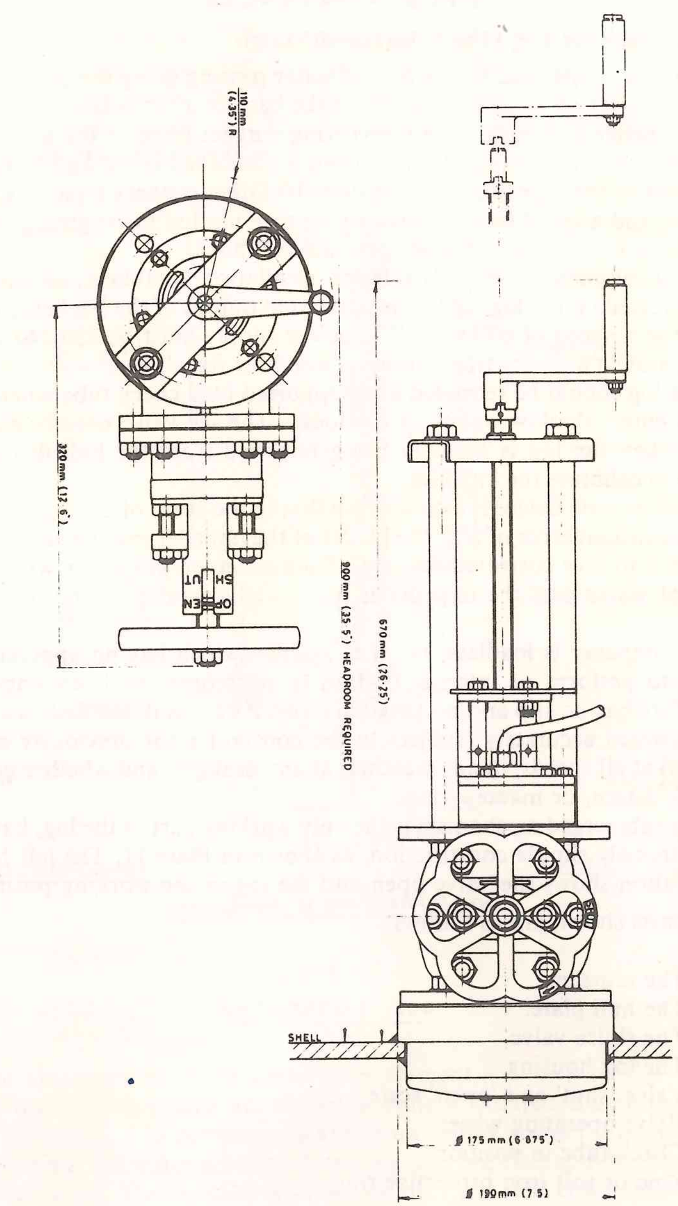


FIGURE 17.1

DIMENSIONS OF SENSOR ASSEMBLY

(c) The Impeller Log (The 'Chernikeeff' Log)

This log is operated by the flow of water passing along the ship's hull, which rotates an impeller situated at the base of a retractable log tube. The impeller is integral with a revolving magnet fitted at the base of a coil. An electronic computer unit feeds a combined speed and distance recorder of the type illustrated in Plate 10. Other distance repeaters may be run, and a speed feed is provided for true-motion radar giving either 200 10-m or 400 5-m impulses per nautical mile.

The equipment is perfectly safe for installation in tankers; no current is impressed on the log cable, the maximum output of the log being only 1 volt at a speed of 60 knots. The power supply must be 230/240 volts A.C., and so a rotary transformer is available for all D.C. voltages.

The log should be retracted and supported by a check tube when the vessel enters shallow waters or drydocks. The sea valve need be closed only when the log is actually being removed from the hull fitting in order to calibrate the impeller.

A calibration device is available, so that in the event of the log having, say, a constant error of 5%, the blades of the impeller may be accurately adjusted to give corrected readings. Such an error will occur when the flow of water past the impeller is not exactly parallel to the impeller shaft.

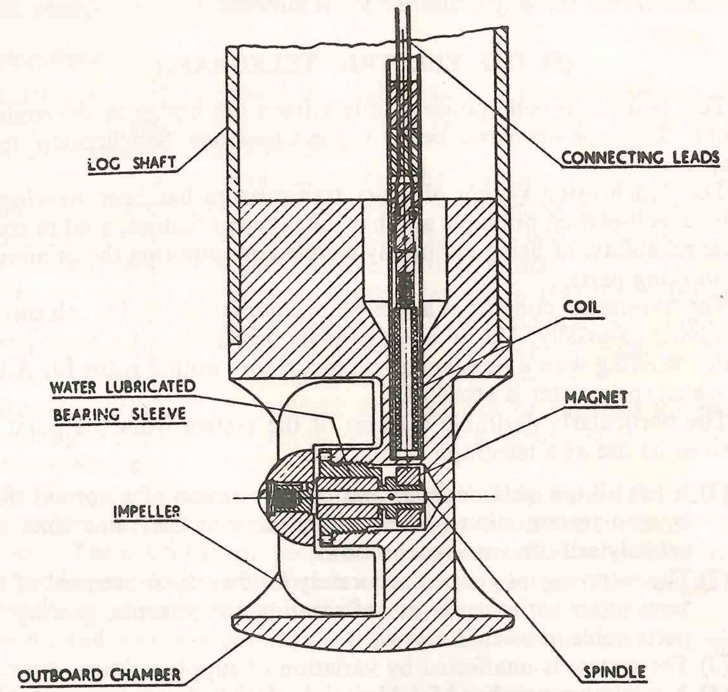
The impeller is loadless, i.e. it is a screw which has no appreciable work to perform or internal friction to overcome. Such an impeller therefore has no slip and no variable error. As a result, the distance run is registered accurately (subject to the constant error previously mentioned) at all speeds, in any weather, at any draught, and whether going ahead, astern, or manœuvring.

The submerged mechanism is the only working part of the log, having an extremely simple construction, as shown in Plate 11. The left-hand illustration shows the valve open and the log in the working position.

The parts shown are as follows:

(1) The impeller.
(14) The hull plate.
(15) The sluice valve.
(16) The log housing.
(17) Valve 'shut' and 'open' scale.
(18) Valve operating wheel.
(19) Check tube in position.
(20) Zinc or soft iron protective ring.

The right-hand side of the plate shows the log withdrawn into its housing with the valve shut. In each diagram there will be noticed a valve at the top of the log. This provides oil injection to the working part of previous-model logs. The electronic log under discussion has a water-lubricated impeller bearing.



ARRANGEMENT OF UNDERWATER ELEMENT

FIGURE 17.2

CHERNIKEEFF LOG

The arrangement of the underwater element is shown in Fig. 17.2, while the revolving parts are shown in Plate 9, compared with the size of a matchbox. The components are, from top to bottom, the magnet, the housing, the water-lubricated bearing, the impeller spindle, and the impeller screw. The impeller is shown on the right. The components are shown in section in Fig. 17.2.

The log incorporates a tide control, whereby the speed indicator can be reset to record the speed over the ground. This assumes a known current, and of course the instrument must be reset when the current changes. The distance recorded is always that through the water.

Remote control is available for raising and lowering the log from the bridge or chart room, either for electric or manual operation.

14-in 30-in The impeller is 35 cm below the plating when in use; 75-cm clearance
49-in is required within the ship while the log is in use; 125-cm clearance is required within the ship while the log is stowed.

(5) THE ELECTRIC TELEGRAPH

This is used to communicate orders from the bridge to the engine-room. The type described below is the Chadburn 'Synchrostep' telegraph.

The Synchrostep system of order transmission has been developed from a well-proven principle and has the inherent feature, vital to complete reliability, of being essentially simple and requiring the minimum of working parts.

The transmitter consists of a face-plate commutator and brush carrier revolving co-axially. The receiver consists principally of a three-phase stator winding with a permanent-magnet rotor (wound rotor for A.C.) to which the pointer is attached.

The particularly desirable features of the system from the point of view of its use as a telegraph system are:

(1) It has all the instantaneous and positive action of a normal step-by-step transmission system while being at the same time absolutely self- or auto-synchronous.
(2) The receiving instrument accurately follows the movement of the transmitter without the use of rotating components, gearing, or parts liable to wear in service.
(3) The system is unaffected by variation of supply voltage.
(4) A minimum number of cable conductors between instruments is employed.
(5) The system is equally suitable for operation on ships' mains (A.C. or D.C.) or on low-power supply.
(6) Transmitters can be mechanically or electrically interconnected, and any number of repeaters can be included in the system.

Operation

The Synchrostep Telegraph operates in the same manner as the orthodox mechanical installation, with the notable exception of the bridge and engine-room alarms. These are arranged to sound continuously from the time an order is given until that particular order is acknowledged. Such an arrangement has two advantages—for the bridge the immediate operation of their alarm confirms that their order

has been transmitted, and for the engine-room the fact that their bell operates continuously ensures that attention must be drawn to the telegraph, even if the Engineer is not on the starting platform at the time.

The operation of pointers is positive and instantaneous, and the power of the motors operating them is such as to ensure accurate location, even under conditions of severe vibration.

Instruments

Instruments are supplied in high-quality corrosion-resistant aluminium castings, stove-enamelled grey, hammer finish. Brass instruments are available where required.

Transmitters are of quadrant form, the dial occupying a sector of some 160 degrees. This design, while maintaining true directional characteristics of a lever and pointer which do not move below the horizontal, gives the largest possible width of order.

The transmitter provides an unusual feature in that the instrument has both a peripheral and a side dial, with reply pointers working over each, and this design is of great benefit to the operator, particularly in the case of vessels which use their telegraphs frequently.

Receiver dials are of quadrant form, or can be supplied for panel mounting in circular form, for incorporation in starting-platform panels and consoles, etc.

The instruments are of robust construction, fully watertight, and the transmitter is provided with double night illumination lamps and dimmer. The electrical components and dials are effectively sealed from the mechanical linkage by means of a watertight compartment. This prevents condensation and moisture settling on any electrical component, and so obviates the possibility of short-circuits and corrosion damage.

In all cases the electrical equipment is chassis mounted and can be readily and easily withdrawn for servicing purposes or for replacement of interchangeable units.

Supplementary Equipment

A *Wrong-way Alarm* may be fitted, which is a warning device to sound should the propeller shaft or manœuvring gear (as applicable) be operated in a direction contrary to the transmitted order. A lamp and bell indicator is mounted in a convenient position on the starting platform and, by means of a directional switch working in conjunction with directional contacts in the receiver, the audible and visible alarms are put into operation if the engine is manœuvred in a direction contrary to the transmitted order, and they remain so until the mistake is rectified.

The directional switch may be operated by a friction clutch from any engine member whose direction of rotation is that of the propeller shaft or by linkage from the manœuvring gear.

A *Current-failure Alarm* automatically indicates, both visibly and audibly, that there is a supply failure to the telegraphs. It is normally fed from an independent battery supply. Arrangements can be made whereby as soon as the supply fails, an auxilliary supply is automatically established.

The *Isolator–Selector System* enables any number of instruments, wherever they may be located, to be electrically connected. In this way, one instrument can take charge of the whole installation. The reply-back, however, is shown on each instrument whether it is in charge or not. The one instrument remains in charge until a different transmitter is operated. The system is useful where instruments are remotely located, such as in the wings of bridges, etc.

Remote control is possible with the Synchrostep Telegraph, so that the engines can be controlled directly from the bridge.

The servicing of these telegraphs will not concern the Deck Officer. Should he find himself on a vessel fitted with mechanical telegraphs operated throughout by wire and chain, the only servicing necessary will be adjustment of the chain-lengths, which is provided for with tightening screws, and adjustment of the bronze pulleys to compensate for wear. All metal parts are bronze, galvanised steel, or brass. The mechanical telegraph may be fitted with electric illumination in addition to oil lamps, wrong-way alarms, and a supplementary alarm whereby a klaxon sounds if an order is made after long periods of 'Full ahead'. The wire-and-chain telegraphs, of which Chadburns were the patentees and original manufacturers, are also available for transmitting docking, steering, anchoring, and warping orders.

Plate 12 shows desk-mounted Chadburn 'Synchrostep' electric transmitters, as fitted to the *Oriana*.

(6) THE WELIN–MACLACHLAN QUADRANT BOAT DAVIT

This is an extremely reliable luffing davit, the design of which has remained virtually unaltered since its introduction in 1901.

The fundamental feature of the quadrant davit is a toothed quadrant at the lower end of the arm engaging and rolling upon a rack on the davit deck frame, which has the effect of moving the pivoting point of the davit progressively outwards as the davit arm is swung outboard, thus levelling the path of the davit head and making the davit easily operated.

The movement of the arm is controlled by a non-ferrous screw some distance above and parallel with the base of the deck frame, the arm being located by a guide rod immediately above the screw.

A winding handle is provided at the end of the screw for operating the davit, and a two-speed gear is available on the larger sizes.

Hitherto, this type of davit has been made in cast steel. It is now available fabricated and welded entirely from wrought mild steel.

This construction, while retaining all the strength of the cast steel, is considerably lighter and has other important advantages. The quadrant and teeth of the arm are of such construction as to be less liable to be affected by ice and the two-speed gear (when fitted) is totally enclosed and operates in an oil bath.

The davit arm is of rectangular box form, fabricated and welded together to form a very strong and light member, the inside being hermetically sealed and airtight.

The davit is made in the same variety of sizes and types as those previously associated with the cast-steel quadrant davit, namely, the ordinary type for use outside the end of the boats; the long-arm type for use with superimposed boats; and the overhead type for use within the length of the boat, the boat being stowed in the davit arm with the keel some distance above the deck.

The davit is suitable for use with either manila falls and bollards or wire falls and winches, using any normal purchase of block and tackle.

Plate 13 shows the earlier type of quadrant davit, and the reader should note the operating handle on the left-hand davit, which is not fitted with two-speed gear. A stag-horn bollard is clearly shown at the base of the davit, with the fall leading to the winding reel. When operating this davit in the turning-out condition it is very easy for the davit to take charge, and for this reason the handle should always be firmly held. If it is released by a novice marvelling at the way the davit runs out by itself (with rapidly rotating handle) the davit will be brought to a halt at its outermost plumbing position with considerable force.

Plate 14 shows the Welin overhead type quadrant davit fitted with wire-rope falls and an electric winch. At the extreme left-hand side of the photograph the long-arm type is just visible, together with two nested boats. On the overhead davit the two-speed gear is visible on the right hand side of the photograph, just above the operating handle.

(7) THE WELIN–MACLACHLAN GRAVITY DAVIT

The outstanding feature of the Welin–Maclachlan gravity davit is its extreme simplicity and reliability. Its construction, which is well known, consists of a pair of trackways, and a pair of cradles. The inner flange of the channel trackways forms the path along which the rollers of the cradles run; the inclination of the trackways is 30 degrees, consequently the davits will operate under extreme conditions of list.

The outboard end of the inclined trackways is bent downwards until it is vertical, the lower end being rigidly connected to the deck. The radius around which the two front rollers of the cradles run swings the head of the davit outboard, and gives the outreach necessary to lower the boat clear of the ship's side.

The use of these davits leaves the boat deck completely clear of obstructions and provides a clear promenade, not only fore and aft but also up to the ship's rails.

The channel trackways are made up from standard sections, and the bent portion is fabricated in a special manner, ensuring that the section remains constant, allowing the rollers to be a close fit in the channel trackways and preventing side sway and slogger (judder).

The cradles are of a fabricated box section, hermetically sealed to prevent internal corrosion. They carry four rollers which run in the trackways, and the simplicity of the design gives accessibility to all parts, there being no links or other complications to screen portions of the davits and cause corrosion. This simplicity of design makes inspection and maintenance very easy.

The cradles in the stowed position are held rigidly with the trackways by a trigger operated by the lifeboat gripes, the pressure exerted by the gripes being multiplied by the trigger lever, thus ensuring complete rigidity when the gripe wires are tightened. In the stowed position the lifeboats are entirely prevented from any fore-and-aft surge in a seaway, as the boat under these conditions is not suspended by the falls at the davit head, but is resting its full weight on the keel support of the cradle. This has the effect of lowering the suspension point of the boat in the stowed position, which makes it easier to control; in those cases where nested boats are in use, an arrangement such as this is vital.

The four rollers of each cradle are carried on pins with gunmetal bushes and grease lubricant, the various sheaves on the cradle being similarly supported. The floating blocks are fitted with roller bearings, giving smooth operation and reducing friction to a minimum. All the bearings are packed with grease at the maker's works, and further grease can be added at intervals by means of a high-pressure grease gun supplied with the equipment.

The general layout and disposition of the various components of these gravity davits is generally arranged to suit the particular ship to which they are being fitted. The inboard end of the trackway is supported either on a deck house or on an 'A' frame, preferably of tubular construction. Winches are available both in the vertical and horizontal types. The vertical winch (with one drum above the other) may be placed adjacent to one of the trackways, at the edge of the boat deck, making a very simple and convenient arrangement, and ensuring a good lead for the wire falls, which are all carried overhead. Drip trays under the wire-rope falls are easily arranged, and ensure a clear and clean boat deck.

On the other hand, where a deck house is available, a very neat arrangement can be provided by a horizontal winch placed on the deck house, mid-way between the inner attachments of the two trackways, with the wire ropes leading fore and aft from the winch. An objection often raised to this arrangement is that the winch operator cannot see the boat as it is being lowered down the ship's side, but this difficulty can be overcome by a remote-control arrangement, enabling the main brake to be operated from the edge of the deck despite the winch being placed some little distance away on an upper deck. The remote control does not rely upon rods, links, etc., and is extremely simple and reliable.

These davits are capable of launching a lifeboat within 20 seconds from the time when the gripes are cast off.

Plate 15 shows the davits in use on board the *Saxonia* (Cunard Line). Among the features which the reader should study are:

(1) The boat-gripes, and one of these is visible just to the right of the Officer who is standing at the ship's rail. It is hanging in a bight from the base of the trackway to the trigger-mechanism, mounted just below the fall at the top of the trackway.

(2) The method whereby the block of the nearest boat fall is hooked to the davit cradle.

(3) The tricing pendants referred to in Chapter XVIII. The left-hand nearest davit has one suspended from the cradle just below the centre sheave. It is fitted with a patent slip at its lower end. The boat at the bottom of the plate has its tricing pendant slip made fast to the link on the block. These pendants are fully discussed in Chapter XVIII.

Plate 16 shows gravity davits fitted to a British Transport Commission vessel. The tricing pendants are again visible.

The canvas-covered gripes can be seen extending across the boat forward and aft, and if their lead is followed inboard they will be observed secured to the cradle trigger-mechanisms. At the after end of the boat it is possible to see the hand-linkage ring for quick release of the after hook.

(8) THE WELIN-MACLACHLAN UNDERDECK GRAVITY DAVIT

In recent times Naval Architects have again been giving considerable thought to the desirability of entirely removing boats and davits from exposed upper decks and installing them on a lower covered deck with the object of keeping upper decks clear, reducing top weight, and reducing deterioration and maintenance to a minimum.

This problem was complicated by the need for gravity davits, which by Regulation require either a trackway inclination of 30 degrees or a continuous positive turning-out moment with the vessel listed 25 degrees either way.

The new boat deck consists of a bay occupying the height of *two* decks and running the requisite length of the vessel to accommodate the necessary number of boat stations; trackways are connected to the underside of the deck above, and the winches are mounted on the cabin bulkhead to give full headroom on the operational deck, which will also be the embarkation deck. The lifeboats will be suspended at a sufficient height to permit of full headroom for promenade purposes on the bay deck; and the height and angle of the lifeboats has been carefully adjusted to permit an unobstructed view from the windows of the two decks inboard of the lifeboat bay deck.

The necessary gravitational operation of the davits has been obtained by a combination of trackway inclination and a counterweight; and the positive turning-out moment stipulated by the Regulations has thus been ensured.

The trackway is in mild steel, but the cradle and the gunwale steadying arms are made of aluminium alloy. The light weight of the cradle reduce the size of the counterweight, and it is interesting to note that this new davit complete with counterweight is approximately 15% lighter than the standard trackway-type overhead gravity davit. Another novel feature is the tusk, which holds the floating block in position on the cradles; this tusk is controlled by the movement of the cradle, and can release the floating block (which carries the lifeboat) only when the davit reaches the fully outboard position.

This davit can therefore release and lower a lifeboat against a 25 degrees adverse list and a 10 degrees trim, and this has been confirmed by tests carried out by the British Department of Trade and Industry.

Among the many benefits obtained are the following:

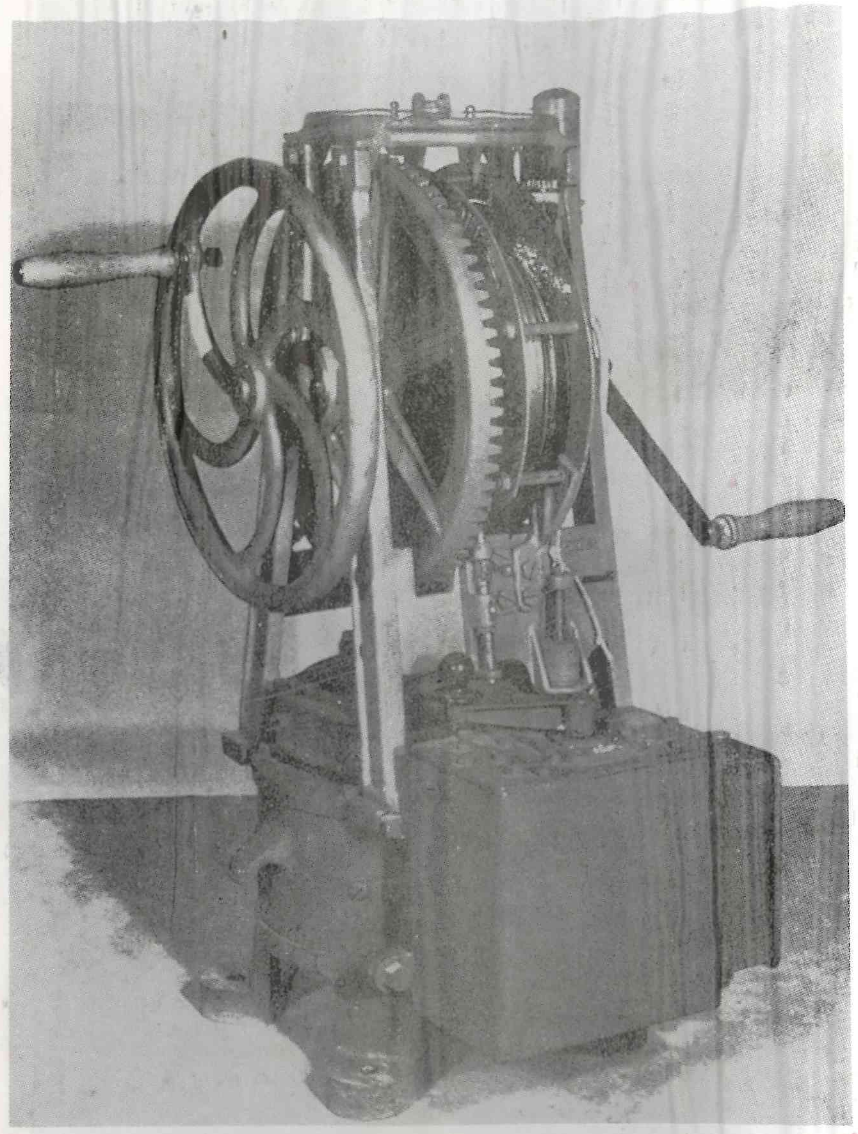
(1) The Davit can actually launch a lifeboat at 25 degrees adverse list.
(2) Clear upper decks.
(3) Reduction of top weight.
(4) Protection of boats and davits from deterioration.
(5) Easier maintenance.

Plate 17 includes two photographs of a working-model of the new davits, while Plate 18 shows them in actual use on board the Orient liner *Oriana*, used in conjunction with polyester glass-fibre lifeboats.

(9) THE CLARKE-CHAPMAN ELECTRIC WINDLASS
(Plate 18)

A watertight electric motor mounted on the after side of the windlass bedplate drives, by means of worm and spur gearing, two five-snug cable

1. Firing 'Speedline' with buoyant head on rocket. *Above:* ' Speedline' self-contained line-throwing apparatus.



24. Kelvin electrically-driven sounding machine.

lifters suitable for steel stud link anchor cable having either bolt or lugless shackles. These are fixed to, and revolve with, the mainshafts when letting go or when heaving up. They are fitted with large sheaves to take powerful screw band brakes.

When heaving anchor the appropriate main wheel is engaged with the gypsy by means of screw gear (the operating handle being on the after side of the windlass), which slides the mainwheel outboard and along the mainshaft until the jaws on its outboard face engage the jaws on the inboard face of the gypsy. The main wheels are always engaged with the pinions on the intermediate shaft.

The basic principle of the windlass is that the engine or motor driving pinion is forward and in the centreline. This drives the large intermediate wheel, which is mounted on the intermediate shaft. This shaft has warping ends and also a small pinion on either side of the intermediate wheel. For this reason, whenever the windlass is working the intermediate shaft, warping ends, and main wheels always revolve.

The main wheels are in no way fixed to the mainshafts, and the latter (which are independent so that one gypsy may be used even though the other may be damaged) revolve only with the gypsies.

The warping drums are of high-duty iron and are secured to the intermediate shaft by gib keys. When using the warping ends the cable lifters are held on the band brakes, the main wheels are taken out of gear with the gypsies, and they then revolve freely on the stationary mainshafts.

Hand crank gear is available if required.

All bearing and working parts are lubricated by means of grease gun and 'Tecalemit' nipples. The motor may be mounted, if desired, either on deck integral with the windlass, or below decks, or in a separate deckhouse.

A windlass having a 64-kilowatt motor will have a cable duty of 27·5 tonnes at 7·5 m per minute and will be able to warp 9 tonnes at 25 m per minute or slack rope at 49 m per minute.

(10) THE CLARKE–CHAPMAN STEAM WINDLASS
(Plate 20)

The layout and operation of this windlass is identical to the electric type, except that the motive power is derived from a powerful twin-cylinder double-acting reversible steam engine. In the most recent design all engine and gearing parts are totally enclosed in an oil-tight casing providing splash-lubrication throughout. The outer frame bearings are lubricated by grease cups. The machine is extremely silent in operation.

A drain cock is fitted to each end of each cylinder. When about to heave anchor the drain cocks are opened and the steam turned on gradually, the engine being run both ways to clear the cylinders and lines of water. The drain cocks are then closed, the main wheels slid into gear, and the windlass is fully operational.

When letting go (in steam or electric windlasses) the band brakes are screwed tight, the main wheels slid out of gear, and the cable is controlled by the brake only.

Regarding maintenance, the cylinder draincocks should be kept open when not in use to prevent corrosion in the cylinders and steam chest, and frost damage. Both the cylinders and the steam chest should be opened periodically to ensure that the bores, valves, and chest faces are in good condition. The underside of the cylinders and steam chest require particular attention, and should be frequently painted. Greasing is by 'Tecalemit' grease gun. Unless splash-lubricated, the spur gearing should be smeared with grease at regular intervals.

(11) THE CLARKE–CHAPMAN ELECTRIC MOORING CAPSTAN (Plate 22)

A watertight A.C. electric motor, three-phase and two-speed with built-in magnetic disc braking, is mounted vertically inside the capstan head. The baseplate houses the gears and also grease nipples in an oil-tight case. The master controller is visible on the right of the photograph with a deadman handle feature and a speed control for heave and veer. This capstan may be bolted directly to the deck.

A 48 kilowatt motor in this capstan provides a duty of about 14
50 ft tonnes at a rate of 15 metres per minute or slack rope heaving at 30
100 ft metres per minute.

(12) THE CLARKE–CHAPMAN TOTALLY ENCLOSED SPLASH-LUBRICATED CAPSTAN

This is very quiet-running and employs a powerful twin-cylinder, double-acting, reversible steam engine. Draincocks are again fitted to the cylinders, and should be used as in the windlass. One such capstan
100 lb/in^2 can, provided 7 kg/cm^2 pressure is maintained at the cylinders, exert
a pull of 10 tonnes at 30 metres per minute. Such an engine consumes
7 000 lb roughly 3200 kg of steam per running hour.

(13) THE CLARKE–CHAPMAN WARD–LEONARD ELECTRIC WINCH

This is suitable for either A.C. or D.C. supply, employs a horizontal electric motor, and is entirely self-contained, with no outlying contactor gear. The motor drives a single shaft carrying a cargo runner barrel and

two warping ends. Grease-nipple lubrication is provided, and the winch is controlled at remote-control pedestals adjacent to the hatch coamings. A 41-kilowatt motor provides a lifting capacity of 5 tonnes at 40 m per minute on full load, reaching this speed in a few seconds. A light hook can be worked at 100 m per minute.

(14) THE CLARKE–CHAPMAN SPLASH-LUBRICATED CARGO WINCH (Plate 23)

The standard A.C. cargo winch comprises one wire rope drum and one warping end. Both are cast iron and both are keyed to the shaft. Options include two warping ends, a secondary drum for heavy derrick operation and portable controllers. In Plate 23 the warping end is out of view on the left side of the rectangular gearcase.

The gearing is totally enclosed and oil splash-lubricated. Two fans are used to cool the motor. The master controller is fixed to the deck and has the same features as the electric capstan mentioned in section (11). The motor is a marine watertight unit, of three-phase squirrel-cage type with built-in disc-type magnetic braking.

Using high gear, this winch will hoist 5 tonnes at between 4 and 40 13 ft 130 ft
metres per minute depending upon the control step. Low gear will lift
2·5 tonnes at between 8 and 80 metres per minute. 26 ft 260 ft

As with all splash-lubricated meachines, the casing must be regularly dipped to ensure that the correct oil level is maintained.

(15) STEERING-GEAR (TELEMOTOR AND HYDRAULIC)

Deck officers are required to understand the basic principles of their steering-gear, and the following short discussion will suffice.

The wheelhouse telemotor transmitter consists basically of two vertical cylinders, each containing a piston. The pistons are driven in alternate vertical directions by means of a single central pinion mounted on the wheel shaft. The telemotor gear is filled with oil or a mixture of glycerine and distilled water. When the wheel is turned one piston moves down, compressing the fluid in that cylinder. This pressure is transmitted through small-bore copper piping to the receiver or telemotor mounted in the steering flat aft.

Here, the pressure is used to cause two floating cylinders to move over four fixed, hollow pistons, the cylinders being bridged and connected by means of a cross-head. The cross-head carries a rod which is connected by a floating link to the steering-pump motor.

The electric-pump motor rotates at constant speed and direction, the controls merely altering the discharge and suction outlets of the pump.

One end of the floating link operates the pump, and the other end is secured to the tiller. The tiller is keyed to the rudder stock. The end of the tiller is secured to the centre of a sliding ram, which moves to port or starboard under the action of the pump fluid.

When the cross-head rod is caused to move, then the floating link operates the pump and the ram slides to one side, carrying the tiller with it, thus rotating the rudder. As the tiller turns, the fulcrum of the floating link moves from the tiller head to the end of the telemotor rod. This eventually causes the pump to cease driving the ram. The rudder therefore comes to rest at the desired angle. This 'switch-off' of the power is known as the hunting gear.

By now, the telemotor rod has caused a spring to be in either tension or compression. As soon as the steering-wheel is released the spring relaxes, the rod, cross-head, and floating cylinders move back to their original positions, and the wheel and rudder are centralised.

Variations of this method of steering may be found.

The telemotor may also be used to control a steam engine driving a floating quadrant. This quadrant, though free to revolve on the rudder stock, is secured by springs to a tiller which is keyed to the stock. In the event of tiller fracture, arrangements are sometimes incorporated whereby the floating quadrant can be keyed to the stock and become a fixed quadrant.

Emergency transmission sometimes consists of a wheel aft which is directly connected to the telemotor rod. This is used in the event of failure in the bridge transmission.

Auxiliary steering-gear consists, in the case of a quadrant, of two double or three-fold purchases rove with a wire fall. The purchases are secured to each side of the quadrant, the falls are led to the deck winches, and the steering engine is slid clear of the quadrant.

In cases where no quadrant is employed, such as in the hydraulic gear, a second pump having an independent circuit is fitted. Arrangements are often made for the second pump to automatically cut-in as the first pump fails.

CHAPTER XVIII

THE SHIP'S BOAT

REQUIREMENTS BY LAW

A PASSENGER ship engaged on voyages, any of which are long international voyages is required to be equipped as follows:

(*a*) Lifeboats, partially or totally enclosed, on each side for 50% of the total number of persons the ship is certified to carry. *The figure may be reduced to 37½% with the remaining 25% made up with liferafts served by launching appliances evenly distributed on both sides of the ship.*

(*b*) Liferafts for 25% of the people, served by at least one launching appliance on each side.

(*c*) At least one Rescue Boat on each side if of 500 tons or more.

(*d*) One EPIRB on each side ready for rapid placing in survival craft.

(*e*) At least three two-way radio-telephone sets.

(*f*) Two radio installations in lifeboats if 1500 or more persons are carried, otherwise one together with one portable radio.

(*g*) Eight to thirty lifebuoys depending on the ship's length. One on each side is to have a buoyant lifeline. At least half are to have self-igniting lights. Two are to have smoke signals fitted as well and to be readily released from the bridge.

(*h*) Lifejackets for the total number of persons certified to be carried, plus enough spare for 5% of that number. A suitable life-jacket shall be carried for each person on board weighing less than 32 Kg. The inflatable type shall be carried for crews of rescue boats. Each lifejacket shall have a light.

(*j*) An immersion suit for each person crewing a Rescue Boat.

(*k*) A line-throwing appliance and twelve parachute rockets.

(*l*) Emergency alarm and public address systems, and lighting.

(*m*) A bridge copy of '*Lifesaving Signals and Rescue Methods*' *(SOLAS 1)*

(*n*) A training manual in each mess and recreation room and posters showing operating instructions on or near survival craft.

(*o*) On-board maintenance instructions for lifesaving appliances.
(*p*) Two-way communication at muster and embarkation stations.

Cargo vessels engaged on voyages any of which are long international voyages, shall be equipped as follows:

(*a*) On each side of the ship, enough totally-enclosed boats to carry all on board. *Partially-enclosed boats may be substituted if the ship operates in suitable climatic areas.*
(*b*) Liferafts for all persons on board, launchable on either side. Alternatively the ship may carry enough totally-enclosed boats for all on board, arranged for free-fall stern launching together with rafts for 200% of the ship's complement.
(*c*) If craft are stowed more than 100 m from the stem or stern, an extra liferaft is to be carried as far forward or aft (or one at each end) as is reasonable.
(*d*) If of 500 tons or more, at least one Rescue Boat, otherwise an inflatable rescue craft. Each lifeboat, rescue boat or inflatable is to have its own launching appliance.
(*e*) Portable radio equipment or a lifeboat radio installation. At least three two-way radio telephone sets.
(*f*) An EPIRB on each side capable of being placed quickly into survival craft, except those mentioned in (*c*) above.
(*g*) Eight to fourteen lifebuoys according to ship's length, equipped as in passenger ships.
(*h*) One lifejacket for each person on board plus one of the smaller type for each person under 32 Kg. Also sufficient extra for persons on watch and for use at remotely-located survival craft, normally amounting to an extra 25%. Each lifejacket to have a light. Inflatable types may be used by Rescue Boat crews.
(*j*) Immersion suits for crews of inflatables or Rescue Boats. On ships under 85 m such suits may be required for all persons on board.

Also all items (*k*) to (*p*) listed overleaf for passenger ships. Cargo ships carrying cargoes which evolve toxic vapours or gases must carry lifeboats with a self-contained air support system lasting at least 10 minutes. If the cargo has a flash point of not more than 60°C the boats must also be of the fire-protected type to withstand eight minutes of enveloping fire, using a water spray.

General requirements

Rescue boats are to be boarded and launched within 5 minutes, at

up to 5 knots headway. Rapid recovery must be arranged, laden with a full complement, using pendants and hanging-off wires in adverse weather.

Lifeboats carry a maximum of 150 persons. They are fitted with compression-ignition engines capable of 6 knots fully laden and 2 knots when towing a fully-laden 25 person liferaft. They carry fuel for 24 hours at full speed. Other requirements include a release mechanism on all falls, an automatic drain valve, a release device for the forward painter when under tension, switchable and waterproof electric lighting above and below the enclosure able to work for 12 hours and visible on a dark clear night for 2 miles. The number of persons allowed to be carried by a lifeboat will be those of average mass of 75 Kg wearing lifejackets, who can be seated without interfering with equipment or its functions. On cargo ships, rapid boarding of boats is to be accomplished within 3 minutes.

Manning. A Deck Officer or a Certificated Person should be in charge, with a similarly qualified person as second-in-command. They must have crew lists. A similar person must be assigned to each liferaft launching appliance. A person capable of operating the engine must be present together with someone able to operate the radio, if any.

Inspections. Launching falls are to be turned every 2½ years and renewed every 5 years. Stainless steel falls need only be renewed however when there are signs of defect. Liferaft auto-release hooks must be serviced every 2½ years and proof-tested every 5 years. Release gears are to be overhauled every 5 years. Inflatable boats and rafts are to be serviced annually, as are hydrostatic release units.

Lifebuoys must be readily available on both sides of the ship with at least one near the stern. One on each side must have a buoyant line of length equal to twice the maximum dropping height, or 30 m, whichever is the greater. These two lifebuoys are not fitted with smokes or lights. The latter function for 2 hours, flashing or continuous, while the smoke signals burn for 15 minutes.

Immersion Suits should allow no undue ingress of water after 20 minutes in a disturbed sea. After 6 hours in water between 0°C and 2°C the wearer of an insulated suit should not suffer a core temperature drop of more than 2°C.

Lifejackets should be capable of being donned in one minute. After 24 hours immersion they should retain 95% of their buoyancy. The lights have a duration of 8 hours, fixed or flashing. The extra 5% carried on passenger ships should be stored on deck or at Muster Stations.

Pyrotechnic Distress Signals should be stowed on or near the bridge. Parachute rockets rise 300 m, and burn for 40 seconds. Hand flares last for one minute. The smoke floats in survival craft burn for 3 minutes. Some classes of ship carry red star distress rockets rising to 45 m and have 2 or more stars burning for only 5 seconds. All pyrotechnics have a storage life of 3 years.

Launching. On some passenger ships boats are to be boarded and launched from the stowed position but davit-launched liferafts can be boarded and launched adjacent to the stowed position. Generally, Rescue Boats should be boarded and launched from the stowed position. Survival craft must not interfere with any other, should be stowed as near the water as possible, and at least 2 m above the water for embarking with the ship fully laden, with adverse trim and listed 20° either way. Craft should be in continuous readiness so that two members of the crew can prepare each one for launching and embarkation within 5 minutes. They must be lowered at least a boat's length forward of the ship's propeller. Liferafts must have painters permanently attached with float-free arrangements, except for those stowed right forward or aft. Survival craft stowed forward must be abaft the collision bulkhead. Unless liferafts can be boarded from less than 4.5 m above the lightest waterline, they must have launching appliances. On passenger ships all survival craft must be capable of being launched within 30 minutes of the Abandon-Ship order. On cargo ships this time is reduced to 10 minutes and if they are of 20,000 tons or more, the launching of boats must be possible with a headway of 5 knots. All boats must be strong enough to withstand this.

Equipment for Lifeboats

(1) Sufficient buoyant oars to make headway in calm seas.
(2) Two boathooks.
(3) A buoyant bailer and two buckets.
(4) A binnacle and an efficient compass.
(5) A sea anchor with a warp 30 m long, stable when towed at 6 knots.
(6) Two painters each of length equal to twice the maximum lowering distance. One to be secured to the forward releasing device.
(7) One waterproof torch suitable for Morse, plus a spare bulb and a spare set of cells.
(8) One whistle or equivalent sound signal.
(9) A first aid outfit.
(10) A jack-knife on a lanyard.
(11) Two buoyant rescue quoits each on 30 m of buoyant line.

(12) Two portable fire extinguishers.
(13) A searchlight capable of 6 hours working, of which 3 shall be continuous.
(14) An efficient radar reflector.
(15) Thermal protective aids for 10% of the complement.
(16) A survival manual.
(17) Four parachute rockets, six red hand flares and two buoyant smoke signals.
(18) One daylight signalling mirror.
(19) A copy of the Rescue Signal Table.
(20) Six doses of anti-seasick medicine and one sick-bag per person.
(21) Three tin openers.
(22) Three rustproof graduated drinking vessels.
(23) One set of fishing tackle.
(24) Sufficient tools for minor engine adjustments.
(25) A manual pump.
(26) Two hatchets, one at each end of the boat.

Rigid Rescue Boats are not required to carry items (16) to (26) inclusive.

Equipment for Inflatable Liferafts

(1) A buoyant rescue quoit on at least 30 m of buoyant line.
(2) Two sponges.
(3) One safety knife with a buoyant handle, two if 13 or more persons.
(4) One buoyant bailer, two if 13 or more persons are carried.
(5) Two sea anchors, one permanently attached.
(6) Two buoyant paddles.
(7) One rustproof graduated drinking vessel.
(8) Survival instructions in English.
(9) Instructions for immediate action.
(10) A puncture repair kit and a top-up pump or bellows.
(11) Items (7), (8), (9), (14), (15), (17), (18), (19), (20) and (23) listed above for lifeboats.

Rations for Lifeboats and Liferafts

For each person, food totalling not less than 10,000 kilojoules, kept in airtight packaging capable of being opened with wet or cold hands and stowed in a watertight container. The ration shall be readily divisible into three one-day portions per person. Also watertight receptacles containing a total of 3 litres of fresh water per person. In liferafts 1.5 litres of fresh water is carried for each person. In both boats and rafts, one-third of the water may be replaced by desalting apparatus capable of producing the equivalent amount of fresh water within two days. The water may be packed in cans, bottles, tanks, or sachets.

Food and water rations are not required to be carried in Rescue Boats.

Musters and Drills

A *Muster List* must be prepared by the Master before the ship proceeds to sea and it must be kept revised as necessary due to crew changes. It specifies the General Emergency Alarm Signal, the action to be taken by crew and passengers following the signals, the Abandon-Ship Signal and how it will be given, other emergency signals and the appropriate subsequent action and the location of passenger Muster Stations. The List also shows the duties assigned to crew members, including the closing of watertight and fire doors, valves, skylights, portholes and similar openings; the equipping, preparation and launching of survival craft; the mustering of passengers; the use of communication equipment; manning of fire parties and duties relating to the use of fire-fighting equipment and installations. Also included is the warning of passengers, making sure they are suitably clad and wearing their lifejackets properly, controlling movements and keeping order, and taking blankets to survival craft. The List specifies which Officers are responsible for the maintenance of lifesaving appliances.

Copies of the List are posted in conspicuous places, especially the Bridge, Engine Room and crew accommodation.

Illustrations and instructions in English, and any other appropriate language, are to be posted in passenger cabins, at Muster Stations, and other passenger spaces to indicate the location of Muster Stations, how to don lifejackets and the action to take in an emergency.

The *General Emergency Alarm Signal* for summoning crew and passengers to Muster Stations is seven or more short blasts followed by a long blast on the whistle or siren, and also on an electric bell or klaxon.

Each member of the crew shall take part in at least one Abandon-Ship Drill and one Fire Drill every month. If more than 25% of the crew have not participated on that ship in the previous month, there must be a Drill within 24 hours of leaving port. On passenger ships the Drills must be held *weekly*. Passengers are to be mustered within 24 hours following embarkation. They must be instructed in the use of lifejackets and the action to take in an emergency.

During Abandon-Ship Drills each boat should be launched and

manœuvred in the water at least *once* every 3 months. Rescue Boats must be launched every month and manœuvred by the assigned crew. The emergency lighting is tested at these Drills together with each lifeboat engine and liferaft davit.

The Master must keep records of these Drills and Musters together with his reasons as to why Drills were not held on any occasion.

There is no statutory *Abandon-Ship Signal*. It is likely to be given verbally and through a public address system, if any.

ENCLOSED LIFEBOATS

Usually, these are constructed of fibreglass pigmented with a distinctive colour such as International Orange. The cross-section can be likened to a divided 'O', the lower part being the hull, the upper section the canopy and the division carrying the fendering. They offer full protection from fire, toxic gases and exposure; simple operation by unskilled personnel; speedy launching, and require little knowledge of boatwork.

Spray nozzles fitted around the hull and on the top of the canopy ensure that the exposed surface can be covered with a layer of water enabling the boat to travel safely through a sea-surface fire. Tests carried out on a 50-person craft during a seven minute fire test showed that while the ambient temperature rose to 1150°C, inside the boat there was a viable life-support environment, free of atmospheric pollutants and with an average head-height temperature of 26°C. Self-righting, which is dependent upon all occupants being strapped in place with safety belts, was completely satisfactory with the engine running throughout.

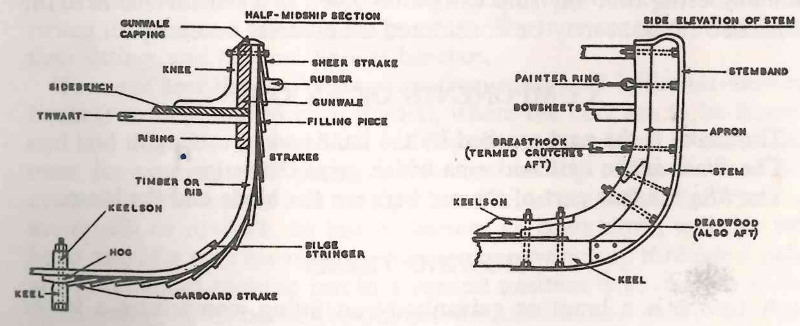


FIGURE 18.1

COMPONENTS OF WOOD BOAT

Compressed-air bottles supply air to both occupants and engine for a period of some ten minutes which is enough to traverse a floating oil fire of about one mile diameter, assuming calm weather. Most craft offer wheel steering with a tiller as standby. The helmsman can operate the lowering of the boat (with a control line), the releasing of the hooks, and the engine. Two hooks are fitted to avoid boat spin during descent. This is important when the helmsman's view is obscured by flame and smoke. In such cases, as soon as the boat is waterborne, it should be steered ninety degrees away from the ship's side at full speed.

Entry to these boats is normally through a door, which may be an elevating or sliding type. There may be two doors in each side of a larger craft together with a hatchway through the top of the canopy. It can be argued that embarkation into enclosed boats is slower than into open boats and that difficulties can arise when there are stretcher cases. In small boats with only one door on each side, boarding can be very slow.

With any new design there are bound to be some disadvantages and it is healthy to discuss these so that in a survival situation, personnel know the good and bad factors. Some seamen find these boats are claustrophobic and object to being strapped in. On the other hand they cannot expect to have self-righting and full protection from fire, gas and cold unless some discomfort is borne. As rescue boats, they are not ideal because there is only a very narrow strip of decking around the canopy. To pick up a person from the water it is usually necessary to position one of the entry doors alongside the person and this can be difficult. Rowing of the boats is limited, perhaps only through the entry doors. Should the engine break down in a sea-surface fire, then in the face of a diminishing air supply, there is little that can be done in the way of propulsion.

Regarded simply as a device for safely abandoning ship, and remembering that any ship can be involved in a sea-surface fire, the enclosed lifeboat may be considered a universal necessity.

COMPONENTS OF AN OAR

The *Loom* is the part grasped by the hands when rowing.
The *Blade* is the flattened area which grips the water.
The *Shaft* is that part of the oar between the blade and the loom.

ROWING TERMS

A *Crutch* is a brass or galvanised-iron fitting, comprising a lower cylindrical stem with a horse-shoe-shaped piece above it. The stem fits

into a metal-lined hole in the gunwale, and the shaft of the oar rests in the curved part.

A *Rowlock* is merely a rectangular piece *cut out of the gunwale*. The shaft of the oar rests in the gap when rowing. The gap is capable of being filled with a piece of wood (attached to the boat by means of a lanyard) known as a *poppet*.

A *Thole Pin* projects up from the gunwale into which it is bedded. The oars used with this fitting are drilled, the hole being metal-lined, so that the oar may be lowered on to the thole pin, which then passes through the oar, holding it in place.

'*Out oars*'—an order at which the crew fit their oars into the crutches, rowlocks, or thole pins, and sit on their thwarts, hands grasping the looms of the oars. The oars should be horizontal.

'*Give way together*'—an order at which both port and starboard oarsmen commence rowing. The stroke oar, i.e. the man rowing adjacent to the coxswain, sets the stroke and timing, and the others each watch the back of the man immediately in front, and not their individual oars. In this way the men are able to keep in step.

'*Oars*'—an order at which one more stroke is made, the oars are raised from the water, and allowed to rest horizontally projecting from the boat.

'*Hold water*'—an order at which the blades are placed in the water and the oars held rigidly at right angles to the gunwale. This assists in taking the way off the boat.

'*Back water*'—an order at which the oars are used in the reverse direction in order to gather sternway, i.e. the looms are pushed aft instead of being pulled forward.

'*Bow*'—an order at which the bowman boats his oar and stands by in the bow sheets with boathook or painter, ready for going alongside.

'*Way enough*'—an order at which one more stroke is made and the oars are then placed as for the command 'Oars'.

'*In oars*'—this follows 'Way enough' almost at once. Each loom is swung forward and towards the gunwale. The oars are then lifted from their fittings and laid on the side benches.

'*Toss and boat the oars*' is an order frequently used in double-banked boats (two oarsmen on each thwart), where the oars are to be boated and laid down the fore-and-aft midships line of the boat. A port oarsman, for example, will place his left hand on top of the loom at the extreme end of the oar and his right hand underneath the shaft close to the crutch or rowlock. In one movement he bears down with his left hand and lifts with his right, so that the oar swings up through a right angle. It should come to rest in a vertical position with the end of the loom resting on the bottom boards between the oarsman's feet, and at the same time being given a twist so that the blade plane is fore and aft. All oars are then simultaneously lowered, blades forward in this case, and laid on the middles of the thwarts, again twisting the oar so that the blade lies flat. It is extremely spectacular, but not greatly favoured by inexperienced lifeboat crews. Before a boat leaves a ship's side it is often very useful to toss the inside oars and use the blade tips to bear away the boat.

GENERAL REMARKS ON BOAT HANDLING (see also Chapter IX)

A boat should preferably be on an even keel with no list. A slight trim by the stern, however, is favourable when running before a heavy sea, since this prevents the bows from being driven under.

When unhooking the falls, particularly when the ship has way on her or, what amounts to the same thing, the boat is fast alongside head-to a stream current, the after fall should be unhooked first. When berthing heading into a current the forward block should be hooked *on* first. In both cases the boat is then prevented from being swung athwart the tide.

Once clear of the ship or quay, all fenders and loose ends of rope should be brought inboard. Needless to say, when lowering a lifeboat from davits the plug should be checked well before the boat is launched. At night the plug is often difficult to find, and many boats have a mark or arrow cut into the gunwale or side benches abreast of it. If such a mark is brightly painted it serves a useful purpose by day and prevents burrowing under the bottom boards.

Careful allowance should be made for all currents in the vicinity, remembering that, generally speaking, they are weakest close inshore. A wide berth should be given to all anchored ships, and in a stream current it is advisable to pass astern of them. It is surprising otherwise how quickly a boat may be swept towards the anchor cables. When handling a rowing-boat, it should be borne in mind that large rudder angles retard the boat and put an added stress on the oarsmen.

In a moderate or heavy sea, rather than running to a destination beam-on to the waves, it is better to zig-zag, i.e. steer a *dog's-leg* course. Survivors in boats should use the oars only for heading towards a rain-storm (when short of water), for exercise in freezing conditions, and for avoiding navigational dangers. They will initially be used for clearing the abandoned ship, although it must be emphasised here that one of the prime duties of a motor-boat is to muster the rowing-boats together and tow them until such time as the fuel supply is exhausted. This is particularly important when rowing-boats are desperately trying to clear a ship which is rolling heavily, on fire, or liable to capsize over the boats.

Breaking waves, and the wash of other craft, should be met bows-on, the oars possibly being temporarily feathered, i.e. rested horizontally with blade planes parallel to the water.

The wind or stream, whichever has the stronger effect, should always be stemmed when going alongside, and as soon as possible, in a tideway,

a painter should be led well ahead from the inside bow. If this is kept tight the boat can be sheered either way while riding alongside, and is thus under the control of her rudder. Only one fairlead is usually fitted to lifeboats, on the forward gunwale, and this is primarily for passing the sea-anchor warp.

If the lifeboat is to anchor the bitter end of the anchor line should be well secured, the stock of a common anchor well locked in place, and sufficient line streamed to reach the bottom before the anchor is let go. It is as well to have a little sternway on the boat when paying out the anchor warp. A scope of at least four should be used, calculated on high-water depths. If the lifeboat continually snatches at her anchor warp more line should be veered. As a last resort, a heavy object should be slid down the warp until it lands on the sea-bed. If the boat is to be anchored on a rocky bottom it is as well to secure the warp to the crown of the anchor, stopping it lightly to the anchor ring. If the anchor is later found to be fouled a sharp tug on the warp will carry away the stopping, the anchor then being hove up crown first.

HOISTING A BOAT INBOARD

A long boat-rope should be passed along the hull and secured fore and aft. The falls should be slacked down until the blocks are just at the right height for hooking-on, and if within reach they should be tended to make sure that they do not become twisted or that the lower blocks become thorough-footed, i.e. capsized upside-down. In very heavy weather scrambling (cargo) nets should be rigged overside, together with mattresses to act as fenders.

The vessel should form a lee, and spread oil if necessary, to reduce the breaking of waves.

As the lifeboat rises to a wave the forward block should be secured and the after one hooked-on almost immediately following this. The only advantage of this procedure is that since the boat will undoubtedly have approached heading into the waves, if the after block fails to hook-on, when the boat is virtually jerked bows out of the water in the next wave trough, the more buoyant end is still waterborne. Further, the boat is in a better position to meet advancing cross-seas. If a cross-sea met the boat while it was stern out of the water the bows would undoubtedly be swamped.

If time permits the blocks should be turned to remove any twists in the falls.

The boat should immediately be hoisted clear of the sea and raised to the davit heads. The plug may be removed to drain the bilge water, and the crew should hold on to the lifelines, in case the falls should part. The boat-rope, which should by now be secured in the boat fore and aft, is tended by the crew to prevent the boat from surging back and forth along the hull. If the surging becomes excessive the hoisting should be checked until the crew are able to control this movement. It cannot be emphasised too strongly that *no person should be allowed to stand abaft the after block, or forward of the stem block, either when hoisting or lowering.* The reader should visualise himself standing almost at the stem post when the *after* fall parts. He will be crushed between the bow sheets and the forward fall, which now takes the whole weight of the laden boat.

A flooded boat should be hoisted clear of the water and the plug removed. If possible, in the case of independent falls, the boat should be trimmed so that the water flows out over the stem or stern. If this is not possible, then the boat should be left to drain before attempting to hoist it the full distance.

Before leaving a boat, the crew should make sure that the oars and mast are stowed so as to be well supported throughout their length. If this is overlooked these components will quickly warp and become virtually useless.

LOWERING A LIFEBOAT

The crew should be wearing life-jackets. The plug must be checked and fenders rigged over the inboard side. The boat-rope should preferably be passed as before, to prevent surging, together with a painter, which must be kept tight. No one should stand between the falls and the boat ends. All crew members should grasp the lifelines, in addition to working the boat-rope if necessary.

The after block is cast-off first in a tideway to prevent the boat from broaching to. In a heavy sea the boat may be lowered on to a wave crest. As she slides into the succeeding trough, her falls are automatically overhauled (slacked) by the boat's weight. On rising to the next crest they are amply slack for rapid unhooking.

The painter should be kept tight in order to keep the boat fore-and-aft when launched. If the ship is making way, or if a stream is running down from ahead, a tight painter enables the boat to be sheered clear using her rudder. It also means that as soon as the boat is launched, no matter whether the ship is making way or a stream is running, the boat is virtually towed alongside and is kept vertically below the davit heads, facilitating unhooking.

On gravity davits a chain pendant is secured to the lower blocks by means of a patent slip. The other end is shackled to a point roughly two-thirds of the way up the davit. As the boat is lowered from the davit heads, the pendant tightens and the boat swings in to the embarkation deck-level, virtually on a union purchase.

If this pendant is later slipped, when the boat is ready for further lowering, the lifeboat will swing violently outboard as the fall seeks the vertical. This has been the cause of many serious accidents, for the swing

is sufficiently sudden and rapid to hurl a crew member over the side. Again, these accidents are prevented if the lifelines are held and the crew keep low down in the boat.

Once the boat has been triced in to the ship's side by these pendants, a length of 24-mm manila rope, provided for the purpose, is passed be- 3-in
tween the boat sheets and the cleat on the lower davit body. The two or three parts are then held taut in the hands by gripping them together. The chain pendant may now easily be slipped, the manila jerks slightly as it grows bar-tight, and the boat is readily for easing out fore and aft on both manilas. A better arrangement is to use two small tackles and ease the boat out on these.

When time permits both of these remedies may be dispensed with: once the boat is ready for lowering to the water, it is hoisted on the winch, moves away from the ship's side and the pendant grows slack. The latter is cast off and the boat launched in the normal way. One advantage, however, of passing the tricing lines or tackles is that they act as preventers in case the chain pendant should part.

Some davits fitted with fibre rope falls provide for the boat to be lowered by hand control. A stag's head bollard is usually provided in way of each davit. A suitable method of passing the fall around such a bollard is shown in Fig. 18.2, where it is rigged ready for lowering.

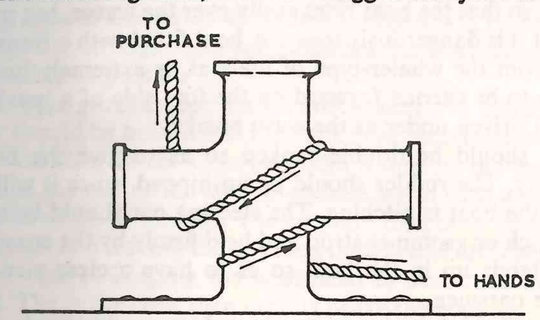


FIGURE 18.2

LOWERING TURNS ON STAGHORN BOLLARD

BEACHING A LIFEBOAT

There is little that can be used here except man-power. As soon as the boat grounds, the crew should jump out and evenly distribute themselves along the sides of the boat. They should then make a combined effort as the next wave breaks, taking care that the boat does not broach-to and injure them. It should be hauled up the beach above the high-water mark, and for this reason, beaching at high water is ideal. The painter may be passed round the hull of the boat, led up the beach, and hove-on by the crew. The yard, mast, and any other short pieces of round timber will act as useful rollers to relieve the stresses.

When it is desired to beach the boat in an area of surf great care must be exercised, wrong judgement quite easily resulting in substantial damage to the boat and possible serious injury to the crew members.

The greatest danger exists within an area of breaking waves. On a gently shelving beach this area may extend well out to seaward. The coxswain should preferably be experienced in this type of boat handling, and the crew must obey all orders implicitly.

A rowing-boat is preferable to a motor-boat when beaching through surf, because not only does the propeller of a power boat race a great deal when pitching, contributing nothing to the boat's way, but there will also usually be poor manœuvring qualities when the boat is running astern. A diesel-engined lifeboat usually has poor acceleration properties, particularly when reversed. A major consideration is that within an area of surf, there is a great deal of white, aerated water, upon which the propeller develops a poor grip. A pulling boat, on the other hand, is more manœuvrable, since the oars can be adjusted for inclination in order to grip the deeper water.

The boat should have sufficient freeboard not to be swamped when proceeding through the unbuoyant surf water. The ends should be lightly laden so that the boat rides easily over the waves, but not to such a degree that it is dangerously lively. A boat fitted with a transom stern, as distinct from the whaler-type of lifeboat, is extremely buoyant aft, and is liable to be carried forward on the fore side of a breaking wave (surfing) and driven under as the wave breaks.

The crew should be double-banked so as to give the boat better manœvrability. The rudder should be unshipped, since it will be of no value when the boat is pitching. The steering oar should be shipped in the after crutch or grommet strop and held firmly by the coxswain, who preferably stands up in the boat so as to have a clear view over the heads of the oarsmen.

While beaching, there is a very great danger of being broached-to, swamped, or hurled shorewards on the fore side of a breaking wave, completely out of control.

Both when beaching and launching in a heavy surf the boat should be headed bows out to sea. Although the crew will have to back water while beaching, a tiring process, the boat will be in a much safer attitude. One consolation is that the surf itself will assist the boat's motion shorewards. In this way the coxswain has a clear view of the dangerous seas advancing towards the boat, and further, the crew are *not* in a position to see them. This serves a dual purpose, reducing any fears, and also enabling them to concentrate entirely on the coxwain's orders, which should be curt and instantly obeyed.

If the boat is capsized it is better for the crew to momentarily strike clear of it, so that they are not hurled against it by succeeding waves.

The boat should meet each advancing wave at right angles to the line of the wave. During the beaching process the stroke oarsmen should keep a sharp lookout for rocks and other dangers.

Given a good crew and coxswain, a 9-m lifeboat should be able to 30-ft
negotiate waves up to 4·5 m in height, by day. At night waves higher 15 ft
than about 2 m should not be attempted. The relationships hold good 7 ft
for other lengths of boats.

It must be remembered that waves have a cycle of development and deterioration, there being from five to seven waves in a cycle. At the end of each cycle there is a period of relatively quiet sea. This period must be chosen for the commencement of the run ashore, and for the actual grounding. Ideally, the boat should ground on the heels of the last wave of a cycle.

Once the area has been selected, then the end of a wave cycle should be awaited and the boat turned head-out to sea. The oars are then used to back the boat shorewards. Ideally, the boat should be kept at least two boat-lengths ahead of a breaker. As a wave reaches the boat, whether breaking or not, the oars should be used to hold water, keeping them inclined well downwards so that they are not snatched from the oarsmen's grasps. If the waves are slow-moving it will be preferable to give way together strongly as a wave reaches the boat so that it is traversed as quickly as possible.

When the boat grounds, say on a shallow beach in a light surf, the steering oar should be boated and the stroke oarsmen ordered out of the boat. They will cling to the stern and hold it against the beach as best they can while the rest of the crew keep backing in such a way that the boat is kept bows-on to the surf. The crew are then ordered out in pairs, starting from aft and leaving the bowmen until last of all. These two men continue the task of keeping the boat head to sea, until they too are ordered out. The entire crew then rapidly heave the boat on to the shore.

In a very heavy surf there is a great danger presented by the undertow, which may sweep the men out to sea and hurl them on to the sea-bed in the inshore breakers. As soon as the boat touches therefore, the whole crew should leap out and heave the boat rapidly on to the shore. Precise timing is needed for this operation, otherwise the boat will broach-to and the men be sucked out and into the breakers.

LAUNCHING A LIFEBOAT FROM A BEACH THROUGH SURF

In a light surf the oars should be fitted into the crutches and laid across the gunwales ready for immediate use. The crew station themselves around the hull and stand abreast their respective thwarts. The boat is quickly launched and the bowmen immediately board the boat and keep her bows-on to the seas. The others then jump in quickly, in pairs, working from forward to aft. As each pair boards, they use their oars to hold the boat in attitude. Last of all, the coxswain boards and the crew pull strongly out to sea.

The boat should continue at speed through the surf, the oarsmen holding water only when a wave is breaking well ahead. The steering oar is again used to keep the boat at right angles to the wave-line.

In a very heavy surf the procedure is similar, except that as soon as the boat is waterborne the crew jump in together and give way strongly. Again, precise timing is necessary to prevent the boat from being broached-to. In each case the end of a wave cycle should be chosen as the instant for launching.

APPROACHING A ROCKY SHORE

Here the boat is used either to land the crew, who then dispense with the boat, or else to embark people from the shore.

The boat should approach the beach heading bows-out. The anchor should be let go when well outside the limit of the breakers, and the boat then backs in towards the beach, streaming the anchor warp. When about half-way inshore from the anchorage the hold of the anchor should be tested. If it breaks out the procedure will have to be repeated until a suitable holding ground is found. The stroke oarsmen again keep a sharp lookout for rocks, and when these are in sight the anchor warp is secured. The crew continue to gently back water, thus holding the boat in position, while the persons ashore enter the boat, carefully watching its motion before they choose their instant of boarding. The task will be made easier if an oarsman jumps out and holds the stern steady by means of a painter. Once the boat is loaded it can be hove out to the anchor, and the latter weighed.

If using a motor-boat there is no reason why the approach should not be made bows-on to the shore, provided there are good securing arrangements aft for the anchor warp.

MANŒUVRING ALONGSIDE A SHIP AT SEA

If the vessel is a wreck or derelict the approach should be made as described in Chapter IX.

For a normal approach the bows and stern of the ship should be avoided, since there will be excessive swirl at these localities. The best place for the landing will be roughly amidships on the lee side. Great care should be taken to avoid the propeller area of a twin-screw ship, since the vessel may be using her engines even as the boat moves close in.

A boat-rope will be rigged overside together with ample fenders and a ladder. If the ship is pitching this motion will be felt least alongside the

midships section. Should the vessel have a projecting rubbing strake or band, close to the water level, an oar may be held vertically against this and the boat's gunwale while alongside. This will prevent any chance of the gunwale catching underneath the rubber.

TOWING OTHER LIFEBOATS

This will usually be done by means of a painter. It should be made fast in the sternsheets of the towing boat, either to a towing bollard or to the after two thwarts. A useful method of distributing the stress of the towline is to make an eye in the end which is aboard the towing boat. The eye is then rove beneath the after thwart and held up forward of it. An oar is passed through the eye and laid flat along the thwarts, fore and aft. The oar then acts as a toggle. The eye should be slid down the oar until it is hard up against the forward edge of the after thwart. This will avoid excessive bending stresses in the oar.

The towed boat should stream a sea-anchor when running before a heavy following sea to prevent surfing ahead and on to the towing craft. The length of the towline should be adjusted so that both boats are in step with the waves. (See Chapter X.)

Any number of boats may be towed, but the painter of each should be secured into the sternsheets of the next in line ahead, preferably by means of the 'toggle oar'.

In breaking seas each boat should stream oil from the bows.

LIFEBOAT SAILING

Terms in General Use

Close-hauled, *By the wind*, *On the wind*, are expressions used to denote that a boat is sailing as closely as possible in the direction from which the wind is blowing. In a lifeboat about five points is the closest possible angle to the wind. The boat is only free to alter course away from the wind, i.e. to pay off.

Reaching refers to a boat which is sailing with the wind on the beam (a broad reach), or forward of the beam (a close reach), but not so as to be close-hauled. She is free to alter her course in either direction, but more so down-wind.

Tack: a boat is on the port or starboard tack when the wind is on the port or starboard bows. For the purpose of fog-signals, it extends as far as the beam.

Tacking or *Going about* occurs when the boat changes from one tack to the other by sailing through the wind's eye (wind direction). It is preceded by the order '*Ready about*' or '*Stand by to tack*'.

Beating refers to a boat which is sailing to windward, close-hauled on a series of alternate tacks, i.e. she steers a zig-zag or dog's-leg course.

If she can sail to her destination on one tack, and back on another, she is said to have a *Soldier's wind.*

Running or *Running free* refers to a boat which has the wind abaft the beam.

Sailing free refers to a boat which is able to alter her course either way; it does not therefore include boats which are close-hauled.

Gybing. This occurs when the wind is from aft and, due to yaw or gusting, the wind catches the sail on the wrong side. The sail is then flung violently across the boat, and if not loose-footed, i.e. if it has a boom attached to the foot, it may do serious injury to the crew. In addition to this, the violence of a gybe can often carry away the mast and/or rigging. The danger is most prevalent when sailing with the wind dead astern. Gybes are often executed purposely, but in this case they are controlled.

Wearing is a means of changing tack by moving the boat's stern through the wind's eye. The boat is headed away from the wind, her stern runs into the wind, a controlled gybe is carried out, and she is slowly brought round on to the other tack.

On the port (*or starboard*) *gybe* refers to a boat which is running with the wind on the port (or starboard) quarter.

Brought by the lee refers to a condition where the wind catches the sail on the lee side; an example of this occurs when the boat gybes accidentally.

No higher is a term used to indicate that the boat must not be brought any closer to the wind.

Nothing off is the reverse of 'No higher', and therefore means that the boat is not to pay off any more.

To miss stays refers to a boat which has tried to go about but which has paid off again on the original tack.

In irons or *In stays* refers to a boat which has tried to go about, has headed into the wind's eye, but which has failed to pay off on *either* tack. It may be remedied by holding the clew of the jib out to the original lee side, i.e. the jib is *backed.*

Helm. The tiller is usually referred to as the helm. The lee and weather sides of the boat are respectively called the *down* and *up* sides for the purpose of helm orders, so that when the order '*Down helm*' is given the tiller is put a-lee and the boat runs up into the wind. Similarly, '*Up helm*' results in the boat paying off. Other terms are '*Up-wind*' and '*Down-wind*'. '*Bear up*' means the same as 'Up helm'.

Carrying lee helm indicates that if the tiller is left amidships the boat tends to pay off. In this condition she is likely to broach-to in squally conditions, and *carrying weather helm* is a preferable state of affairs, for the boat is constantly seeking the wind.

One point on the sail surface is considered to be the centre of effort, where all the wind force may be considered to act. One point on the underwater hull surface, at or near the pivoting point, is considered to be the centre of lateral resistance. If the two points, centres of effort, and lateral resistance are not in line the boat will carry lee or weather helm, for a couple exists between these two points.

Luff, or *Luff-up* means to steer closer to the wind.

Weathering an object means to pass to windward of it.

Flat aft refers to sails, the sheets of which have been hauled as tightly aft as possible.

A boat is *Taken-aback* when the sails fill suddenly from the wrong direction, due to a yaw or a sudden change in wind direction. *Hugging* means sailing as close to the wind as possible, while *Pinching* refers to a boat which is sailing too close for efficiency. *To reef* or *Shorten sail* means to reduce the sail area. A boat *Lies to* when she is in the wind's eye with a small sail area hoisted. She is *Hove-to* when she is stopped in the water; it is achieved by backing the sails in the wind's eye. A boat is *Goosewinged* when running dead before the wind with the sails set on both sides of the boat.

SAILING THE LIFEBOAT

Generally, this is an unsatisfactory procedure, the best that is achieved being a trend in the desired direction. The boat has no drop-keel and only a small lateral resistance, as a result of which she will invariably make considerable leeway.

The lifeboat is fitted with a lugsail, the one illustrated in Fig. 18.3 being a standing lugsail, since once it is hoisted, no further manœuvring of the yard or gaff boom is necessary, unless of course the wind freshens. The dipping lugsail, however, extends considerably farther forward from the mast, and its tack is secured at the stem head. This lugsail must always lie on the lee side of the mast, so that the yard must be lowered and dipped around the mast each time the boat changes tack. In the case of the standing lug it is left permanently rigged on one side of the boat.

The sail is made of terylene or flax canvas and is loose footed, i.e. has no roping at the foot. The roping extends along the head, the luff, and around the clew as far as the reef band. This sail roping may be manila or boltrope, which is a tarred soft hemp. It is always sewn on the port side of a sail.

The reader should study the various parts of the sail and learn the names. The letters MV on the sails represent the first and last letters of the ship's name, e.g. S.S. *Mativ.* The jib may be secured to a forestay by means of jib clips, but usually the lifeboat has no forestay, and so the jib is hoisted free on the halliards. If the jib halliards are set up tight the

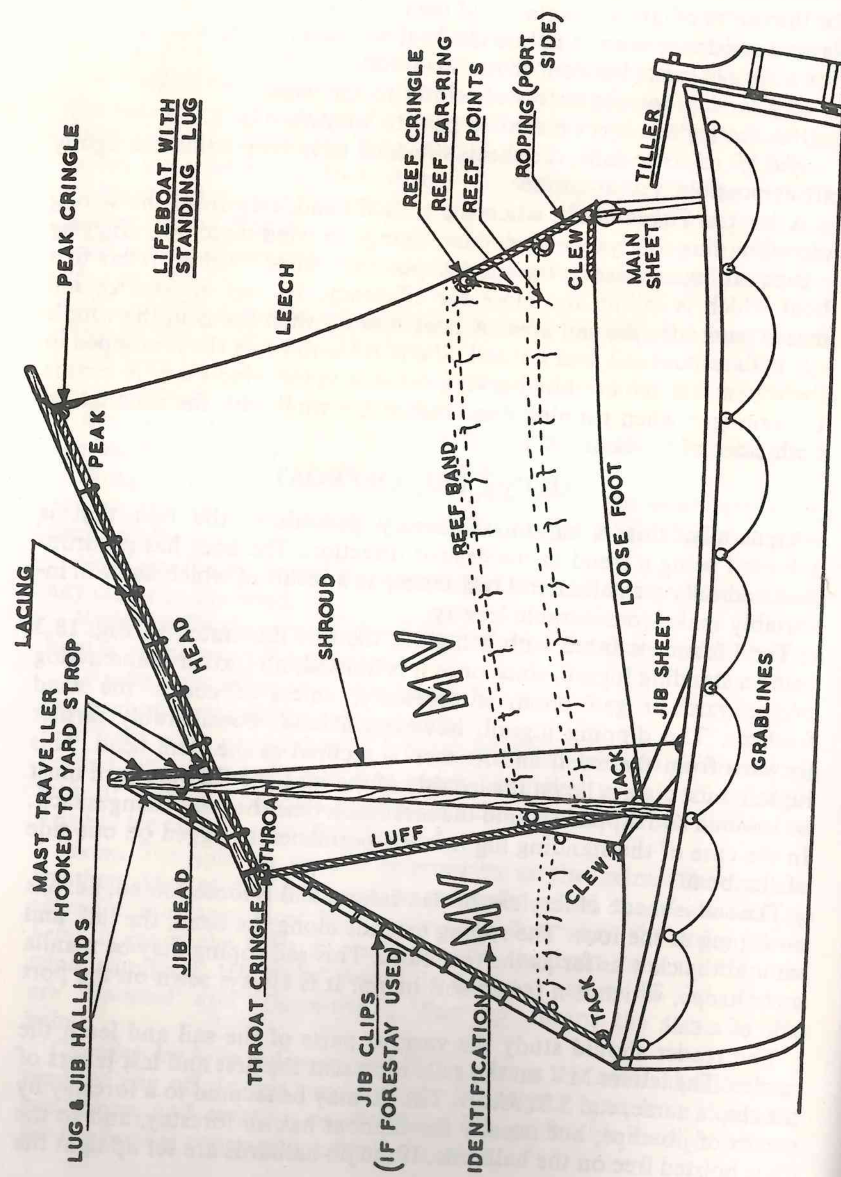


FIGURE 18.3

roping on the jib luff acts in the same way as a forestay.

The mast traveller is simply a metal ring sliding on the mast. Forged in to the ring is a hook projecting downwards and an eye projecting upwards. The eye is secured to the main halliards and the hook is passed through the strop on the yard, leaving the lugsail ready for hoisting.

The head of the mainsail is bent on to the yard by means of peak and throat lashings or ear-rings, passed through the peak and throat cringles. The remainder of the head may be secured by means of a spiral lacing passed around the yard and through the eyelets worked into the sail. This has the disadvantage of carrying away the majority of the sail head if one part of the lacing chafes through. A preferable arrangement is to use separate stops for each eyelet, as shown in the illustration.

The sails must always be carefully handled and maintained; periodically at sea, they should be unrolled and hung up to air, making sure that they are sufficiently secure to prevent them flapping about. They should never be stowed away wet, and all traces of salt must be washed off with fresh water, before they are dried and stowed. A close watch must be kept for signs of mildew.

New cotton duck or canvas sails should be run-in at an early opportunity, since they stretch considerably when new. The boat should be sailed on a bright, sunny day, reaching in a gentle or light breeze. Beating should not be attempted on this first run. After about three or four hours of figure-of-eight reaching, the sails should be sufficiently stretched for close-hauling. Neither the halliards nor the tack lashing should be too tight, otherwise the luff will stretch more than the leech. The peak lashing should be continually adjusted to take up the slack forming in the head. The sail should never be reefed until it has been properly stretched.

Dirty sails may be lightly scrubbed with fresh, soapy water, endeavouring always to keep such a solution off tarred roping. When dry, the sails should be folded away in their covers; the best way of doing this is to lay the sail flat and fully extended, but not on a sandy or gritty surface, place the luff and leech along the yard, gather up the bight of the sail in a roll, and lightly stop it to the yard with rope yarns.

Setting the Sails

The standing lugsail should be hoisted with the yard strop situated about one-third of the length of the yard abaft the throat. The luff should be set tight and the tack lashing hove taut until a crease just begins to run down from the peak, the crease later disappearing when the sail fills with wind.

The lugsail should preferably be hoisted on the lee side of the mast, heaving the halliards taut on the *windward* side so as to provide extra support to the mast. The jib should be hoisted with the luff tight, and the lead of the sheets should be such that a continuation of the line of the sheet will bisect the angle at the clew. When the mast is later stowed it is surprising how tangled the rigging can become, and it is as well to lay all the lines, shrouds, and halliards along the full length of the mast in the reverse order to that in which they are set up. They are then lightly stopped to the mast with rope yarns, which can easily be cut.

The jibsheet should be adjusted so that the wind can pass freely between it and the lee side of the mainsail, thus creating a pressure drop behind the mainsail. The jibsheet may be belayed at times, but it is unwise to do this with the mainsheet unless a jambing cleat is provided.

Manœuvring the Boat

Fig. 18.4 shows the action of a wind on the sail of a boat. In the upper illustration the boat is close-hauled, ST represents the thrust of the wind

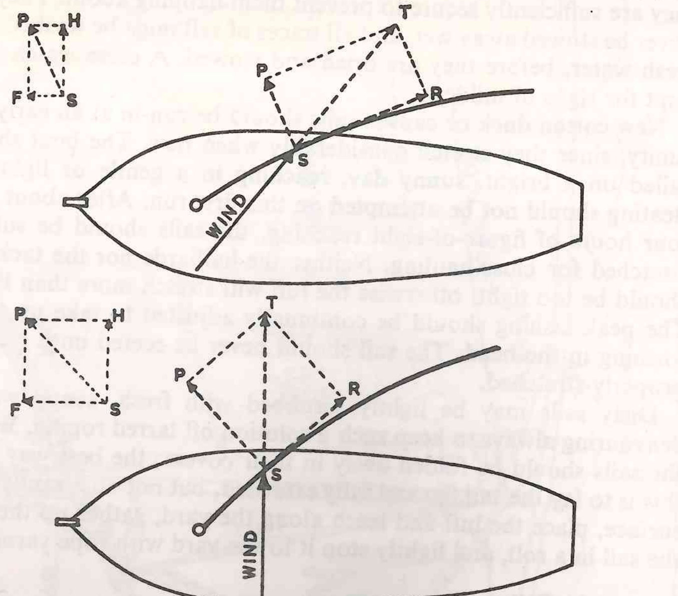


FIGURE 18.4

at the centre of effort, and SR a component of this force acting along the surface of the sail. The other component SP, acting perpendicularly to the surface of the sail, may be resolved into two components, SH heeling the boat and producing leeway, and SF causing forward motion. It will be noticed that the heeling force is greater than the forward propelling force.

In the lower illustration the same boat is reaching. SF is considerably

increased, and a boat sailing in this way does so at a greater speed than when she is beating.

Heeling may be corrected by seating the crew to windward, and leeway by the use of a drop-keel, the use of which is not provided for in a lifeboat. The rudder suffers a loss in efficiency when the boat is heeled, so that the boat should be trimmed slightly by the stern under this condition.

It will be noticed that the sheet must be eased when the wind is brought broader on the bow, otherwise there will be a danger of capsizing. The more the sail can be eased out, the less is the active heeling force; this becomes obvious after careful study of the lower illustration. As the heeling force decreases, so the propelling force increases.

This state of affairs does not hold good, however, when the sheet is eased right out, as when running with the wind dead aft, for then the effective wind on the sail consists of the true wind less the speed of the boat. Although the heel will be zero, the propelling force will not be so great as when reaching, for in this latter manœuvre the effective wind is the same as the true wind and a greater speed is attained. The reader should distinguish between the effective wind on a sail, and the apparent wind felt by the crew. In the reaching position, although the crew will feel a breeze from a direction forward of the beam, the full speed and effect of the prevailing true wind is able to act on the sail.

Summarising, then, the boat's speed is greater when reaching than when close-hauled. Similarly, the speed is greater with the wind on the quarter or gybe, rather than dead astern.

The trim of a boat must vary constantly. Beating, reaching, and running all require different conditions of trim for maximum efficiency. Generally, heavy weights should be kept away from the ends of a boat, otherwise she is likely to ship a lot of water fore and aft. When running, an even keel is desirable, for a trim by the stern causes her to be pooped, while a trim by the head tends to make her continually luff-up.

In this way, it will be seen that a trim by the stern will correct a tendency to carry weather helm, and vice versa in the case of lee helm.

Beating

Here the sheet is drawn aft as tightly as possible and the boat sailed as close to the wind as can be achieved without the luff shaking. If the luff is shaking the sail is not holding the wind and the boat is pinching.

When it is decided to go about, pay off a little in order to gather headway, and then ease the helm down. As the boat comes up into the wind's eye let fly the sheets and stand by to back the jib if it looks as though she may get into irons. As she casts off on the new tack, haul aft the lee jibsheets and the mainsheet, setting her close to the wind.

If the boat gets in stays trim the crew aft, to increase the forward hull wind-area, and back the jib out on to the original lee bow. If she gathers sternway reverse the helm. An oar should be made ready to row the bow through the wind's eye.

Reaching

The boat should be on an even keel with preferably no heel. If any existing heel increases the mainsheet may need easing. Heel which develops suddenly through a gust of wind striking a sail which is sheeted home too tightly may be corrected by putting the helm down. When easing the sheet on a reach, do so until the luff starts to shiver and then heave it in just sufficiently to check this effect.

Running

The sails should be at right angles to the direction of the wind. In addition to sailing more slowly when the wind is dead aft rather than on the quarter, the boat tends to yaw continually, particularly in a rough sea. Further, there is the risk of an accidental gybe. For this reason, it is better to sail a zig-zag course to a downwind destination, sailing on the port and starboard gybes alternately. When running before a heavy sea, a drogue should be streamed from aft, using either the sea-anchor or a bucket. This prevents, to some extent, the risk of surfing and broaching-to.

Wearing

Ease the sheets and put the helm up. The boat then pays off, gathering way. Just before the wind comes astern, give the order 'Stand by to gybe' and heave the mainsheet hard aft. Turn the stern through the wind's eye and the sail will fling across to the other quarter, but the violence of its movement is checked by the tight sheet. The latter must be eased away rapidly as the wind broadens on the quarter. The boat is then luffed-up close to the wind, heaving home the mainsheet. Generally speaking, it is better to avoid a gybe in a lifeboat, whether accidental or otherwise, and the yard is often lowered while passing through the wind's eye astern.

Squalls

If the boat is struck by a squall the sheets should be let fly, the helm put hard down, and the boat allowed to luff-up into the wind, spilling it from her sails. When running with the wind dead aft a gybe must be avoided, and this is done by putting the helm, or tiller, hard over towards the sail clew.

When water is being shipped on the lee side it may be time to take a reef. The boat is run up into the wind and the main halliards are eased. The tack lashing and sheet are secured at the reef cringles and the foot

loosely gathered to the reef points, which are stopped around the folds. A rolled sail will tend to hold spray rather more than one which is loosely folded. A reef is shaken out only after the boat has run into the wind's eye.

If capsized, cast off all the rigging, sails and spars, and unship the mast. This gear is then allowed to float clear on a buoyant line. The crew can then place their feet on the keel and heave on the righting lines. Once the boat is righted, it should be quickly baled out.

Berthing and Unberthing

The berth should always be approached head to wind, lowering the sails in ample time. Over-running can be prevented by using full rudder or backing the foresail. When berthing with the wind aft, it is better to run in on the jib alone.

Unberthing is usually done head to wind, backing the jib so as to cast off on the first tack, clear of the berth.

Accidents

If a crew member falls overside, when reaching or beating, put the helm up and wear the boat round to leeward of the man. The boat should then beat up towards him, coming into the wind's eye at the last moment. If the boat is already running she should be luffed up on the same tack and brought into the wind's eye close to the man.

The Use of the Sea-anchor

This is used mainly to keep the boat head to wind and sea by streaming it from the bows, lowering the sails. It may also prove valuable when running before a very heavy sea, since its drag effect will prevent the boat from surfing and broaching-to.

The sea-anchor is a conical canvas bag, open at both ends. Its larger end, or mouth, faces the boat and is kept open either by means of a galvanised-iron hoop or by iron spreaders. The use of these spreaders enables the sea-anchor to be folded flat when not in use. A bridle runs from the mouth to the sea-anchor warp, which is a heavy manila line of length equal to three times the boat's length. A light tripping line,
4 m longer than the warp, is secured to the tail of the sea-anchor. 12 ft
The tripping line is used to turn the canvas bag so that it may easily be towed back to the boat.

It is important to realise that in a gale of wind the boat may still make a considerable lee drift, perhaps up to 2 knots.

From the statutory specifications for a sea-anchor, it may be seen that the mouth diameter is approximately equal to $\frac{1}{12}$ of the length of the boat's waterline. The length of the bag is roughly one and a half times the mouth diameter, while the tail and mouth diameters are nearly in the ratio of one to eight.

A drogue can also be provided by towing a bucket, or a jib having a 6-in bridle rigged from its corners, the clew weighted, and a 15-cm hole cut in the centre of the surface.

MOTOR-BOATS

These should generally be handled as described in Chapter 3, for large vessels. Their engines should be frequently overhauled, for they are called upon to run at full power for long periods, idle alongside gangways for several minutes at a time, and are usually given little time to warm through.

When starting the engine the maker's recommendations should be followed closely. The oil level should be checked, the circulating-water system ventilated and flooded, and the engine allowed to warm up at half revolutions for a little while before using full power. It is most important to check the flow of oil and circulating water before leaving the berth. The correct grade of sump oil must be used, otherwise extremely difficult starting, not to mention excessive wear, may be experienced in cold conditions.

When leaving the motor-boat, all valves and controls should be left in the maker's recommended positions, otherwise an emergency start may be impossible. If anything unusual is noticed regarding the controls, of if they are not left in the starting positions, a note should be left attached to the throttle lever.

Never race the engine in neutral. In the case of Diesel engines, the maximum power and revolutions are controlled by governors, and adjustments to these should never be made without the permission of the Duty Engineer. Any extra power so gained will usually be at the expense of wear and possible breakdown.

The crew should be trained to watch for: overheating; darkening exhaust; labouring; alterations in engine note not due to throttle adjustments; excessive vibration; strong smells from a *clean* engine; leakage of oil or fuel; an increase in the oil level, which may be caused by water in the sump; a smell of petrol vapour in the bilges, and clutch slip—which should be repaired immediately. All these are warning signs and must not be ignored.

The boat should avoid sandy or muddy water, the particles suspended therein tending to choke the circulating system. Fire extinguishers should be tested regularly and the engine cover kept on at all times, except when repairs or adjustments are made. It is most important to keep salt water from entering the electrical ignition system of a petrol engine.

CHAPTER XIX

THE DEPARTMENT OF TRANSPORT ORAL EXAMINATION—FOREIGN-GOING

THE three following sections include the seamanship syllabuses for oral examination which forms a part of each Certificate of Competency. It should be noted that candidates for Class One and Class Two Certificates are likely to be questioned, in addition, on the work of previous examinations; in other words an Officer who presents himself for a Class One Certificate of Competency is expected to be thoroughly familiar with all previous syllabuses.

Classes 3, 4, 5

The rigging of ships. Methods of ascertaining the proof and safe working loads of ropes, including synthetic fibre and wire ropes. Rigging purchases and a knowledge of the power gained by their use. Knots, bends and hitches in common use. Seizings, rackings, rope and chain stoppers. Splicing plaited and multi-stranded manila and synthetic fibre ropes and wire rope, with strict reference to current practice. Slinging a stage. Rigging a bosun's chair and pilot ladder.

Preparations for getting under way; duties prior to proceeding to sea, making harbour and entering a dock. Berthing alongside quays, jetties or other ships and securing to buoys, with special reference to the after end of the ship. Duties of officers in port.

Helm orders. Conning the ship. Effect of propellers on the steering of a ship. Stopping, going astern and manoeuvring. Turning a power-driven vessel short round. Emergency manoeuvres. Man overboard.

Anchors and cables and their use and stowage. Bringing a ship to a single anchor in an emergency.

Knowledge of the use of all deck appliances including emergency steering gear. I.M.C.O. watch-keeping principles. Use and upkeep of mechanical logs and sounding appliances.

Use and care of rocket and line-throwing apparatus.

Use and care of life-saving appliances.

Bending, setting and taking in lifeboat sails. Starting a compression-ignition engine. Management of boats under oars, sail and power and

in heavy weather. Recovering boats at sea. Beaching or landing.
Survival procedure in liferafts or lifeboats.

Use and care of fire appliances including the smoke helmet and self-contained breathing apparatus.

A full knowledge of the content and application of the Collision Regulations and the Annexe to the Rules. (Candidates will not be placed in the position of handling a sailing vessel, but will be expected to recognise a sailing ship's lights and to have a knowledge of her possible manoeuvres according to the direction of the wind.)

Distress and pilot signals; penalties for their misuse.

Knowledge of D.o.T. Merchant Shipping Notices and Admiralty Notices to Mariners. British and I.A.L.A. Buoyage systems. Wreck marking. Code of Safe Working Practices.

Class 2

The handling of heavy weights with special reference to the type and strength of gear used.

The use and care of all deck and above-deck appliances and fittings including winches, capstans, windlasses, davits, fairleads, emergency steering gear and fittings used between anchor and cable locker.

Different types of anchors. Their advantages and disadvantages. Cables and their care. Preparations for anchoring. Anchoring with a single anchor and the use of the second anchor. Clearing foul anchor and foul hawse. Anchoring in a tideway and confined space. Mooring. Hanging off anchors. Breaking and slipping cables.

Getting under way.

Carrying out anchors in boats.

Effect of current, wind, shallows and draught on manoeuvring. Manoeuvring in rivers and harbours. Berthing alongside and leaving quays and oil terminals, with or without the use of tugs.

Management of ships in heavy weather. Means to employ to keep a disabled or unmanageable vessel out of the trough of the sea and to lessen the lee drift. Handling a disabled ship. Extra precautions to be taken before the onset of bad weather.

Outline knowledge of the regulations concerning life-saving and fire appliances.

Measures to be taken following accidental damage, including collision and grounding. Heavy-weather damage and leaks. Methods of dealing with shipboard fires. Organisation and direction of firefighting, liferaft and lifeboat preparation parties.

Practical knowledge of the screening of ships' navigation lights.

Preparations for drydocking and undocking. Use of shores, bilge blocks and bilge shores.

Measures to be taken to prevent the spillage of oil during cargo work, bunkering or transferring. The keeping of records under the Prevention of Oil Pollution Act.

The Collision Regulations and buoyage systems as for Class 3.

Class 1

Exceptional circumstances. Loss of rudder and/or propeller. Jury steering. Action following collision or sustaining damage of any kind. Action following grounding. Methods of refloating. Surveys subsequent to refloating. Beaching a ship.

Steps to be taken when disabled or in distress. Preservation of passengers and crew. Abandoning ship. Survival procedure. Abandoning a wrecked ship. Communication with the shore. Use of rockets and rocket apparatus. Assisting a ship or aircraft in distress. Use of direction for homing on to a casualty.

Rescuing crew of a disabled ship or ditched aircraft. Launching accident boats.

Bad weather manoeuvres. Precautions at anchor and at sea. The use of oil for smoothing the sea. Anchoring, and working anchors and cables in all circumstances. Approaching rivers and harbours and manoeuvring therein. Approaching off-shore loading points under open-sea conditions. Towing and being towed.

Drydocking. General procedure and precautions to be observed. Distribution of weight. Drydocking with full cargo for inspection of propellers and shafting. Bilge blocks. Leaving the vessel waterborne. Putting into port with damage to ship and/or cargo from both business and technical points of view. Safeguarding of cargo.

Prevention of fire at sea and in port. Methods used and action taken to prevent fire spread. Full knowledge of the use, and precautions in use, of fire appliances.

Methods of pest control and fumigation of holds and living spaces. Safeguards in use of these methods.

The Collision Regulations and buoyage as for Class 3.

Radio-telephony. Knowledge of distress and safety communication procedure on R/T distress- and calling-frequencies as indicated in the International Code of Signals and the Post Office Handbook for Radio Officers.

Portable radio equipment. Preparation and use of portable radio equipment as used in lifeboats and liferafts, including the erection of aerials. Knowledge of facilities and frequencies provided.

Port radio information. Knowledge of the type of service to aid vessels entering ports and assist in berthing as indicated in the Admiralty List of Radio Signals 'Port Radio Stations and Pilot Vessels'.

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