2.

SHIP NOMENCLATURE

Merchant ships exist to carry cargoes across the waterways of the world safely, speedily and economically. Since a large part of the world's surface, approximately three fifths, is covered by water, it is reasonable to consider that the merchant ship will continue to perform its function for many centuries to come. The worldwide nature of this function involves the ship, its cargo and its crew in many aspects of international life. Some features of this international transportation, such as weather and climatic changes, availability of cargo – handling facilities and international regulations, will be considered in later chapters.

The ship, in its various forms, has evolved to accomplish its function depending upon three main factors – the type of cargo carried, the type of construction and materials used, and the area of operation.

The principal cargo – carrying types of ship that exist today: the general cargo vessel, the tanker and the passenger vessel. The general cargo ship functions today as a general carrier and also, in several particular forms, for unit based or unitized cargo carrying. Examples include container ship, pallet ships and 'roll-on, roll-off' ships. The tanker has its specialized forms for the carriage of crude oil, refined oil product, liquefied gases, etc. The passenger ship includes, generally speaking, the cruise liner and some ferries.

The type of construction will affect the cargo carried and, in some generally internal aspects, the characteristics of the ship. The principal types of construction refer to the framing arrangement for stiffening the outer shell plating, the three types being longitudinal, transverse and combined framing. The use of mild steel, special steels, aluminum and other materials also influences the characteristics of a ship. General cargo ships are usually of transverse or combined framing construction using mild steel sections and plating. Most tankers employ longitudinal or combined framing systems and the larger vessels utilize high tensile steels in their construction. Passenger ships, with their large areas of superstructure, employ lighter metals and alloys such as aluminium to reduce the weight of the upper regions of the ship.

The area of trade, the cruising range, the climatic extremes experienced, must all be borne in mind in the design of a particular ship. Ocean-going vessels require several tanks for fresh water and oil fuel storage. Stability and trim arrangement must be satisfactory for the weather conditions prevailing in the areas of operation. The strength of the structure, its ability to resist the effects of waves, heavy seas, etc., must be much greater for an ocean-going vessel than for inland waterway vessels.

Considerations of safety in all aspects of ship design and operation must be paramount, so the ship must be seaworthy. This term relates to many aspects of the ship: it must be capable of remaining afloat in all conditions of weather; it remain afloat following all but the most serious damage, and it must remain stable and behave well in the various sea states encountered.

TYPES OF SHIPS

2. The development of ship types will continue as long as there is a sufficient demand to be met in a particular area of trade. Recent years have seen such developments as very large crude carriers (VLCCs) for the transport of oil, and the liquefied natural gas and liquefied petroleum gas tankers for the bulk carriage of liquid gasses. Container ships and various barge carriers have been developed for general cargo transportation. Bulk carriers and combination bulk cargo carriers are also relatively modern developments.

Several basic ship types will now be considered in further detail. The particular features of appearance, construction, layout, size, etc., will be examined for the following ship types.

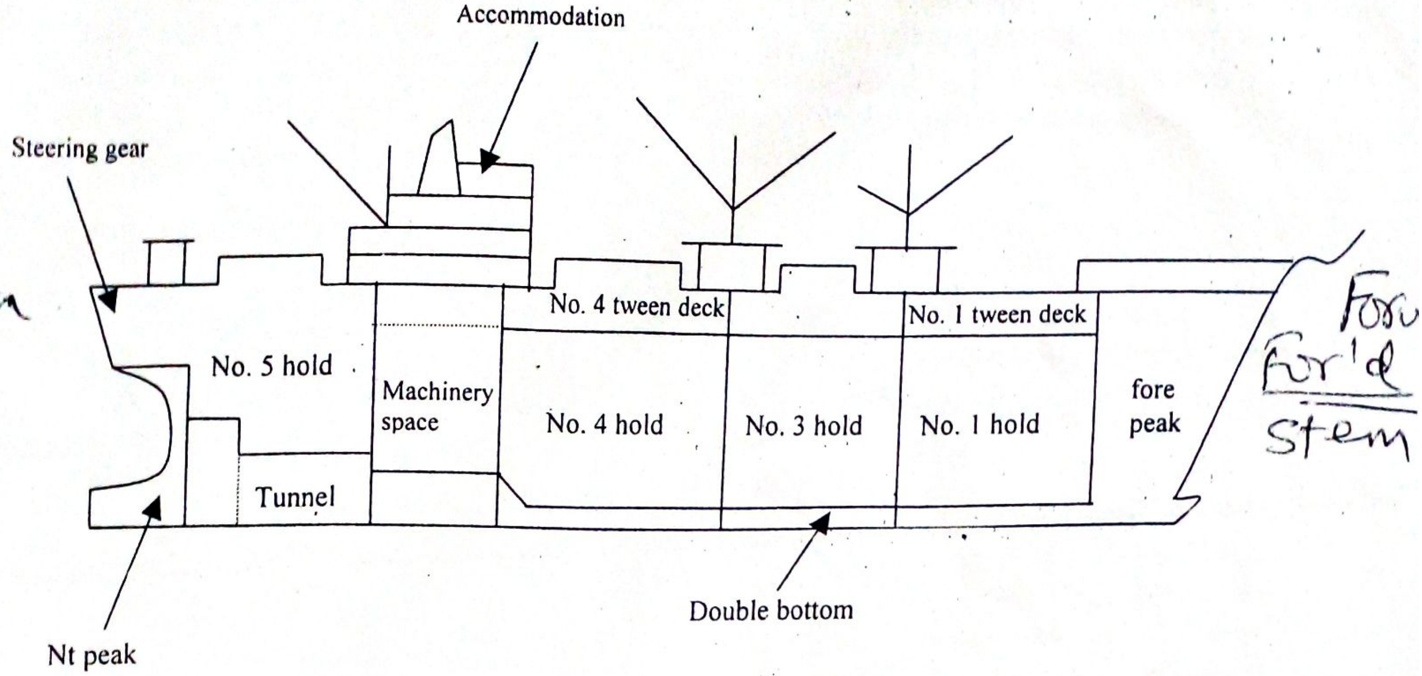
(1) General cargo ships.
(2) Tankers.
(3) Bulk carriers.
(4) Container ships.
(5) Passenger ships.
(6) War ships (man-of-war)

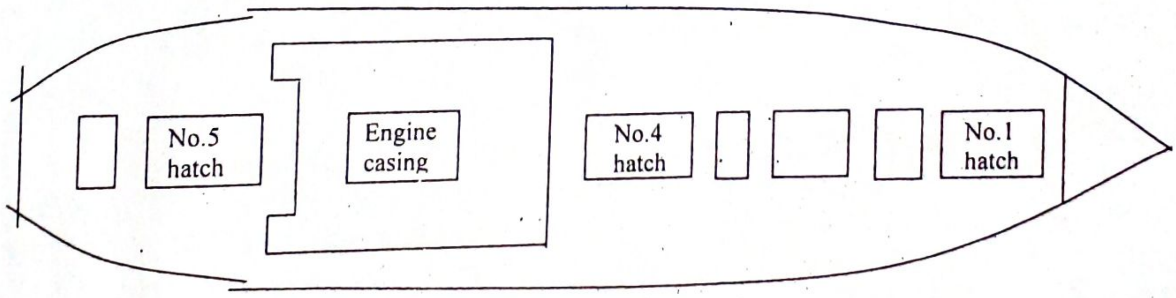
Many other types and minor variations exist, but the above selection is considered to be representative of the major part of the world's merchant fleet.

3. GENERAL CARGO SHIPS

The general cargo ship is the 'maid of all work', operating a worldwide 'go anywhere' service of cargo transportation. It consists of as large a clear open cargo-carrying space as possible, together with the facilities required for loading and unloading the cargo (figure 1.1). Access to the cargo storage areas or holds is provided by openings in the deck called hatches. Hatches are made as large as strength considerations will allow to reduce horizontal movement of cargo within the ship. Hatch covers of wood or steel, as in most modern ships, are used to close the hatch openings when the ship is at sea. The hatch covers are made watertight and lie upon coatings around the hatch which are set some distance from the upper or weather deck to reduce the risk of flooding in heavy seas.

One or more separate decks are fitted in the cargo holds and are known as tween decks. Greater flexibility in loading and unloading, together with cargo segregation and improved stability, are possible using the tween deck spaces. Various combinations of derricks, winches and deck cranes are used for the handling of cargo. Many modern ships are fitted with deck cranes, which reduce cargo-handling times and manpower requirements. A special heavy-lift derrick may also be fitted, covering one or two holds.





Since full cargoes cannot be guaranteed with this type of ship, ballast-carrying tanks must be fitted. In this way the ship always has a sufficient draught for stability and total propeller immersion. Fore and aft peak tanks are fitted which also assist in trimming the ship. A double bottom is fitted which extend the length of the ship and is divided into separate tanks, some of which carry fuel oil and fresh water. The remaining tanks are used for ballast when the ship is sailing empty or partly loaded. Deep tanks may be fitted which can carry liquid cargoes or water ballast.

The accommodation and machinery spaces are usually located with one hold between them and the aft peak bulkhead. This arrangement improves the vessel's trim when it is partially loaded and reduces the lost cargo space for shafting tunnels compared with the central machinery space arrangement. The displacement tonnes with speeds of 12 – 18 knots.

TANKERS

The tanker is used to carry bulk liquid cargoes, the most common type being the oil tanker. Many other liquids are carried in tankers and specially constructed vessels are used for chemicals, liquefied petroleum gas, liquefied
LPG
natural gas, etc.
LNG

The oil tank has the cargo-carrying section of the vessel spilt up into individual tanks by longitudinal and transverse bulkheads (figure 1.2). The cargo is discharged by cargo pumps fitted in one or more pump-rooms either at the ends of the tank section or sometimes in the middle. Each tank has its own suction arrangement which connects to the pumps, and a network of piping discharges the cargo to the deck from where it is pumped ashore. No double bottom is fitted in the cargo-carrying section of an oil tanker. Fore and aft peak tanks are used for ballast, with often a pair of wing tanks situated just forward of midships. These wing tanks are ballast-only tanks and are empty when the ship is fully loaded. Small slop tanks are fitted at the after end of the cargo section and are used for the normal carriage of oil on loaded voyages. On ballast runs the slop tanks are used for storing the contaminated residue from tank-cleaning operations.

Large amounts of piping are to be seen on the deck running from the pump-rooms to the discharge manifolds positioned at midships, port and starboard. Hose-handling derricks are fitted port and starboard near the manifold. The accommodation and machinery spaces are located aft in modern tankers. The range of sizes for oil tankers at present is enormous, from small to 700,000 deadweight tonnes. Speeds range from 12 to 16 knots.

Liqd. petroleum prod

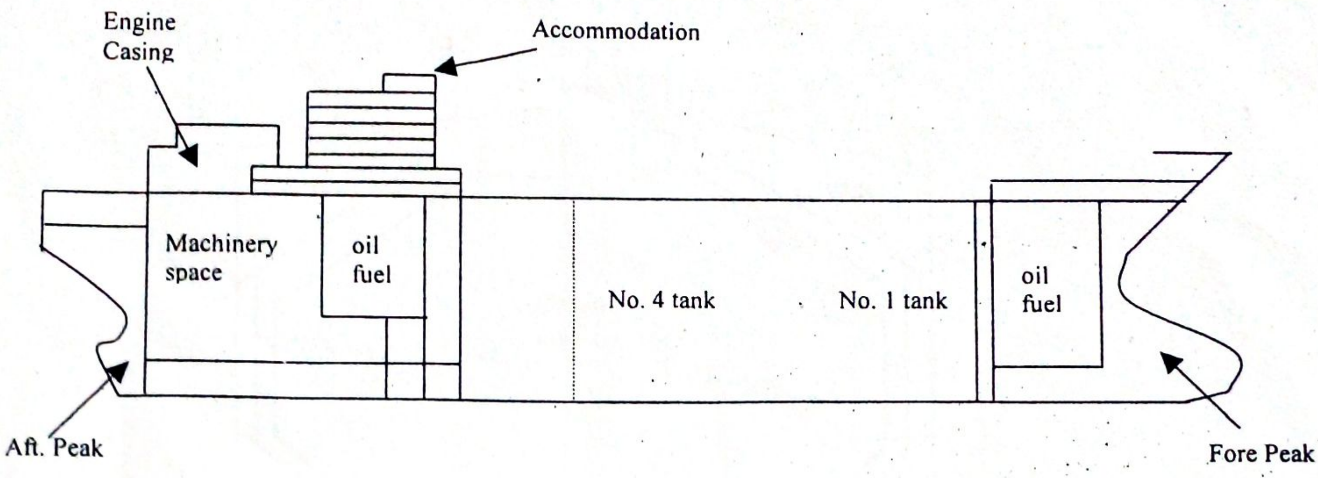


Figure 1.2: Oil tanker

LNG

LIQUEFIED GAS TANKERS

Liquefied gas tankers are used to carry, usually at low temperature, liquefied petroleum gas (LPG) or liquefied natural gas (LNG). A separate inner tank is usually employed to contain the liquid and this tank is supported by the outer hull which has a double bottom (figure 1.3).

LNG tanks carry methane and other paraffin products obtained as a by-product of petroleum drilling operations. The gas is carried at atmospheric pressure and temperatures as low as – 160°C in tanks of special materials which can accept the low temperature. The tanks used may be prismatic, cylindrical or spherical in shape and self-supporting or of membrane construction. The containing tank is separated from the hull by insulation which also acts as a secondary barrier in the event of leakage.

LPG tankers carry propane, butane, propylene, etc., which are extracted from natural gas. The gases are carried either pressurized, part pressurized, part refrigerated or fully refrigerated. The fully pressurized tank operates at 18 bar and ambient temperature, the fully refrigerated tank at 0.25 bar and -50°C. Separate containment tanks within the hull are used and are surrounded by insulation where low temperatures are employed. Tank shapes are either prismatic, spherical or cylindrical. Low temperature steels may be used on the hull where it acts as a secondary barrier.

Displacement sizes for gas carriers range up to 60,000 tonnes, with speed of 12 – 16 knots.

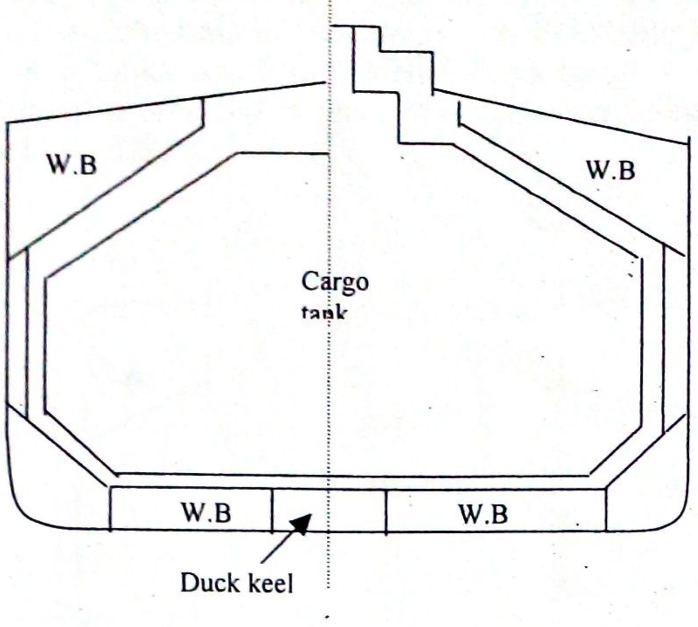


Figure 1.3: ***Liquified petroleum gas (LPG) tanker (W.B. water ballast tanks)***

BULK CARRIERS

Bulk carriers are single-deck vessels which transport single-commodity cargoes such as grain, sugar and ores in bulk. The cargo-carrying section of the ship is divided into holds or tanks which may have any number of arrangement depending upon the range of cargoes to be carried. Combination carriers are bulk carriers designed for flexibility of operation and able to transport any one of several bulk cargoes on any voyage, e.g. ore or crude oil or dry bulk cargo.

The general-purpose bulk carrier, in which usually the central hold section only is used for cargo is shown in Fig. 1.5a. The partitioned tanks which surround it are used for ballast purposes either on ballast voyages or, in the case of the saddle tanks, to raise the ship's center of gravity when a low density cargo is carried. Some of the double-bottom tanks may be used for fuel oil and fresh water. The saddle tanks also serve to shape the upper region of the cargo hold and trim the cargo. Large hatchways are a feature of bulk carriers, since they reduce cargo-handling time during loading and unloading.

An ore carrier has two longitudinal bulkheads which divide the cargo section into wing tanks port and starboard, and the centre hold which is used for ore. The high double bottom is a feature of ore carriers. On ballast voyages the wing tanks and double bottoms provide ballast capacity. On loaded voyages the ore is carried in the central hold, and the high double bottom serves to raise the centre of gravity of this very dense cargo. The vessel's behaviour at sea is thus much improved. The cross-section is similar to that of the ore/oil carrier shown in figure 1.5b. Two longitudinal bulkheads are employed to divide the ship into centre and wing tanks which are used for the cargo. A double bottom is fitted beneath the centre tank but is used only for water ballast. The bulkheads and hatches must be oil tight.

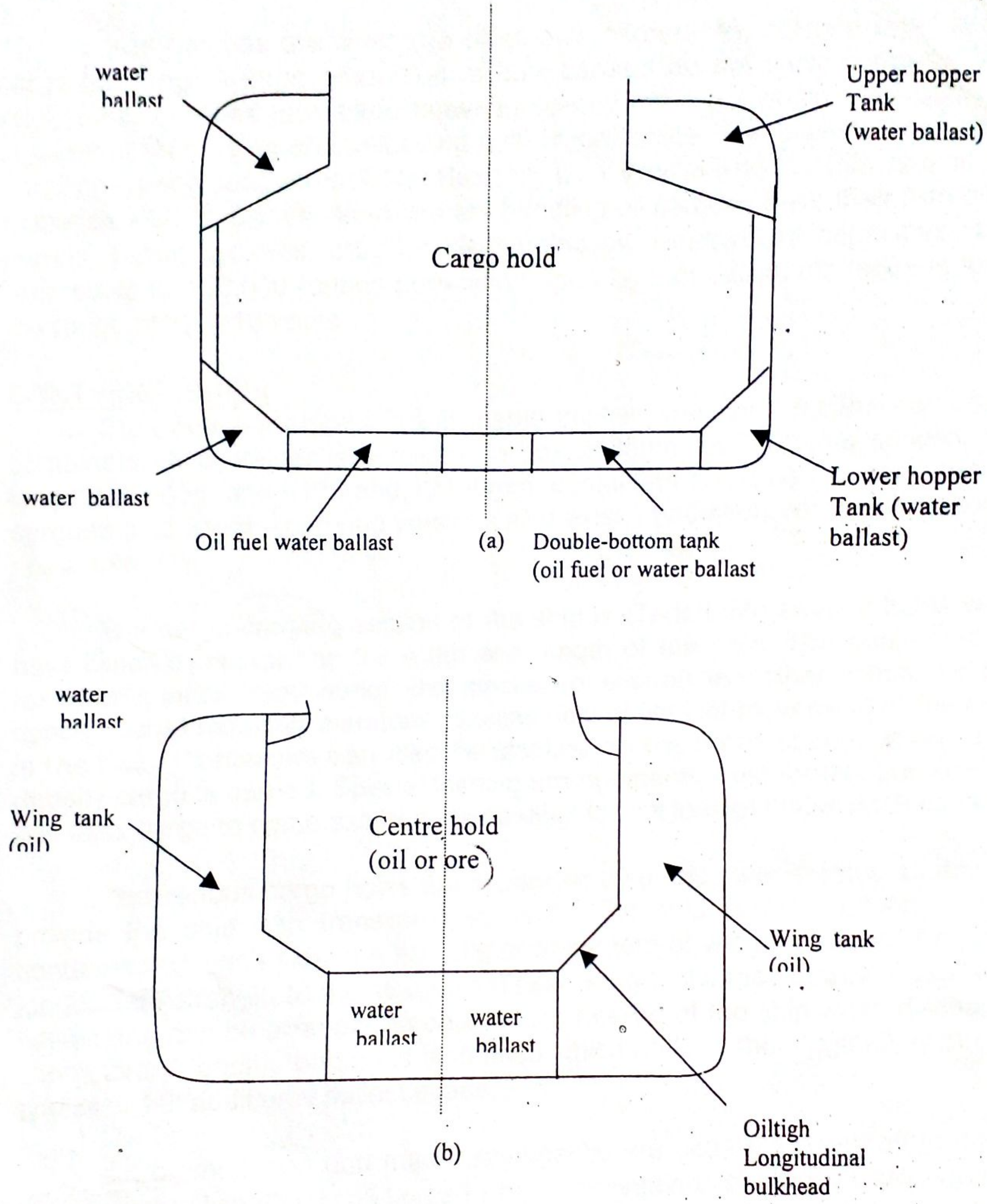


Figure 1.5: Transverse (a) bulk carrier (b) ore/oil carrier.

The ore/bulk/oil carrier has a cross-section similar to the general bulk carrier. The structure is, however, significantly stronger, since the bulkheads must be oiltight and the double bottom must withstand the high density ore load. Only the central tank or hold carries cargo, the other tank areas being ballast – only spaces, except the double bottom which may carry fuel oil or fresh water.

Large hatches are a feature of all bulk carriers, to facilitate rapid simple cargo handling. A large proportion of bulk carriers do not carry cargo-handling equipment, because they trade between special terminals which have particular equipment for loading and unloading bulk commodities. The availability of cargo-handling gear does increase the flexibility of a vessel and for this reason it is sometimes fitted. Combination carriers handling oil cargoes have their own cargo pumps, piping systems, etc., for discharging oil. Deadweight capacities range from small to 150,000 tonnes depending upon type of cargo, etc. speeds are in the range of 12 – 16 knots.

CONTAINER SHIPS

The container ship is, as its name implies, designed for the carriage of containers. A container is a re-usable box 2435mm by 2435mm section, with lengths of 6055, and 9125 and 12190mm. containers are in use for most general cargoes, and liquid – carrying versions also exist. In addition, refrigerated models are in use.

The cargo-carrying section of the ship is divided into several holds which have hatch openings the full width and length of the hold. The containers are raked in special frameworks and stacked one upon the other within the hold space. Cargo handling therefore consists only of vertical movement of the cargo in the hold. Containers can also be stacked on the hatch covers where a low density cargo is carried. Special lashing arrangements exist for this purpose and this deck cargo to some extent compensates for the loss of under-deck capacity.

The various cargo holds are separated by a deep web-framed structure to provide the ship with transverse strength. The ship section outboard of the containers on each side is a box-like arrangement of wing tanks which provides longitudinal strength to the structure. These wing tanks may be utilized for water ballast and can be arranged to counter the heeling of the ship when discharging containers. A double bottom is also fitted which adds to the longitudinal strength and provides additional ballast space.

Accommodation and machinery spaces are usually located aft to provide the maximum length of full-bodied ship for container stowage. Cargo handling gear is rarely fitted, as these ships travel between specially equipped terminals for rapid loading and discharge. Container ship sizes vary considerably with container – carrying capacities from 100 to 2,000 or more. As specialist carriers they are designed for rapid transits and are high powered, high speed vessels with speeds up to 30 knots. Some of the larger vessels have triple-screw propulsion arrangements.

PASSENGER SHIPS

The passenger liner, or its modern equivalent the cruise liner, exists to provide a means of luxurious transport between interesting destinations, in pleasant climates, for its human cargo. The passenger traveling in such a ship pays for, and expects, a superior standard of accommodation and leisure facilities. Large amount of super structure are therefore an essential feature of passenger ships. Several tiers of decks are fitted with large open lounges, ballrooms, swimming pools and promenade areas. a place to stroll to & fro for gentle exercise/pleasure

Aesthetically pleasing lines are evident with usually well-raked clipper-type bows and unusual funnel shapes. Stabilizers are fitted to reduce rolling and bow thrust devices are employed for improved maneuverability. Large passenger lines are rare, the moderate sized cruise liner of 12,000 tonnes displacement now being the more prevalent. Passenger-carrying capacity is around 600, with speeds in the region of 22 knots.

4.

SINGLE – LETTER SIGNALS FOR COMMUNICATION

May be made by any method of signaling:

A I have a diver down; keep well clear at slow speed.
B I am taking in, or discharging, or carrying dangerous goods.
C Yes (affirmative or "The significance of the previous group should be read in the affirmative").
*D Keep clear of me; I am maneuvering with difficulty.
*E I am altering my course to starboard.
F I am disabled; communicate with me.
G I require a pilot. When made by fishing vessels operating in close proximity on the fishing grounds it means: "I am hauling nets".
*H I have a pilot on board.
*I I am altering my course to port.
J I am on fire and have dangerous cargo on board: keep well clear of me.
K I wish to communicate with you.
L You should stop your vessel instantly.
M My vessel is stopped and making no way through the water.
N No (negative or "The significance of the previous group should be read in the negative"). This signal may be given only visually or by sound. For voice or radio transmission the signal should be "NO".
O Man overboard.

P	In harbour. All persons should report on board as the vessel is about to proceed to sea. At sea: It may be used by fishing vessels to mean: "My nets have come fast upon an obstruction".
Q	"My vessel is healthy" and I request free practice.
*S	My engines are going astern.
*T	Keep clear of me; I am engaged in pair trawling.
U	You are running into danger.
V	I request assistance.
W	I require medical assistance.
X	Stop carrying out your intentions and watch for my signals.
Y	I am dragging my anchor.
Z	I require a tug. When made by fishing vessels operating in close proximity on the fishing grounds it means: "I am shooting nets".

Semaphore held in both hands

THE INTERNATIONAL CODE OF SIGNALS, 1969

There are nine editions of the International Code of Signals translated into nine languages, English, French, German, Greek, Italian, Japanese, Spanish, Norwegian and Russian. The book consists of one volume devoted to all means of communication at sea, namely, Visual Signs by code Flags, Flashing Light Signals using Morse symbols, Sound Signaling using Morse, Voice over a loud hailer, Radiotelegraphy, Radiotelephony, Signaling by hand-flags or arms in Semaphore or Morse.

The code is intended to cater for situations related to safety of navigation and persons, especially where language difficulties arise between ships and aircraft or authorities ashore, such as harbour authorities, quarantine authorities, agents etc.

hanging object like rope or an object from the deck-head etc.

THE CODE FLAGS

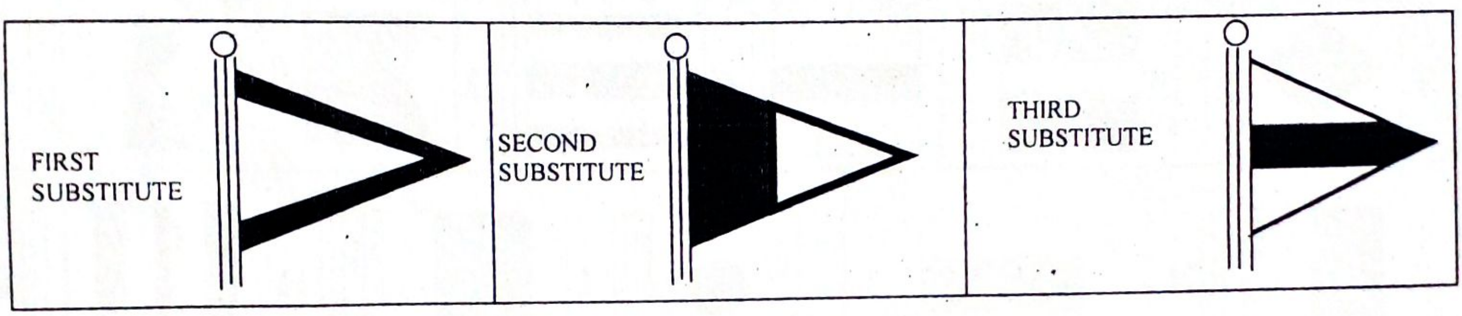
The set of code flags consists of 26 alphabetical flags (one for each letter of the alphabet), 10 numerical pendants (one for each unit 1,2,3,4,5,6,7,8,9,0) 3 substitutes and the answering pendant – 40 flags in all. The flags shown on the coloured plate should be memorized so that they may be recognized at a glance. The substitutes are intended to indicate a repeat of a flag or pendant, in a hoist, so that double or even triple letters or figures may be conveyed in the same hoist by one set of flags only. (See code flags).

– Code flags
– Numerical pendants
– Substitutes
Answering pendants
= Total

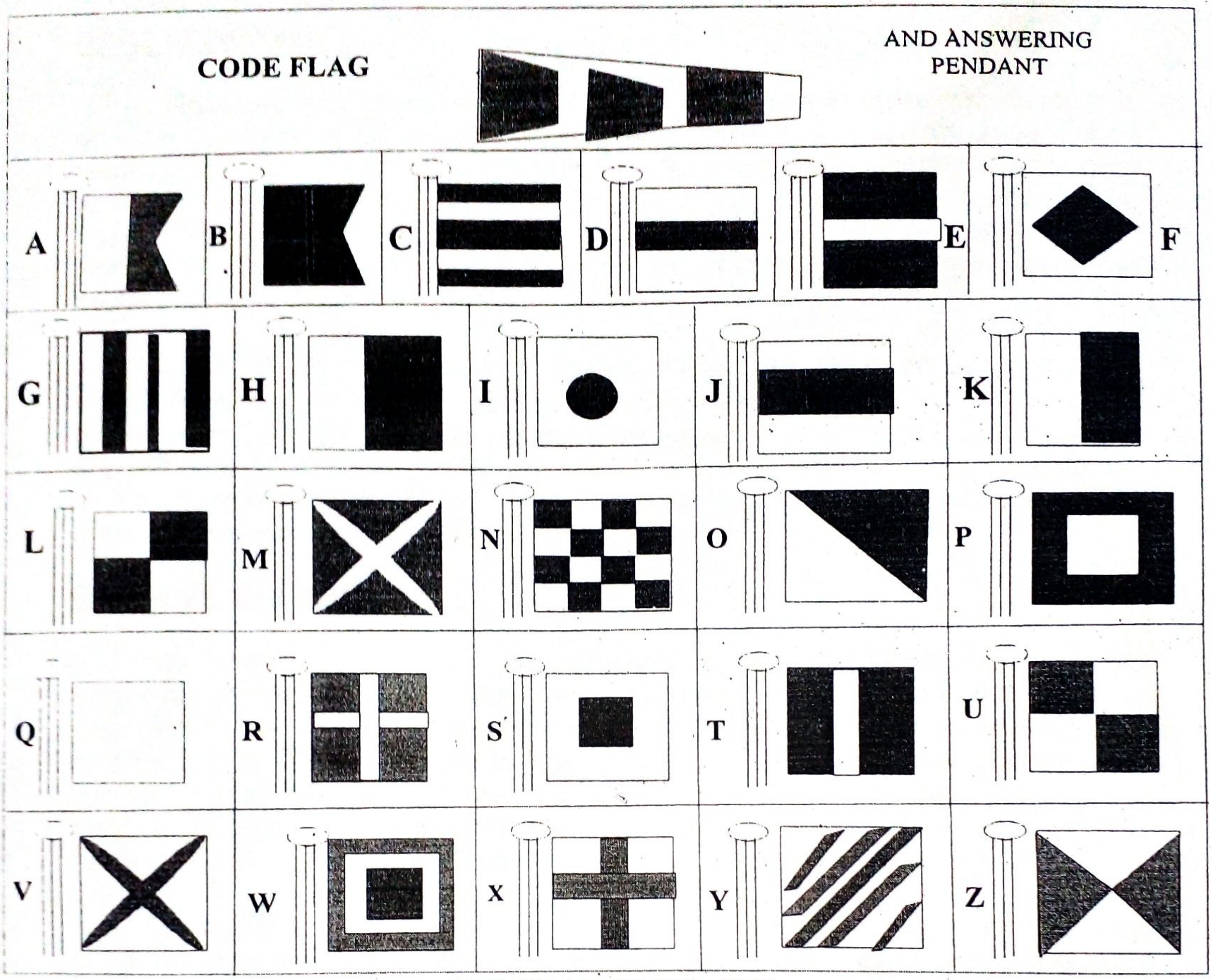
SINGLE – LETTER HOISTS

Single – letter signals relate to phrases which are very urgent, important or of very common use.

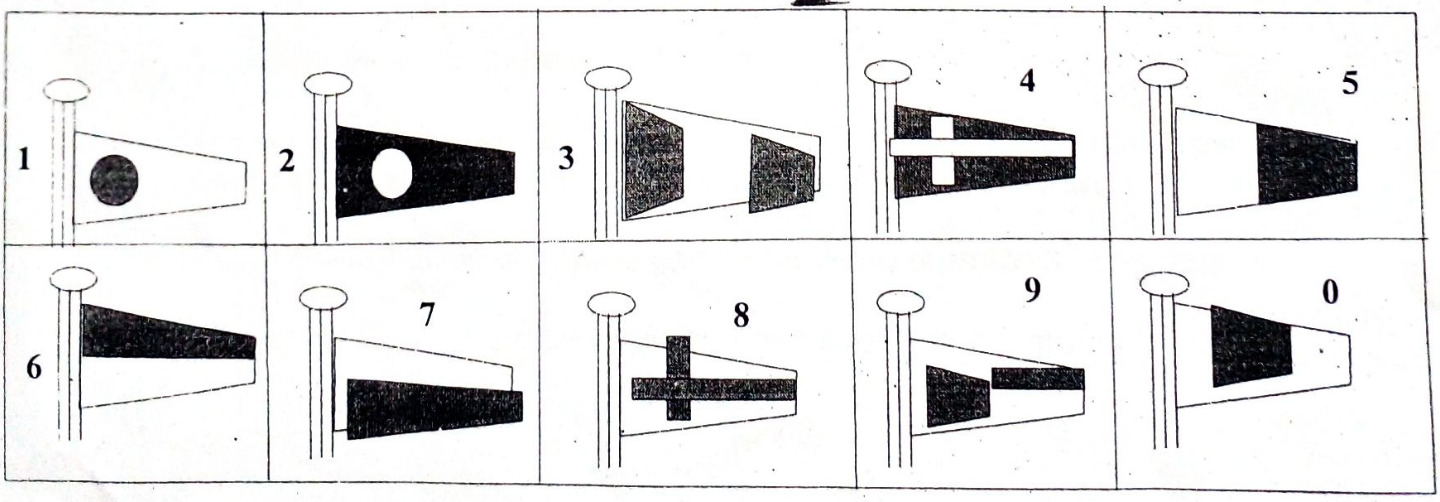
SUBSTITUTES



THE INTERNATIONAL CODE OF SIGNALS



NUMERAL PENDEANTS



*5.0

LIFE-SAVING APPLIANCES

BOAT LOWERING

This is due

The launching of a boat from a small ship at sea in moderate weather is an easy operation as The crew, being few in number, are usually experienced seamen and accustomed to team work. In large ships the launching of a life boat is a more difficult job, ~~owing~~ to the height of the boat – deck above the waterline. Cargo ships are equipped with lifeboat accommodation under davits on each side of the ship sufficient to carry all hands, and therefore bigger boats and heavier davits tackles are needed.

This is

The problem of carrying a sufficiency of buoyant life-saving appliances in ocean passenger liners to accommodate all hands is complicated, not so much b/c ~~by~~ the large complement of passengers and crew they may carry, but mainly by the difficulty to providing stowage space for boats and devising mechanical launching arrangements so that they can be put into the water safely and rapidly even under unfavourable conditions of list and trim.

DISTRESS SIGNALS

All ocean going ships are required to carry 12 Parachute signals displaying a single bright red star of not less than 30,000 candle power which is projected by a rocket to a minimum height of 230m with a minimum burning time of 40 seconds. The parachute controls the rate of fall to 4.5m per second, and the signal must burn-out at a height of not less than 45m from the sea level. The rockets are fired from brackets fitted on either side of the ship at an angle of 10 to 15 degrees from the perpendicular.

Coasting ships and small craft may carry either the 12 parachute signals or 12 Red Hand Flares emitting 2 or more red stars to a height of not less than 45m or 12 "2 star red" distress signals.

Ship's lifeboats must be provided with:

4 Parachute signals displaying a red flare of 15,000 candle power to a height of 180m and a minimum burning time of 30 seconds.

6 Red Hand Flares of 15,000 candle power to burn for 55 seconds.

2 Buoyant Orange-Smoke signals, smoke for 2 to 4 minutes.

LINE – THROWING APPLIANCES

All ocean going ships must carry a line throwing appliance capable of throwing a line a minimum distance of 230m in calm weather. The lateral deflection of the line must not exceed 10 percent of the length of flight or the rocket. Four rockets and four lines 4mm in diameter, of suitable length, having a breaking strain of not less than 114kg are carried.

LIFE SAVING EQUIPMENT

A number of items are considered under this general heading. They are emergency equipment for power generation and pumping, survival equipment such as life boats and life crafts, and the sound signal equipment in the form of the whistle.

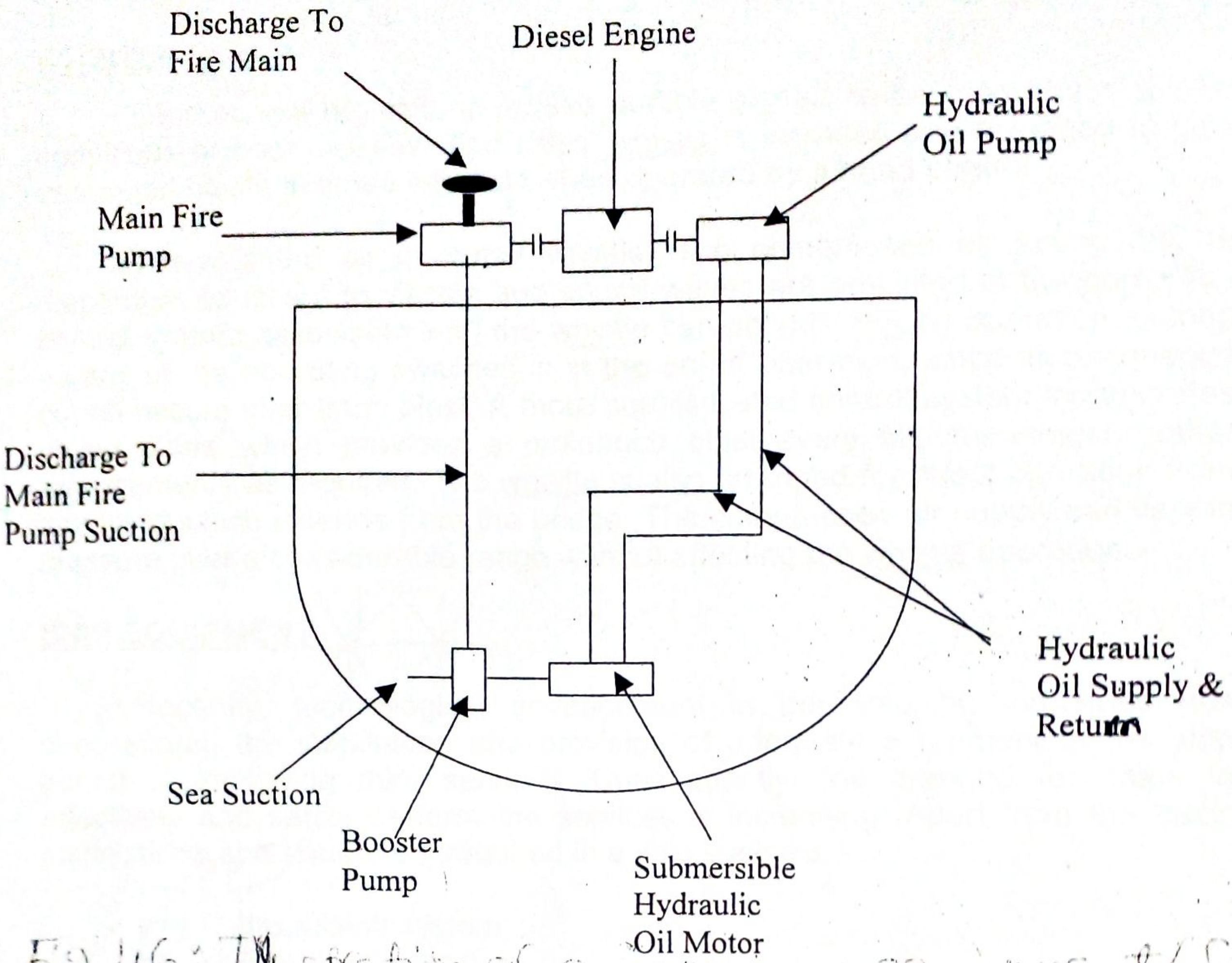
EMERGENCY EQUIPMENT

Emergency equipment is arranged to operate independently of all main power sources. It includes such items as the emergency generator and the emergency fire pumps. Both items of machinery are located remote from the engine room and usually above the bulkhead deck, that is at the weather deck level or above. The emergency generator is usually on one of the accommodation decks while the emergency fire pump is often inside the forecastle.

The emergency generator is diesel driven generator of sufficient capacity to provide essential circuits such as steering, navigation lights and communications. The diesel engine has its own supply system, usually of light diesel oil for easy starting. Batteries, compressed air or an hydraulic accumulator may be used for starting the engine. Small engines may be air cooled but large units are arranged usually for water cooling with an air cooled radiator as heat exchanger in the system. A small switch-board is located in the same compartment to connect the supply to the various emergency services.

Modern systems are arranged to start up the emergency generator automatically when the main power supply fails. The system should be checked regularly and operated to ensure its availability when required.

The emergency fire pump is arranged to supply the ships' fire main when the machinery space pump is not available. One possible arrangement, as used on large tankers, is shown schematically below. in Fig 1.6



(1.6)

Fig 1.6: Illustration of emergency equipment / fire ppd diesel engine arrgt

EMERGENCY FIRE PUMP ARRANGEMENT (See Fig 1.6)

A diesel engine with its own fuel supply system, starting arrangements, etc., drives at one end and a main fire pump at the other end, the hydraulic oil pump supplies a hydraulic motor, located low down in the ship, which in turn operates a sea water booster pump. The booster pump has its own sea suction and discharges to the main pump then supplies sea water to the fire main. The booster pump arrangement is necessary because of the considerable depth of many large modern ships.

SURVIVAL EQUIPMENT

life raft

Life saving equipment on board ship, apart from the smaller items as lifebuoys and life jackets, consists of life-boats and life-crafts. Lifeboats are rigid vessels secured into davits which enable the boat to be launched over the ships side.

D/Dx life raft & lifebuoy.

horn

WHISTLE

International regulations require audible signals to be made by a ship in conditions of poor visibility. The ships' whistle is provided and arranged to give prolonged blasts at timed intervals when operated by a hand control.

horn.

There is the air operated whistle. The compressed air acting on the diaphragm causes it to vibrate and sound waves are amplified in the horn. The control system associated with the whistle can provide whistle operation as long as any of the operating switches is in the on-off operation, since instantaneous cut off occurs after each blast. A more sophisticated control system incorporates timing gears which provides a prolonged blast every two minutes, or other arrangements as required. The whistle is also arranged for direct operation from a lanyard which extends from the bridge. The compressed air supply can vary in pressure over a considerable range without affecting the whistle operation.

horn

SHIP EQUIPMENT

Recently, technological advancement in the shipping industries has necessitated the installation and provision of adequate equipment in the ship aimed at improving their services. Consequently, the demand for ships to effectively and safely perform the services is increasing. Apart from the basic installations and equipment required in a ship such as follows :

a) Propulsion system
b) Electrical system
c) Navigational equipment
d) Steering equipment
e) Cold storage equipment (refrigeratory equipment)
f) Crew catering services
g) Air conditioning systems
h) Equipment for special ship i.e. research ships.

These include

There are still some other equipment in the ship for such function as discharging and taking in of cargo into the ship, anchoring and mooring of the ship to keep the ship stationary. Towing of some other ships in problem or being towed, ventilating, heating and air conditioning of the various compartments as would be necessary, closing of the hull's cargo holes, protection against fire, life saving and some other functions accomplishing a safe and economic operation of the ship. The equipment are standardized by the various ship's classification and maritime agencies who issue the regulations.

All ships on international lines must satisfy the requirements of the international agencies. The requirements for inland water vessels are established by the appropriate agencies. In Nigeria, there is the Federal Inland Water ways which is responsible for the classification of all vessels in the inland waters. Some of the standards in ship equipment must in addition conform to the guide lines of the international organization of standard (ISO).

I O S

HATCH COVERS

Hatch covers are used to make the cargo hatch water tight to protect the cargo and to stiffen up the hatch opening. Two basic types are generally used;

i) The wooden hatch cover fitted across hatch beams and
ii) The patent steel covers of various designs.

The hatch covers fits on top of the hatch coamings. The weather deck coamings are at a height set by the load line rules. The twin deck coamings are set flush or almost flushed with the deck to reduce interference with cargo stowage in this area.

The following are therefore required for hatch covers;

a) It must be watertight (by means of panels with various types of gaskets)
b) It must be secured in a way such that movement of the ship or the effect of forces of the sea, deck cargo, etc. do not alter the water tightness (by the use of cleats).
c) It must be constructed solidly to withstand these forces and resist their destructive effects.

All these conditions if fulfilled will satisfy the classification authorities and ensure safety of life at sea.

Heating, Ventilation & Air Conditioning (HVAC).

VENTILATION, AIR CONDITIONING AND HEATING

The air for the ventilation and air conditioning plants is required to provide an acceptable climate for the crew to live and work, sufficient air for machinery use and to maintain temperature and humidity at acceptable levels for the cargo. All these must be achieved regardless of the conditions prevailing external to the ship.

VENTILATION: Inadequate and poor quality air supplies can seriously damage most cargoes. Fairly simple systems of cargo ventilation can prevent such damage.

Certain cargoes, some fruits and vegetable cargoes and hydroscopic (water absorbing or emitting) cargoes are carried in non-insulated holds. As a result, they are exposed to all climatic changes which may cause condensation on the hull or cargo. Ventilation of the hold in which they are carried is therefore necessary. Refrigerated and frozen cargoes are carried in insulated holds but because of the living, gas producing nature of the cargo, they also require ventilation.

The purpose of ventilation in non-insulated holds is to remove excess heat and humidity and to remove gases produced in the ripening of some fruits and vegetable cargoes.

VENTILATION OF NON-INSULATED HOLDS

Natural and mechanical ventilation are used for this purpose. Natural ventilation is accompanied by inlet and outlet pipes and trunking to each cargo space. These inlet and outlet consist of cowls or ventilators of various designs. Most modern ships use mechanical ventilation. Mechanical ventilation operates in two distinct systems – the opened and closed.

The open system uses axial flow fans fitted in the inlet and outlet trucks. The closed system re-circulates air and a controlled amount of fresh air can be admitted.

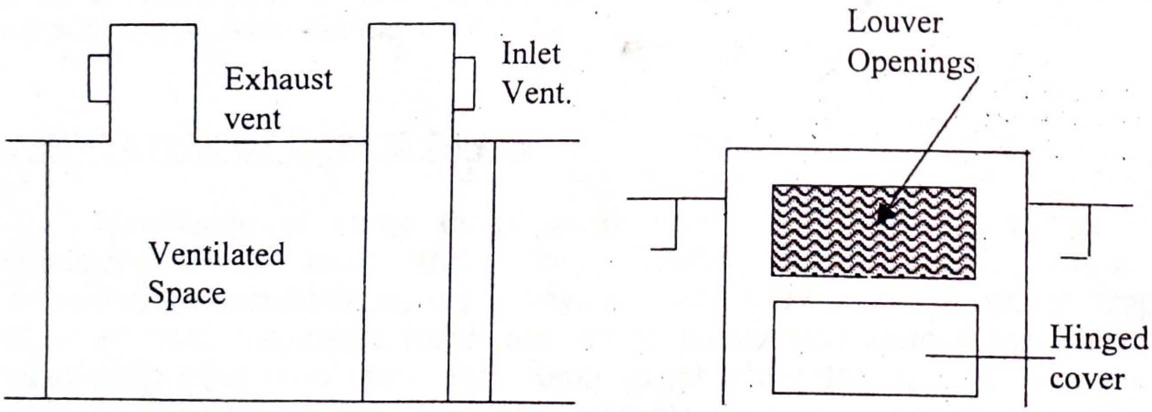
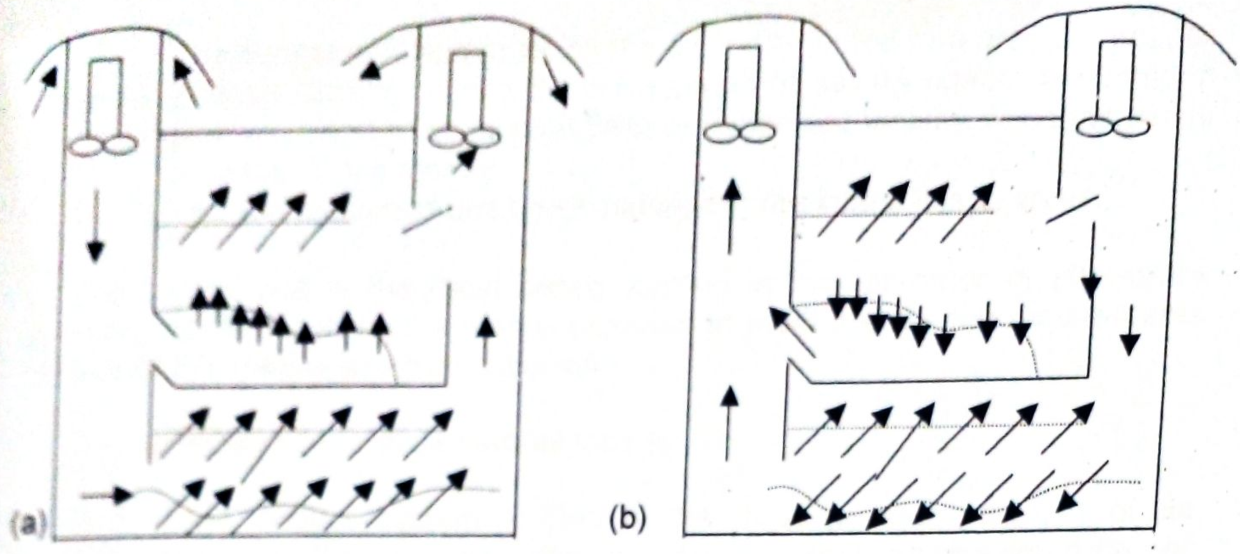


Fig 1.7: *Natural Ventilation of Tween –Desk space or workshop*



Open Ventilation (a) normal Circulation (b) Reversal Circulation

PUMP ROOMS VENTILATION

Tanker pump rooms requires ventilation to carry away poisonous cargo fumes resulting from leaking glands or pipe joints. The working climate in this space is well below deck level, must also be comfortable for any personnel present. Mechanical exhaustion of air is achieved by the use of axial flow fans and trucking. The trucking draws air from the pumproom flow and emergency in takes at a height of 2.15m from the working platform. These emergency intakes must be fitted with dampers which can be opened or closed from the weather deck or the working platform.

VENTILATION OF CARGO TANKS

Ventilation of cargo tanks avoids over pressure or partial pressure conditions which could occur during loading and unloading of cargo. Temperature fluctuation during a voyage could have a similar effect. Vapour pipelines from the cargo hatch are led to pressure/vacuum relief which are usually mounted on a stand pipe some height above the deck. Individual vent lines are fitted for each tank for large tankers and a common venting line is led up a mast or sampson post on smaller vessel.

AIR CONDITIONING

Air conditioning systems may be divided into two main classes;

a) The central unit type in which the air is distributed to a group of spaces through ducting. It has the advantages of saving space, economy in pipe-work and minimal possibility of refrigerant leaking since the circuit is sealed in the factory.

b) The self contained unit types installed in the space it is to serve.

The central unit is the most widely applied in one or other of alternative systems characterized by the means provided to meet the varying requirements of each of the spaces being conditioned.

The systems in general use are as follows:

1) Zone control system – This is the most popular because of its simplicity. The accommodation is divided into zones having different heating requirements. Separated air heaters are provided at the central unit for each zone.

2) Double duct systems – In this system, two separate ducts are run from the central unit.

3) Reheat system – In winter, the air is preheated at the central unit, its temperature being automatically controlled. The air terminals are equipped with electric or hot water heating elements. This raises the temperature of the air to meet the demand of the individual set room thermostats.

DECK COVERINGS

The weather deck of a ship is exposed to very severe conditions of the weather elements prevalent in the sea and those caused by men, deck machinery and the fluids that may spill on it.

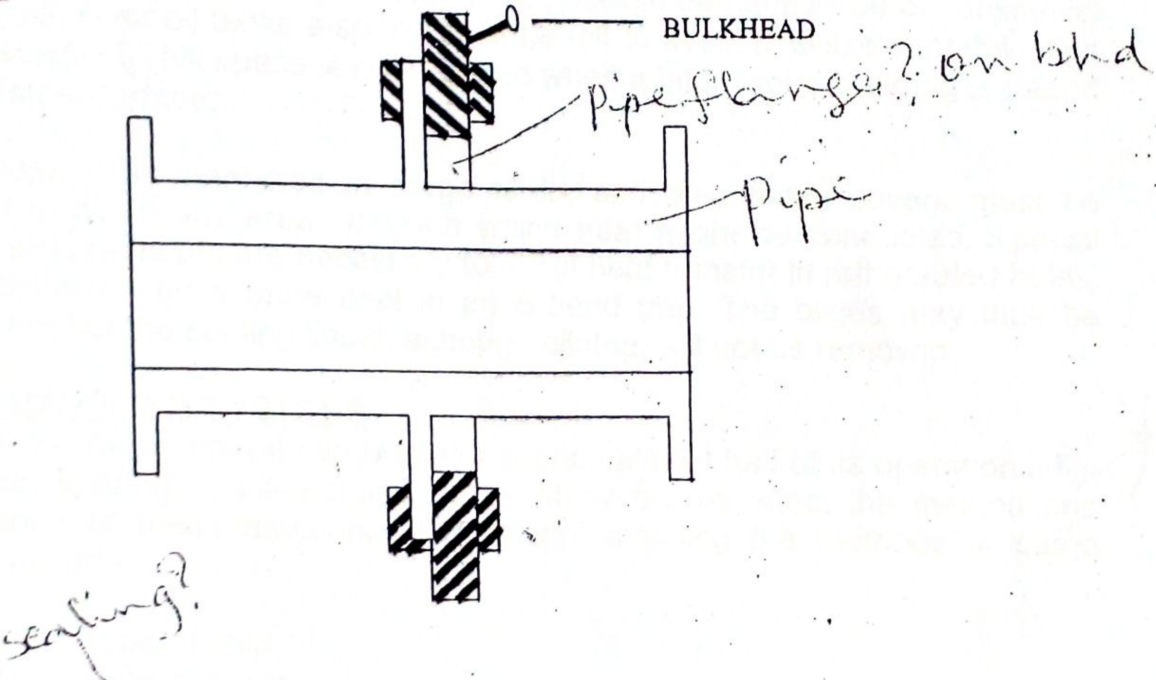
Therefore the paint for the weather deck requires exceptionally good resistance to wear and abrasion and some non-slip quality. The deck coating should also be resistant to any oils or chemicals carried as cargo or fuel. Initial protective coating topped by grit-reinforced oleo-resinous paints have been used successfully, as have primers and chlorinated rubber deck paints. Certain metallic final coats have been used with success, more particularly on naval vessels.

The constant abrasion on weather decks from traffic, cargo handling and general ship operations makes long-term protection by paint alone almost impossible. Self – sealing coatings utilizing epoxide resins are used on top of epoxide resin paint for a hard-wearing deck covering.

JOINER BULKHEADS, LININGS AND ~~CEILINGS~~ Sealings — Need to know

Pipes are carried through bulkheads by fittings such as shown. Joints between flanges should be of materials impervious to the fluids carried, e.g. compressed asbestos for steam; rubber, with or without cotton insertion for water; cork, fibre, cardboard or (best of all) liquored leather for oil. They may be sheathed with copper or stainless steel, sometimes grooved finely and lightly in the area adjacent to the pipe bore. Mating flanges should be parallel, bolts reasonably well fitted with good threads.

The diagram shows bulkhead piece for use when a pipe passes through a watertight bulkhead.



LININGS, CEILINGS AND INSULATION

Holds and tanks can be coated with epoxy, PVC and rubber coatings to resist a wide range of contents including abrasive materials. These will last a long time, perhaps for life, but in any case should not require re-coating more than two or three times, and probably little more than touching up.

INSULATION: A ship's steel hull and structure will conduct heat very well. In way of heated tanks, refrigerated spaces and exposed accommodation spaces, some form of insulation is necessary to reduce the heat flow to an acceptable level.

Various materials such as glass fibre, cork and some foam plastics are in use as insulation. Glass fibre matting or sheet is used in modern ships since it is easily fitted, is fire resistant, does not support animal life. The amount of insulation fitted in a compartment is decided by the temperature which is to be maintained or accepted in the comprtment.

Fastening is now largely by random pinning, using a stud gun to fix the pins to the steel work. The pins penetrate the insulation, and caps fitted on the ends of the pins hold the insulation in place. Some slab insulation may be glued to the steelwork. Joins between sections of insulation are sealed, usually with an adhesive tape. In accommodation spaces, insulation will be behind decorative panels. In places where it is exposed to possible damage, a protective cladding or lining, such as galvanized mild steel sheeting, may be fitted. Insulation on tanks tops must likewise be protected from possible damage or be of substantial nature itself. Over oil tanks a space must be left to avoid possible contamination of the insulation. This space is not required when a bituminous covering is placed over the steel surface.

Plugs over manholes in cargo tanks and also hatch covers must be insulated to avoid any areas through which heat might be conducted. Special scupper arrangements are necessary to avoid heat transfer in refrigerated holds. This is achieved by a brine seal in an S-bend trap. The bilges may thus be pumped out but the sealing liquid, although diluted, will not be removed.

CARGO HANDLING SYSTEMS

An average general cargo carrier spends almost half of its operational life at the port loading or discharging cargo. Many factors affect the method and performance of these functions. The factors affecting the methods of cargo handling include;

1) Type of ship
2) Type of cargo
3) The extent to which the ship and the port are equipped with cargo handling equipment – availability of cargo handling equipment.
4) Organization of cargo handling task.

The importance of fast and efficient cargo handling can not be overemphasized in the light of the fact that the cost of operating a ship at port is almost equal to that at sea. For optimal economic reasons, ship owners tend to reduce the time lapse between voyages. A positive step in this direction has been the introduction of container ships. The decision relating to the selection of the cargo handling system and optimum equipment is taken at the conceptual design stage of the ship. Some factors affect these decision and they are;

1) The type of cargo
2) The envisaged route of the ship

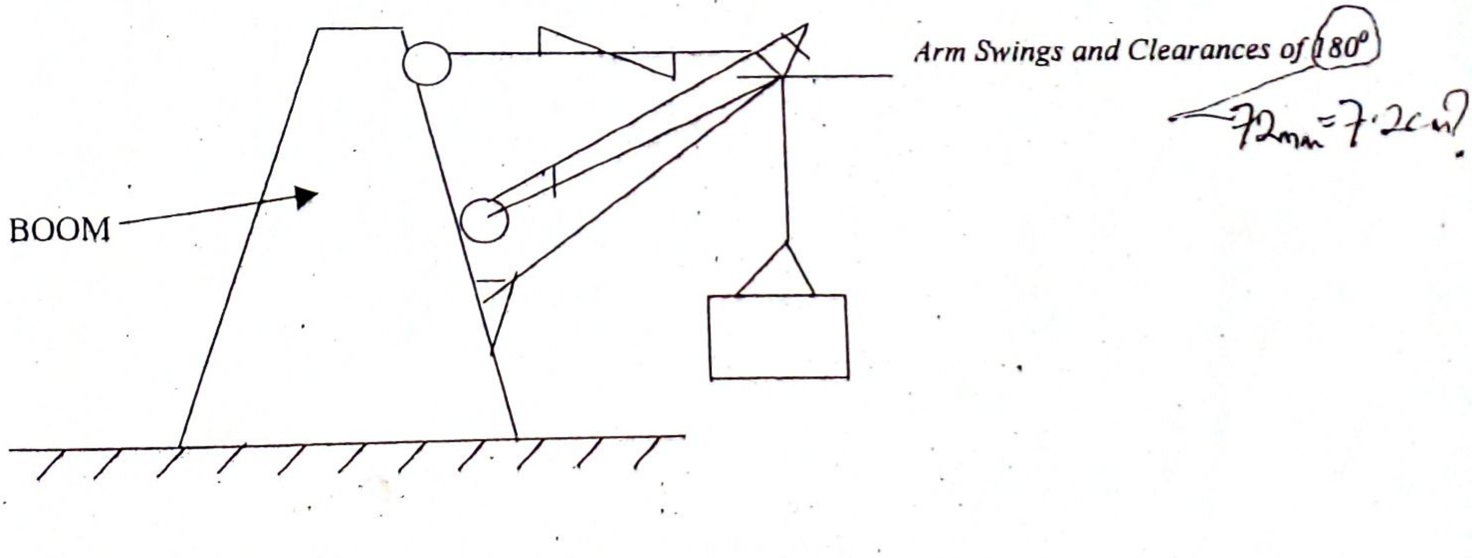
Having these two specified, the choice of systems becomes easier. It is more difficult to select cargo handling equipment for general cargo ships and without a specified route.

TYPES OF CARGO HANDLING EQUIPMENT

A basic ship cargo handling equipment is the Boom Derrick whose main advantage is the capability to handle a wide range of load (from a few thousands to some hundred thousands kilograms). Apart from this, deck cranes are also installed in modern ships. They could be rotating stationary cranes or rotating and moving cranes. The design and construction of deck cranes are similar to cranes on land. The only different problem the construction faces is defining the scope of the crane and installation criterion with regards to foundations and the conditions during sea journeys.

BOOM DERRICKS

A typical boom derrick consist of a boom hanging on a mast by a bearing, cargo cables and chains and shackles (made of wire ropes or synthetic ropes) adequately connected to cargo winch. The boom is held in position by the hoisting cable. Boom derricks can be classified into two categories – heavy and light. Heavy derricks load capability is above 100,000kg and light derrick load capability up to 10,000kg. 100Tons
10Tons



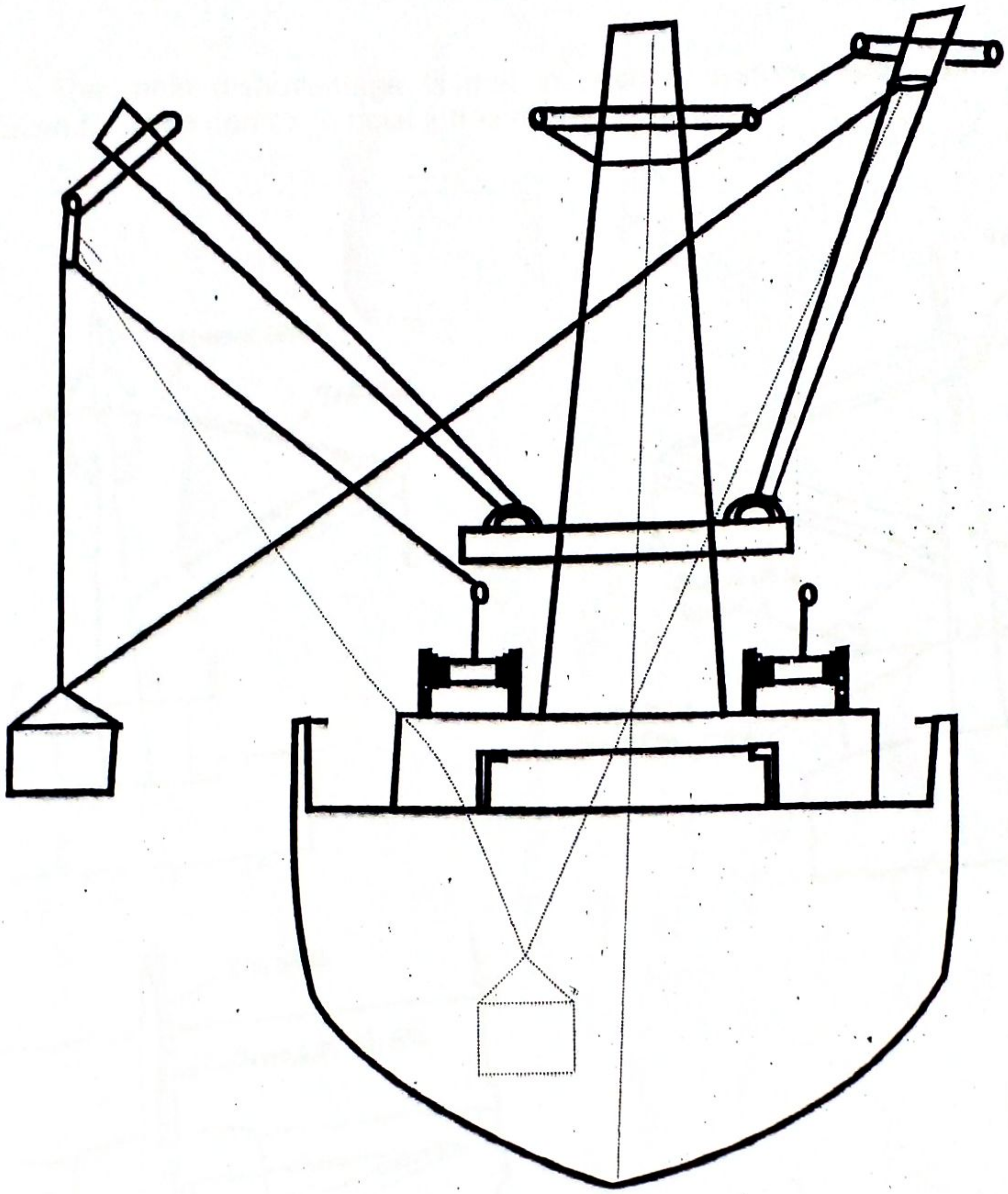
BOOM DERRICK

FIXED OUTREACH AND SLEWING SYSTEMS

The derricks may be arranged for fixed outreach working or slewing derricks may be fitted. A fixed outreach system uses two derricks, one "topped" to a position over the ship's side and the other to a position over the hold. The figure below shows the commonest arrangement adopted, known as Union Purchase Rig. The disadvantages of the fixed outreach systems are that;

a) If the outreach requires adjustment, cargo work must be interrupted
b) The load that can be lifted is less than the safe working load of the derricks since an indirect lift is used. Moreover considerable time and manpower is required to prepare a ship for cargo working.

Study on-line, the detailed working principle of a union purchase rig (fixed outreach systems & slewing systems)



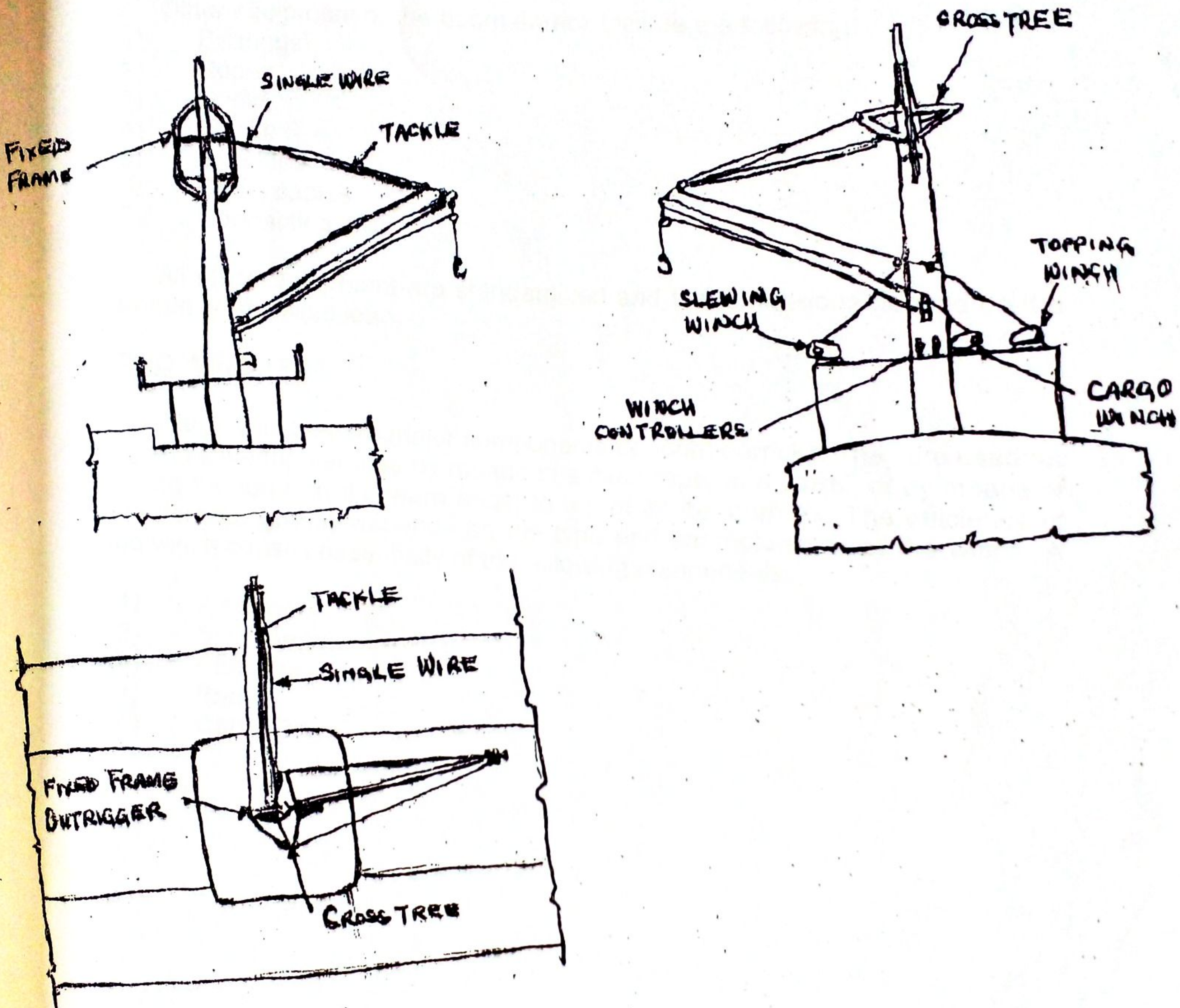
UNION PURCHASE RIG

The main advantages of the system are that only two winches are required for each pair of derricks and it has faster cycle time than the slewing derrick system.

The slewing derrick system, one type of which is shown below, has the advantages that:

a) There is no interruption in cargo work for adjustments and
b) Cargo can be more accurately placed in the hold.

The main disadvantage is that in such a system, three winches are required for each derrick to hoist luff and slew.



SLEWING DERRICK

Slinging?

COMPONENTS OF BOOM DERRICKS

BOOM: Boom are constructed using steel pipes essential constructional parameters include length of the boom.

Other equipment of the boom derrick include the following:

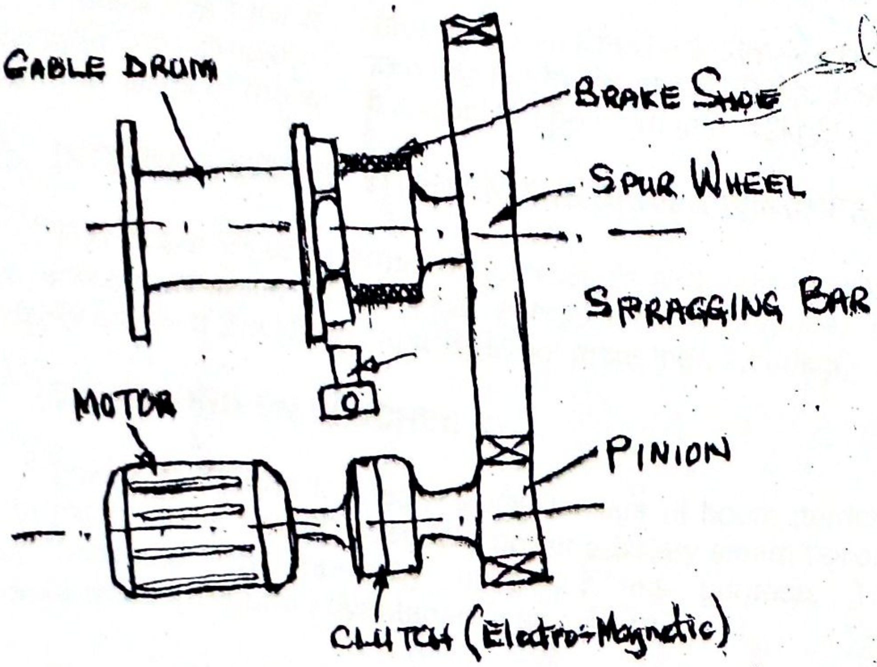
1) Bearings
2) Ropes
3) Hooks
4) Blocks
5) Shackles
6) Chain cables
7) Connecting links

All these equipment are standardized and the dimensions depend on the maximum permissible load.

CARGO WINCHES

Cargo winches are major components of boom derricks. They are used for lifting and lowering cargoes by means of a fixed rope on a barrel, or by means of whipping the load on the warp ends; to top of lift the derricks. The efficiency of boom derricks greatly depends on the type and characteristics of the winch. A cargo winch consist essentially of the following components:

1) A Motor
2) Spur Gear
3) Clutches
4) Brakes
5) Cable Drum



slide

TOPPING WINCH (SELF CONTAINED)

Mention the typ of cargo winche in relation to the drives. (i) Describe the method of any 3 of the briefly. 6

Cargo winches can be driven by the following means;

1) Manually
2) Internal Combustion Engine
3) Steam
4) Electrically
5) Hydraulically
6) Electro-Hydraulically

The increased use of separate topping winches on the various rigging systems has greatly improved the rather lengthy procedure of driving an unpowered lopping unit from a warp end or clutching – in a topping unit from a barrel shaft. The self-contained topping winch shown above makes use of an electromagnetic clutch, the control system providing for the clutch disengaging on failure of supply in which case, the spraying bar engages, thus failing safe. The disengagement of the motor from the gears also ensures that the high referred inertia of the motor is not transmitted to the barrel shaft and sprig gear when stopping the winch. These winches are normally fitted on the mast and can be controlled from any conveniently placed controller and interlocked such that the hoist winch control is inoperative when topping the derrick.

Types of winches :

1. HAND DRIVEN WINCHES

These are rare and found only in small primitively equipped ships. The hoisting (lifting) capacity is normally not more than 1,000kg. The force necessary to turn the crank of the winch should not be more than 12kgf.

2. INTERNAL COMBUSTION ENGINE DRIVEN WINCHES

These are used in small motor vessels and vessels without units which have enough sources of electrical energy for this purpose. The efficiency is generally low and the lifting capacity is not more than 1,500kgf.

3. STEAM DRIVEN WINCHES

These are found in steam ships, tankers (if boom derricks are installed) and in motor ships having adequate power auxiliary steam boilers. Two cylinder piston engines are normally used for this purpose. The operational characteristics are quite advantageous as follows:

a) Easy to regulate
b) Not sensitive to overloading
c) High reliability

The hoisting capacity could be up to 10,000kgf. And the velocity (although depending on the load) could be up to 60m/min. Presently, the commonest is the electrically driven cargo winch.

4. ELECTRICALLY DRIVEN WINCHES

These are installed in most modern ships irrespective of the type of propulsion. Until recently, direct current drives predominated. There are regulations regarding the characteristics of electrically driven winches in relation to hoisting or lowering unloaded booms or keeping loaded booms in position.

5. ELECTRO-HYDRAULIC DRIVEN WINCHES

Further development in winch drives is the Electro-Hydraulic drive, where an electric motor drives a hydraulic pump which supplies pressure fluid to a hydraulic motor that turns the shaft. These units are frequently self-contained and have good operating characteristics such as steeples speed regulation.

PARAMETERS CHARACTERISING THE OPERATION OF CARGO WINCHES

1. **Norminal lifting capacity:** This is the maximum allowable effective load to be lifted by the winch with rope stretched over two pulleys (blocks) of efficiency 0.295 each under norminal rating condition.

2. **Force on the winch drum:** This is force on the first layer of rope wound on the drum under norminal rating conditions. This is usually taken as 1.1 of the norminal lifting capacity.

3. **Lifting velocity (cargo lifting velocity at norminal lifting capacity):** This is the velocity of winching the ropes of the first layer of the winch drum under norminal load.

4. **Lowering velocity:** This is the constant velocity at which the cargo is lowered at norminal rating. It is the velocity of the rope released on the first layer of ropes on the drum under norminal load.

THEORETICAL OPERATING CYCLES OF A CARGO WINCH

1) Hanging of load on the hook
2) Moving the cargo
3) Removing load from hook
4) Moving hook without load

THE EFFICIENCY OF A WINCH

This is the ratio of the product of the Norminal Pull and the Norminal Velocity to the Shaft Power of the Drive.

DECK CRANES

Derricks have been replaced on modern cargo ships by deck cranes mounted on platforms between the holds. The deck crane provides an immediately operational cargo-handling device with minimal rigging requirements and simple, straightforward one-man operation. The safe working load of the crane is determined by its cargo-handling duties, and designs are available up to 50 tonnes as required. Double gearing is a common feature of some of the larger cranes to enable speedier handling of lighter loads. Three basic types of cranes are available:

a) General Cargo Cranes
b) Grabbing Cranes and
c) Twin – Crane arrangements

The general cargo crane is for use on cargo ships and bulk carriers. The grabbing crane is for use with a mechanically – operated grab when handling bulk materials. It requires a multiple – wire arrangement for the operation of the grab.

Twin cranes utilize standard cranes mounted in pairs on a common platform which can be rotated through 360°. The cranes can be operated independently or locked together and operated as a twin – fib crane of double capacity, usually to give capacities of up to 50 tonnes. A single operator is usual with this system by utilizing a master and slave control system in the two cranes. The use of a common revolving platform makes this arrangement possible. On container ships using ports without special container handling facilities, cranes with special container – handling gear are essential. Ships specializing in carrying very heavy loads, however, are invariably equipped with special derrick systems such as the "Stulken". These derrick systems are capable of lifting loads up to 500 tones.

CONTAINER HANDLING

The development of container ships and loading methods have been from the 'Sea Train' of 1928, through intermediate stages such as the 'Piggyback' and 'Seatainer' system and related methods of moving 'packaged' cargo such as Roll-on Roll-off ('Ro Ro') systems, Pallet Deck, and those based on barges such as the "Lash" and Sea Barge 'Clipper' projects. Other possibilities are open 'Floating Dock' systems and 'Ware house' type designs.

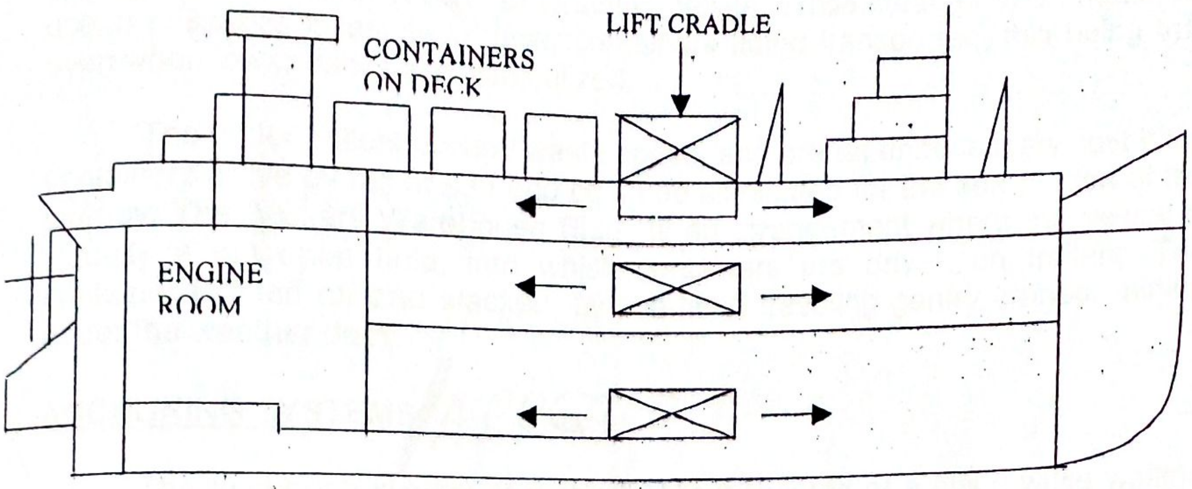
The ultimate development is the 'Lautovick' system which can be completely automated, provides facilities for sorting containers by computer control, and enables continuous loading to proceed with simultaneous loading and discharge. Moreover, in locations where dockside space for pre-assembling is limited the system can be installed in multi-storey warehouse.

It has generally been accepted that reduction in door-to-door transport cost can come about only through containerization.

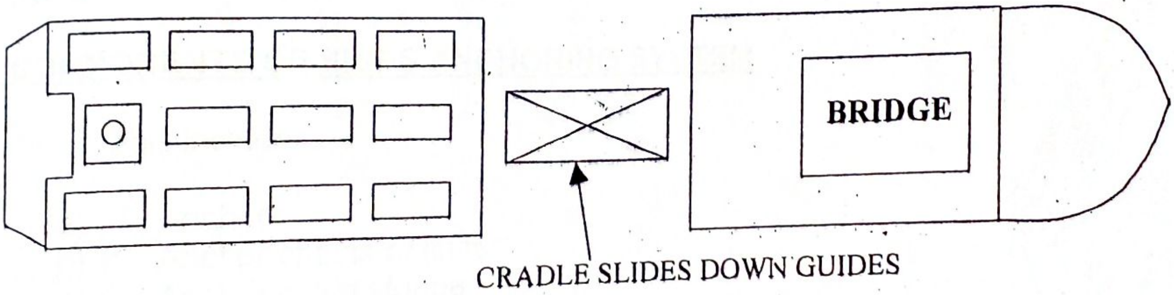
Standard container sizes (Internationally adopted through I.C.H.C.A. and B.S.S. 3951 of 1965) range up to 30ft. x 8ft. x 8ft. having a loaded weight of 25 tons. The average weight of a unit load with conventional break-bulk cargo presently handled with ships' derricks, ranges from 2 to 3 tons according to trade. It is therefore obvious that an entirely new type of handling system is necessary to cope with containers.

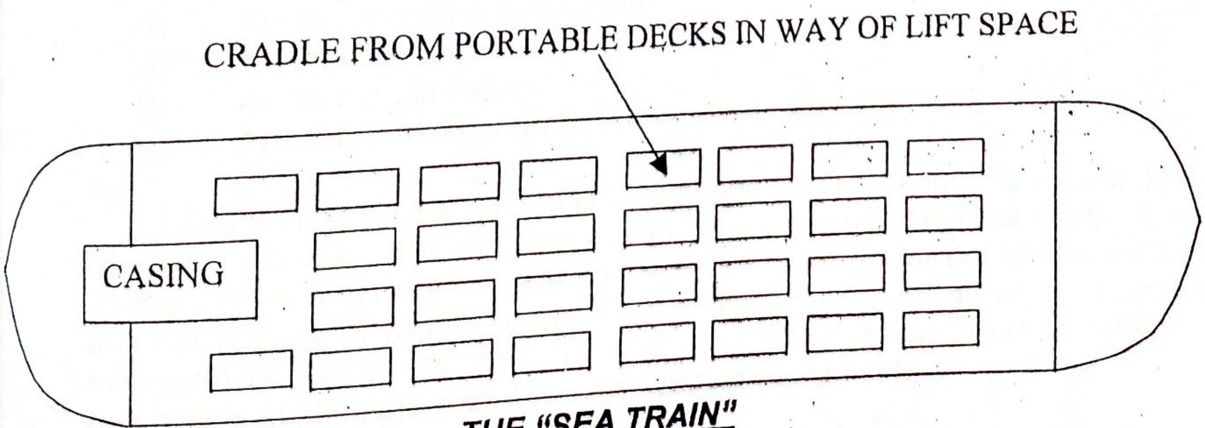
LIFT – IN METHOD

As shown in figure below, containers are loaded by shore – based gantry crane onto four lift cradles located amidships in the vessel; the container are off-loaded from the lift at weather deck, two twin decks, or tank top, and moved forward and aft on roller. Motive power for hauling containers is supplied by winches and ropes.



CONTAINERS MOVED FORWARD & AFT FROM LIFT CRADLE BY WINCHES ON ROLLERS





THE "SEA TRAIN"

The single loading point restricts turnaround time, and extra labour is involved in moving containers forward and aft.

ROLL-ON/ROLL-OFF METHOD (Under Cargo Handling System)

The ship with the fastest turnaround is the 'Ro – Ro' or trailer ship, loading containers on shallow trailers, or wheeled pallets. While ideal for short hauls, for ocean passages it results in fewer containers being transported, this being true even when lower decks are also utilized.

The trailer pallets occupy waste space, and are an unnecessary cost if the containers arrive by rail or sea and could be eliminated for the sea portion of the journey. The 'Vickers Warehouse Ship', is an arrangement where the vessel is virtually a big open hold, into which containers are driven on trailers. The container is lifted off and stacked, by overhead traveling gantry cranes, mining under the weather deck.

ANCHORING SYSTEMS/ARRGTS

The anchoring system of a ship keeps it secured at a place while waiting for clearance at the port or through a canal or in the open sea such as during break downs. They are also used to help during ships maneuver in canals and rivers.

COMPONENTS OF SHIPS ANCHORING SYSTEM

This includes:

a) Anchor
b) Anchor chains or lines
c) Anchor chain stopper
d) Anchor windlass or capstan
e) Chain container
f) Anchor chain release
g) Anchor derricks (only in some special ships).

Depending on the type of ship, tonnage and the route, there exist different constructions of anchor equipment. The horizontal component of the force acting on the anchor does not depend on the depth of the water but on the wind force and the velocity of water current. The vertical component however depends on the depth of water and the weight of the anchor chain. There are rules and regulations guiding the selection of anchoring equipment.

DETERMINATION OF THE BASIC CHARACTERISTICS OF ANCHORING EQUIPMENT

The type of anchoring equipment installed in a ship is determined by an indicator which whose value differs from one classification society to another. This indicator is known as Equipment Number (EN). For Lloyds Register of Shipping, equipment number is expressed as

$$EN = \Delta^{2/3} + 2Bh + A/10$$

Where:

Δ	=	moulded displacement in tonnes to the summer load waterline
B	=	Greatest mouled moulded breadth in meters
h	=	freeboard amidships in meters from the summer load waterline to the upper deck plus the sum of height at the centre line in metres of each tier of houses having a breadth greater than B/4.
A	=	Area in square metres, in profile view of the hull, within the Rule length of the vessel, and of superstructures and house above the summer load waterline, which are within the rule length of vessel, and also having a width greater than B/4.

In the sheer view of the hull within the whole length of the vessel and of the superstructure and deck houses above the summer load water line, the value of h is determined.

From the calculated values, the following parameters are determined;

a) Number of Bower anchors
b) Weight of the Bower anchors
c) Weight of Stream (side) anchor
d) Length of anchor chain cable
e) Length and strength of anchor cables
f) Callbre of anchor chains (internal diameter of chain).

For big and intermediate size ships there must be three Bower anchors. Two at the bow locked up and a spare. The third which is the spare may not necessarily be equipped in ships without limited route. The weight of a bower anchor must be at least.

$$Q = K.EN$$

Where:

EN = equipment number
Q = weight of anchor
K = coefficient depending on the route of the vessel

BOWER ANCHOR CHAINS

The total length of both bower anchor chain should be at least.

$$L = 87.r \times \sqrt[4]{EN}$$

Where:

L = total length of chain in meter

r = coefficient depending on the route

EN = equipment number

Under no circumstance should the total length of both anchor chains be less than 200 meters for ships of unrestricted routes.

The norminal anchor pull is calculated from:

$$P_A = a.\ m.\ d^2\ [KG]$$
$$= 9.81\ a.\ m.\ d^2\ [N]$$

Where:

m = coefficient dependent on the strength of the chain

d = caliber of the chain

a = coefficient dependent on the caliber of the chain

$a = 2.8$ for $d \leq 22mm$

$a = 3.0$ for $22 \leq d \leq 29mm$

$a = 3.4$ for $29 \leq d \leq 35mm$

$a = 3.6$ for $d > 35mm$

For drive selection the following formula is used:

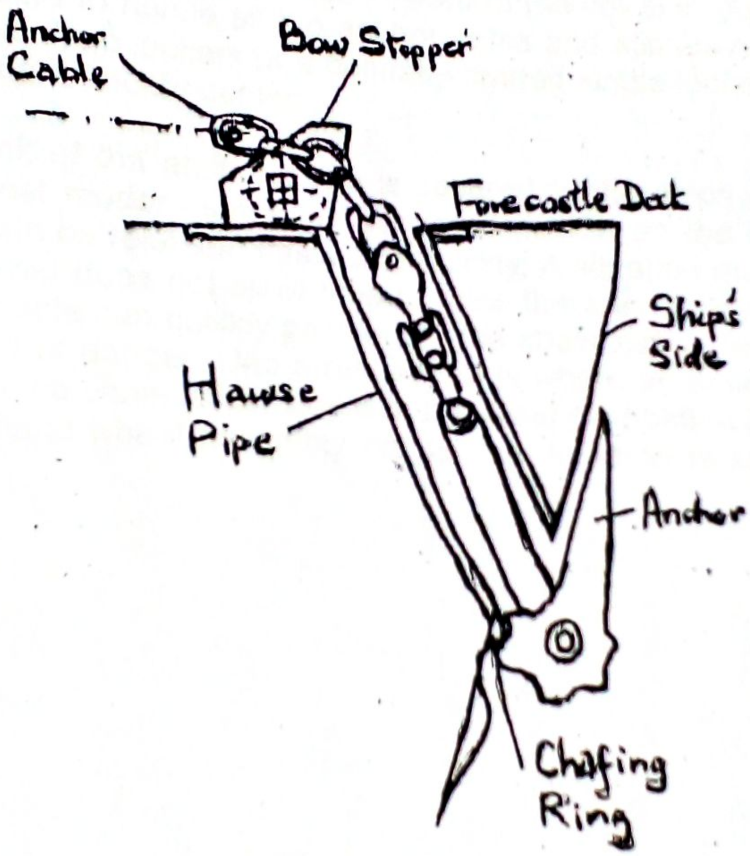
$$N = \frac{P_A \times V_M}{6120 \times \gamma}$$

$$N = \frac{P_A \times V_M}{6120 \times \gamma}$$

Where:

N = power of drive, γ = efficiency of the system, P_A = Nominal anchor pull

The forecastle deck houses the windlass or windlasses which raise and lower the anchor and cable, various items of mooring equipment, such as bollards, fairleads, etc are also arranged around the deck edge. The anchors are housed against the forward side shell sometimes in specially recessed pockets. The anchors cables passes through the shell via the hawse pipe on the forecastle deck. It travels over the cable stopper and onto the windlass cable lifter drum. From the cable lifter it drops vertically down into the chain locker below.



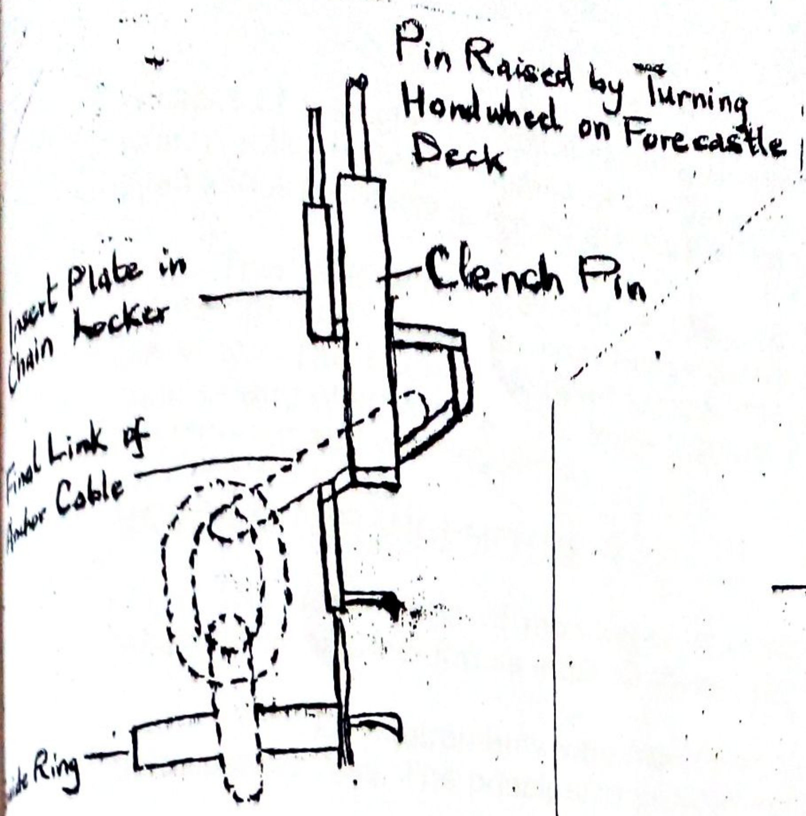
The hawse pipe is fitted to enable a smooth run of the anchor cable to the windlass and to maintain the water tightness of the forecastle. A rubbing or chafing ring is also fitted at the end side shell. A sliding plate cover is shaped to fit over the cable and close the opening when the ship is at sea.

The chain, cable or bow stopper is fitted on the forecastle deck in line with the run of the anchor cable. It is used to hold the anchor cable in place while the ship is riding at anchor or the anchor is fully housed. In this way the windlass is freed and isolated from any shocks or vibrations from the cable. The stopper is not designed to stop a moving cable, but only hold it in place. One type is shown and consists of a fabricated structure of heavy plate with a roller which the cable passes over. A hinged bar is designed to fall between two vertical links and hold the cable in place.

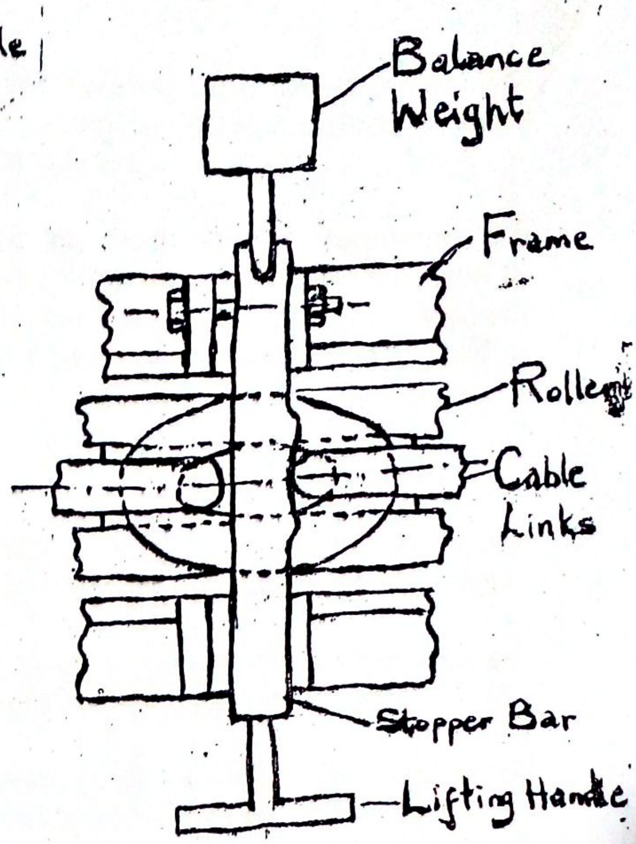
The windlass is the lifting device for the anchor cable or chains and is also used for mooring and winching duties. Various drums or barrels can be "clutched in" to perform the different duties.

The chain locker is normally fitted forward of the collision bulkhead. It is of dimensions adequate to house all the anchor cable and still leave considerable empty space above. Two lockers or a centrally divided single locker are fitted for the port and starboard anchor cables.

The final link of the anchor cable is secured to the ships structure by a clench pin. On most modern ships this pin is positioned on the outside of the chain locker and can be released easily and quickly. A situation may arise where the safety of the ship does not allow time to raise the anchor. By releasing the clench pin all the cable can quickly pass out of the chain locker, leaving the ship free to proceed out of danger. One arrangement is where an insert heavy plate pocket is fitted into the chain locker side with a vertical pin holding the final link of anchor cable. A hand-wheel assembly on deck is used to raise the pin and release the link.



ABLE CLENCH ARRANGEMENT



PLAN VIEW OF BOW STOPPER

The winches and windlasses positioned on the forecastle and poop decks and sometimes the upper deck perform the mooring and warping duties required by the ship when arriving and departing its various ports of call. Various fittings are provided on the deck and around the deck edge to assist in the mooring operation and provide a clear run or lead for the mooring and warping wires. Examples of these fittings are bollards and the various types of fair lead which are found on board ships.

The windlass has warping ends which are used when mooring the ship. One or more warping winches are fitted on the poop deck aft for similar duties. Larger vessels have mooring winches fitted on the upper deck also. Bollards or mooring bits are used to moor the ship once it is alongside.

Fair leads are used to guide the hawsers or mooring wires to the bollards or mooring winches. Fairleads are attached to the deck, a raised seat or the deck and the bulwarks. Several different types are to be seen such as the multi-angled fairlead and two, the pedestal fairlead, the roller fairlead and the panama fairlead. A multi-angled fairlead consists of two horizontal and two vertical rollers with the wire passing through the hole between the rollers. A pedestal fairlead consists of a single horizontal or vertical roller mounted on a raised pedestal or seat. A roller fairlead is almost an elliptical opening formed in a casting which is fitted into a suitability stiffened aperture in the bulwark.

The multi-angled fairlead is fitted at the deck edge and reduces the number of guide rollers or other fairleads required to give a clear lead of wire to the winch. The pedestal fairlead guides the wire across the deck to the winch clear of any obstructions. The roller fairlead is used at the deck edge to lead in the mooring and warping wires.

MOORING ARRANGEMENTS

The basic need of mooring is to retain a vessel in the berth under the influence of external forces such as those resulting from wind and water currents.

Mooring requirements vary much from berth to berth due to different types of jetties/wharves. The principal requirements for mooring equipment are:

1. It must provide the necessary strength and be suitably positioned to heave a vessel into her berth without putting excessive strain on the equipment and without requiring an undue number of men in attendance.
2. The equipment must be able to retain a vessel in her berth under adverse weather conditions and under additional influence of currents without risks of damage to such equipment.
3. The equipment must be sufficiently flexible to meet the requirements of various types of berth taking into account also conventional and single buoy mooring berths.
4. The equipment must also meet any specific requirements applicable to a vessels specialized trade (Panama requirements etc).

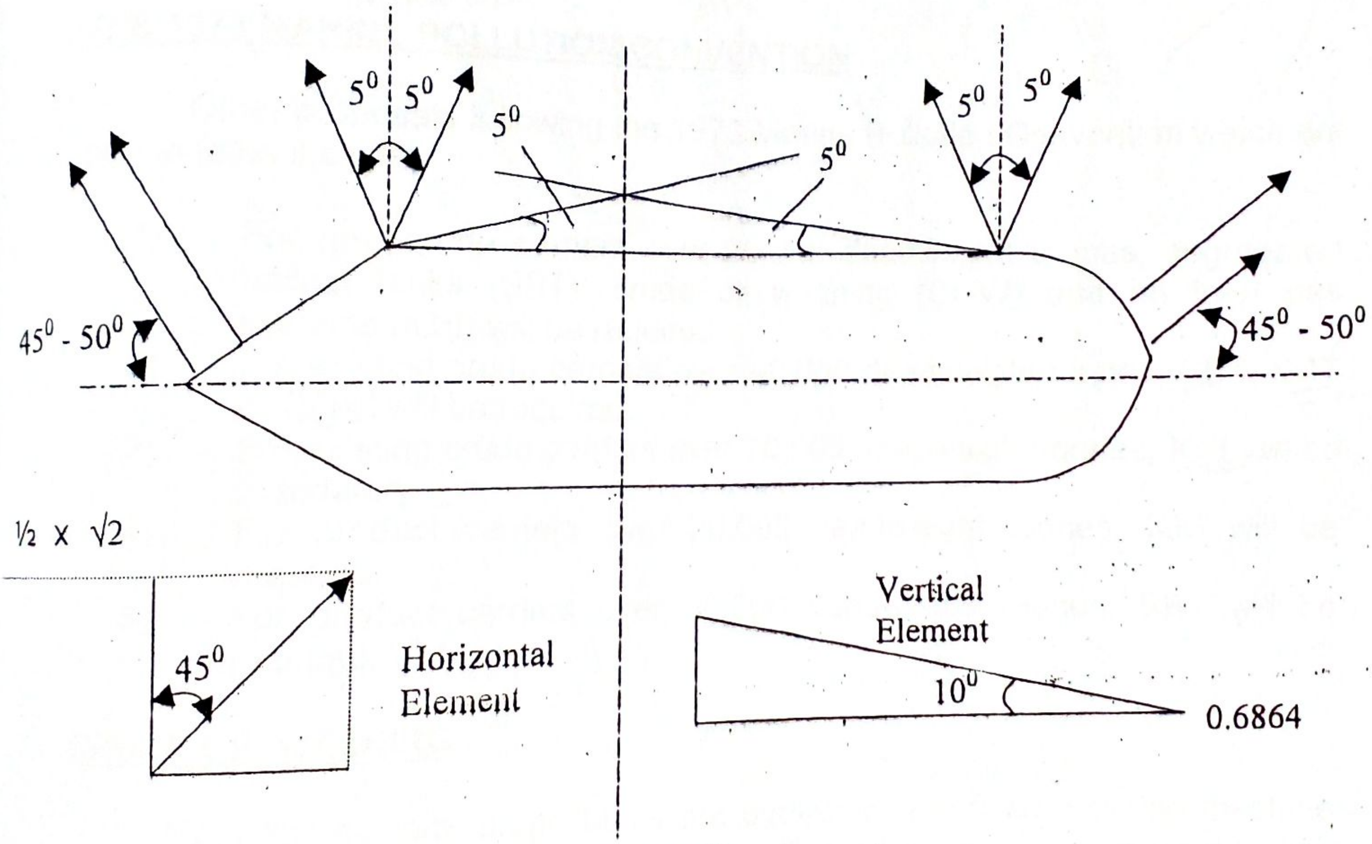
BERTHING PROCEDURE OF SHIPS

Most vessels make use of at least some ropes or wires when being positioned into the berth. Such equipment may either be used to heave a vessel into the berth completely unassisted by tugs or simply to check any forward or aft movements. For instance when being positioned along a quay side with limited fore and aft clearance from other vessels. Ropes are also used from time to time to heave vessel away from a lee shore berth by means of holding off buoys or possibly maneuver vessels into narrow dock entrances.

Under such dynamic conditions, mooring forces may be totally unrelated to the size of the vessel and mooring equipment can never be designed to withstand the force that may result from an unsea – man-like maneuver. Basically therefore, the maneuver should be proportioned to the availability of mooring equipment rather than attempt to meet such dynamic forces by providing equipment in excess of what would normally be necessary for the purpose of holding tactically into her berthing position..

APPROXIMATE LOADS FOR MOORING WINCH

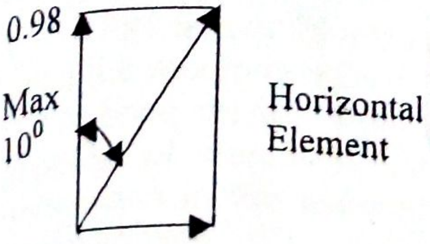
VESSEL SIZE (TONS DIV)	TO OVERCOME WIND (TONS)	TO OVERCOME WATER RESISTANCE (TONS)	TOTAL REQUIRED PER WINCH (TONS PER ROPE)
18 – 23,000	9	3	6
35,000	13	5	9
47 – 53,000	18	6	12
63 – 65,000	20	7	14
80,000	24	10	17
100,000	28	12	20
120,000	32	14	23
160,000	40	20	30

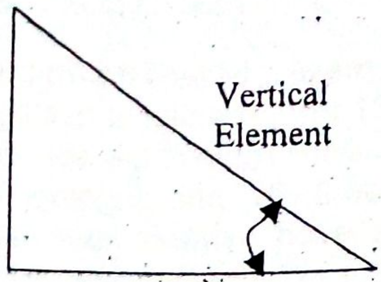


HEAD AND STERN MOORING FORCES

Transverse Holding Power = 0.686 Rope Strength

∴ Taken in calculations: 0.5 x Rope Strength





Abreast Lines Forces

Bilge

Transverse Holding Power = 0.85 Rope Strength

∴ Taken in calculations: 0.8 x Rope Strength

INTERNATIONAL CONVENTIONS

MARPOL

THE 1973 (MARINE POLLUTION) CONVENTION

Other proposals following the 1973 Marine Pollution Convention which are now in force include:

1) For new crude carriers over 20,000 deadweight tonnes, segregated ballast tanks (SBT), crude oil washing (COW) and an inert gas systems (IGS) will be required.
2) For existing crude carriers over 40,000 deadweight tonnes, CBT, SBT or COW will be required.
3) For existing crude carriers over 70,000 deadweight tonnes, IGS will be mandatory.
4) For product carriers over 20,000 deadweight tonnes, IGS will be required.
5) For product carriers over 30,000 deadweight tonnes, SBT will be required.

CRUDE OIL WASHING

With this system, cargo tanks are equipped with fixed washing machine through which crude oil (cargo) is pumped. The oil spray impinges on the tank extremities and frees the sludge which has separated out during shipment. Crude oil washing can therefore mean more efficient discharge of cargo, while also being a useful aid to the load – on – top cleaning system.

THE 1974 INTERNATIONAL CONFERENCE ON THE SAFETY OF LIFE AT SEA (SOLAS)

Fire at sea is an ever-present and much feared hazard. For passenger ships the recommendation, rules and regulations following the 1974 International Conference on the safety of life at sea are extensive. They cover the many aspects of detection, restriction and extinguishing of fires. Cargo ships, particularly in the accommodation areas, must likewise have arrangements to deal with fires.

The arrangements for fire protection, by virtue of details of arrangement of construction, as detailed in the 1974 International Conference on safety of life at sea and Lloyd's rules, are applicable to passenger ships carrying more than 36 passengers and cargo ships of more than 4,000 tonnes gross. The following principles are the basis of the regulation;

1) The use of thermal and structural boundaries to divide the ship into main vertical zones.
2) Thermal and structural boundaries are used to separate the accommodation spaces from the rest of the ship.
3) The use of combustible material is to be restricted.
4) Any fire should be detected, contained and extinguished where it occurs.
5) Access must be provided to enable fire fighting and a protected means of escape.
6) Where inflammable cargo vapour exists, the possibility of its ignition must be minimized.

Consultation between the societies takes place on matters of common interest through International Association of Classification Societies (IACS).

THE 1966 INTERNATIONAL LOAD LINE CONVENTION (ILLC)

Freeboard is the distance measured from the waterline to the upper deck of the deck plating at the side of the freeboard which must be indicated on the ship's side by a special load line mark. This minimum freeboard is a statutory requirement under the Merchant Shipping (loadline) Rule of 1968. These rules are based on the 1966 International Loadline Convention called by IMCO and ratified by each of the countries taking part.

A minimum freeboard is required principally to ensure that the ship is sea-worthy when loaded. The minimum freeboard provides the ship with reserve buoyancy which enables it to risk as it passes through waves and thus remain largely dry on its deck. This reserve buoyancy also improves the vessel's stability and in the event of damage will enable it to remain afloat indefinitely or at least for a time, to effect the escape of the crew.

The assignment of freeboard, follows a calculation which considers the ship's length, breadth, depth and sheer, the density of the water and the amount of watertight superstructures and other features of the ship. Additional conditions of assignment are also made relating to certain openings and fittings. The ship is assigned a minimum free board on the assumption that it is correctly loaded, with adequate stability and strength. A number of terms and dimensions are used in the computation of freeboard.

In order to assign freeboards, ships are divided into type A and B. Type A ships are those designed specifically for the carriage of liquid cargoes in bulk. The cargo tanks have only small openings for access which are closed by watertight covers of adequate strength. Type B ships are all those which are not of Type A. The greater freeboard required for the Type B ship may be reduced in certain circumstances.

THE 1969 TONNAGE CONVENTION

The tonnage values, the gross and the net, are used. The various positions and extent of measurements of length, breadth and depth are defined and differ slightly from the British tonnage system. Excluded spaces, a cargo space and other terms are clearly defined. The gross tonnage is computed from an empirical formula, the terms of which relate to the defined tonnage distances or to constants which are determined from formula given. Net tonnage is similarly found by another empirical consisting of measurements and constants. The convention advocates the use of the terms 'LIMB GROSS' and 'UMS NET' as dimensionless values instead of gross and net tonnage in tons. The acceptance of this convention will remove the tonnage mark scheme which has been the subject of much controversy.

IMO

The international nature of sea borne trade has led finally to the organisation of an international body to provide intergovernmental co-operation on matters concerning ships, shipping and the sea. Under the auspices of the United Nation, the International Maritime Organisation (IMO) was formed. Following its formal approval by 21 states, the first assembly met in London in 1959.

IMO is responsible for carrying out many studies, producing detailed recommendations, developing standards and providing, following conventions mandatory requirements for ship construction, outfitting and operation. The requirements such as those of the 1974 International Convention for the safety of life at sea only becomes mandatory when adopted by the government of the vessels registered country. Some of the many areas of involvement by IMO can be listed as:

1) Navigation equipment
2) Life-saving equipment
3) Personnel training
4) Tanker construction and equipment
5) Fire safety in ships
6) Radio communications
7) Search and rescue techniques
8) Subdivision and stability
9) Carriage of dangerous goods
10) Marine pollution

Items (4) and (5) will now be examined in some detail, since they embody many aspects affecting the construction of merchant ships.

The construction and equipment of oil tankers will continue to be a source of much investigation since large quantities of oil have been, and are still being discharged from damaged or foundered ships. Efforts are being made with the object of preventing or limiting pollution of the sea (and shore) by oil. Two approaches are currently being adopted. The first deals with preventing the escape of the cargo oil in the event of collision or grounding. The second approach is to attempt to limit sizes of centre tanks and wing tanks.

The first arrangement utilized segregated or clean ballast tanks (SBT or CBT). Proposals for the fitting of double – bottom tanks over the cargo tank length and wing ballast tanks have been put forward. These tanks are to be segregated, i.e. for the carriage of clean water ballast only. The second method aims at restricting cargo tank sizes to 50,000m^3 for centre tanks and 30,000m^3 for wing tanks. This would limit the extent of pollution in the event of damage to a particular tank.

COMPUTERS

These can take two form: The special purpose computer for solving specific problems and the general purpose computer for handling such jobs as spares and stores inventory and reordering control, crew wages, log abstracts, etc.

A typical example of the special purpose computer is already aboard many ships in the form of the loading calculator or stress finder. This equipment allows ship officers to rapidly and accurately calculate the bending moment and shear force stresses to which the hull will be subjected due to any desired state of loading. Computers are used to assist the officer to make the fullest possible use of his radar.

Techniques already exist whereby a computer can be used as part of the radar system to receive data on a specific number of targets. Compute which targets offer a collision risk, calculate the best possible evasive action and display this information to be read-off by the navigating officer. Such a computer can calculate up to (or more than) five alternative evasion actions and leave the navigator the final choice as to which action he will adopt.

automated systems

ORGANIZATIONS AND REGULATIONS

The construction of merchant ships is considerably influenced and regulated by a number of organisations and their various requirements.

Classification societies, with their rules and regulations relating to classification, provide a set of standards for sound merchant ship construction, practical knowledge and considerable research and investigation.

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The International Maritime Organization (IMO formerly IMCO) is an international organization which is attempting to develop high standards in every aspect of ship construction and operation. It is intended ultimately to apply these standards internationally to every ship at sea.

A vast amount of legislation is applied to ships and is usually administered by the appropriate government department.

CLASSIFICATION SOCIETIES

A classification society exists to classify or arrange in order of merit such ships as are build according to its rules or are offered for classification. A classed ship is therefore considered to have a particular standard of seaworthiness. There are classification societies within which most of the major maritime nations of the world and some are listed below:

Distinguish b/w classification Societies & Regulatory Authorities

1) Lloyd's Register of Shipping (UK)
2) American Bureau of Shipping (USA)
3) Bureau Veritas (France)
4) Det Norske Veritas (Norway)
5) Germanischer Lloyd (Germany)
6) Registro Italiano (Italy)
7) Register of Shipping (USSR)
8) Nippen Kaifi Kyodai (Japan)
9) NIMASA (Nigeria)

(Nigerian Maritime Administration & Safety Agency)

SUMMARY OF SAFETY PRECAUTIONS

a) Read label on containers and follow instructions.

b) Never store pesticides of any kind in accommodation, where people sleep, or prepare, store or eat food.

c) Never eat or smoke while using pesticides.

d) Never re-use empty containers.

e) After using pesticides always wash hands.

f) When spraying insecticides wear protective clothing, gloves, respirators and goggles appropriate to the pesticide being used and do NOT remove while working under hot conditions.

g) If clothing becomes contaminated, stop work immediately and leave area, remove clothing, take a shower, wash skin thoroughly and wash clothing.

h) After work, remove and wash clothes and other equipment, and take a shower using plenty of soap.

i) Follow strictly the requirements of the fumigator before fumigation, and do not enter a fumigation area until it has been certified safe to do so.

j) If fumigation has been commenced in port with aeration to be carried out while on passage, the master must be provided by the fumigator with written instructions, which must be carefully followed, regarding ventilation and tests to be carried out before crew are allowed to re-enter spaces fumigated. It is necessary in an emergency for crew members to enter a hold containing gas or containers under gas, not less than two men must enter together and they must be adequately protected with approved breathing apparatus lifeline and harnesses, ready for use where appropriate.

NAVIGATION AIDS (NAVAIDS)

If a pre-world war II cargo tramp or tanker is considered from the point of view of navigational equipment, it is found that the following items were in general use:

1) Standard magnetic compass
2) Radio
3) Steering control by hydraulic telemotor — Not a NavAid
4) The sextant
5) Chronometer — Clinometer
6) Tables and charts
7) Hand sounding device and
8) Ship speed log of the stern trailing propeller type

D/DX. Chronometer & Clinometer & Inclinometers

By comparison, a similar class of vessel in the post-war period would carry the following additional equipment as standard aids to navigation:

1) Master Gyro compass
2) Repeater compass system
3) One or two radar sets incorporating north-up presentation and frequently true motion

Radio Aid to Direction And Range

4) Automatic steering — Auto-pilot eqpt
5) Electric steering control
6) Speed log of pressure – or propeller – type extending through the ship's bottom and incorporating electric transmission to the bridge including speed input to true motion radar
7) Echo – sounding equipment
8) Decca navigator and
9) Loran — Long Range Navigation

The above stated equipment are standard on modern ships, and there exist an ample possibility of future advancement in the provision of navigation equipment on board merchant vessels some of which are given below.

INERTIAL NAVIGATION SYSTEM

Possibly the most interesting development in the near future will be the wide spread use of inertial navigation in merchant ships. At present they are used in naval vessels and in their present form are highly complex and very expensive. They however, have some great advantages not available to the navigator by any other means.

Inertial navigation does not rely on receipt of data transmitted by external radio frequency transmitters, such as used for Decca navigator and Loran systems. It senses the ship's position and gives a continuous read-out of altitude, longitude and actual ship speed over the ground as well as heading information from data readily obtained within the vessel; i.e. gravity force, earth rate of turn, true north heading, whip motion accelerations and accurate time base. Such a system will therefore continue to function even if all radio frequency transmissions are distorted, interrupted, beyond receiver range or permanently cut-off due to hostile action. It has a further advantage of being able to operate in a totally submerged vessel. This is very important for military vessels and may become important for merchant service if cargo-carrying submarines ever become economically feasible.

POWER UNITS

Two types of hydraulically powered transmission units or steering gear are in common use;

a) The ram type and
b) The rotary vane type.

RAM TYPE

Two particular variations, depending upon torque requirements, are possible, the TWO-RAM and the FOUR-RAM.

The rams acting in hydraulic cylinders operate the tiller by means of a swivel cross back fork of the rams. A variable delivery pump is mounted on each cylinder and the slipper ring is linked by rods to the control spindle of the telemotor receiver. The variable delivery pump is piped to each cylinder to enable suction or discharge from either. A replenishing tank is mounted nearby and arranged with non-return suction valves which automatically provide markup fluid to the pumps. A by-pass valve is combined with spring loaded shock valves which open in the event of a very heavy sea forcing the rudder over. In moving over, the pump is actuated and the steering gear will return the rudder to its original position once the heavy sea has passed. A spring loaded return linkage in the tiller will prevent damage to the control during a shock movement.

During normal operation one pump will be running. If a faster response is required, for instance in confined waters, both pumps may be in use. The pumps will be in the no-delivery state until a rudder movement is required by a signal from the bridge telemotor transmitter. The telemotor receiver cylinder will then move; this will result in a movement of the floating level which will move the floating ring or slipper pad of the pump, causing turning of the tiller and the rudder. A return linkage or hunting gear mounted on the tiller will reposition the floating lever so that no pumping occurs when the required rudder angle is reached.

The four-ram steering gear basic principles of operation are similar to the two-ram gear except that the pump will draw from two diagonally opposite cylinder torque and the flexibility of different arrangements in the event of component failure. Either pump can be used with all cylinders or with either the two port of two standard cylinders.

The use of a control valve block incorporating rudder shock relief valves, pump isolating valves, ram isolating and by-pass valves, offers greater flexibility with a four-ram steering gear. In normal operation on pump can operate all cylinders. In an emergency situation the motor or a pair of hand pumps could be used to operate two port rams, two starboard rams, tow forward rams or two aft rams.

The crashed arrangement on the four-ram type steering gear described incorporates what is known as the "Rapson slide". This provides a mechanical advantage which increases with the angle turned through. The cross head arrangement may use either a forked tiller or a round ram tiller. Each pair of rams is joined so as to form a double bearing in which the trunion arms of the crosshead are mounted. The straight line movement of the rams is thus converted into an angular tiller movement. In the forked tiller arrangement the ram movement is transferred to the tiller through swivel blocks.

To charge the system with fluid it is first necessary to fill each cylinder then replace the filling plugs and close the air cocks. The cylinder by-pass valves should be opened and the replenishing tanks filled. The air vents on the pumps should be opened until oil discharges free of air, the pumps set to pump and then turned by hand releasing air at the appropriate pair of cylinders and pumping into each pair of cylinders in turn using the hand control mechanism. The motor should then be started up and, using the local hand control mechanism. The motor should then be started up and using the local hand control, operation of the steering gear checked. Air should again be released from the pressurized cylinders and the pumps through the appropriate vents.

During normal operation the steering gear should be made to move at least once every two hours to ensure self lubrication of the moving parts. No valves in the system except by-pass and air vent should be closed. The replenishing tank level should be regularly checked and, if low refilled and the source of leakage found. When not in use, that is in port. The steering motors should be switched off. Also the couplings of the motors should be turned by hand to check that the pump is moving freely. If there is any stiffness the pump should be over hauled. As with any hydraulic system cleanliness is essential when overhauling equipment and only linen cleaning cloths should be used.

FIRE FIGHTING

Fire has been known as one of the most frequent hazards that can occur at sea. The main sources of fire are the engine room, living accommodation apartments and maintenance or routine work on decks. Since a fire on board may be very disastrous especially when allowed to escalate, it is necessary to provide a means of detecting it at its initial stage and also fighting it. Fire may also start from cargoes or in cargo holds especially in crude carriers.

Fire is the result of a combination of three factors.

1) Presence of combustible materials e.g. fuel
2) The ignition source i.e. heat
3) A supply of oxygen, usually from the air.

These three factors are often considered as the sides of the fire triangle. Removing any one or more of these sides will break the triangle and result in the fire being put out. The complete absence of one of the three will ensure that fire never starts.

Fires are divided into three categories, according to the material involved;

CLASS A: This class covers fires in solid materials such as wood and furnishing. Fires in this class are best extinguished by quenching or cooling with a water spray i.e. heat removal.

CLASS B: This class covers fires in fluids such as fuels, lubricating oil and grease or cargo as in crude oil carriers. It is dangerous to try to extinguish such fires with water, although a very fine water spray may be beneficial as a heat screen. These fires are best extinguished by smothering i.e. deprival of oxygen.

CLASS C: This class covers fires in electrical equipment, extinguished by non-conductive agents such as dry powder smothering to exclude oxygen.

Fire fighting at sea may be considered in three distinct stages, detection – locating the fire; alarm – informing the rest of the ship; and control – bringing to bear the means of extinguishing the fire.

Two basic different types of equipment are available on board ship for the control of fires. These are small portable extinguishers and large fixed installation. The portable extinguishers are for small fires which, by prompt on-the-spot action, can be rapidly extinguished. The fixed installation is used when the fire can not be fought or restrained by portable equipment or there is perhaps a greater danger if associated areas were to be set on fire. The use of fixed fire installations may require evacuation of the area containing the fire which, if it is the machinery space, means the loss of effective control of the ship. Various types of portable and fixed fire fighting equipment are available.

There are four principle types of portable extinguisher usually found on board ship. These are:

a) The soda-acid
b) The foam (chemical foam and mechanical foam)
c) The dry powder
d) The carbon dioxide extinguishers

12.1 The portable fire extinguishers which are comparatively inexpensive are provided as required by the various safety agencies at various locations in the ship. The various types of fire extinguishers and their characteristics are listed below.

12.1: Various Types of fire Extinguishers & Their Xtics

	CLASS OF FIRE			OPERATION	RANGE AND DURATION	YEARLY MAINTENANCE	REMARKS
TYPE	A	B	C				
Soda Acid	√	X	X	Turn upside down. Direct stream at base of fire.	Not less than 6m 60-80 sec (9 litres)	Discharge clean recharge	Should not be kept at a temperature below 5°C
Gas cartridge and water	√	X	X	Release gas. Hold upright. Direct stream at base of fire.	Length of jet 10.6m spray 6m coverage $37m^2$ (9 litres)	As above	
Foam	√	√	X	Turn upside down. Direct at bulkhead just above fire.	Jet of foam 6m. 60 sec (9 litres)	As above	Should not be kept at a temperature below 5°C
CO_2	√	√	√	Release gas. Direct discharge at base of fire and maintain slow sweeping motion.	Over 2250 litres of gas from 4.5kg container.	Weigh or check with isotope. Recharge if loss is more than 10%	Can be of value on class A fires. Not allowed in accommodation.
Dry powder	√	√	√	Release gas and control discharge with squeeze grip nozzle. Direct at base of fire with a sweeping motion.	In still air 7.6m long, 1.8m wide, 1.2m high	Weigh gas cartridge. Renew if 10% loss. Check that powder is free running.	Can be of value class A fires. Needs careful aim.

FIXED INSTALLATIONS

A variety of different fixed fire fighting installations exist, some of which are specifically designed for certain types of ship.

a) **FIRE MAIN:** A sea water supply system to fire hydrants is fitted to every ship. Several pumps in the engine room will be arranged to supply the system, their number and capacity being dictated by legislation. An emergency fire pump will also be located remote from the machinery space and with independent means of power.

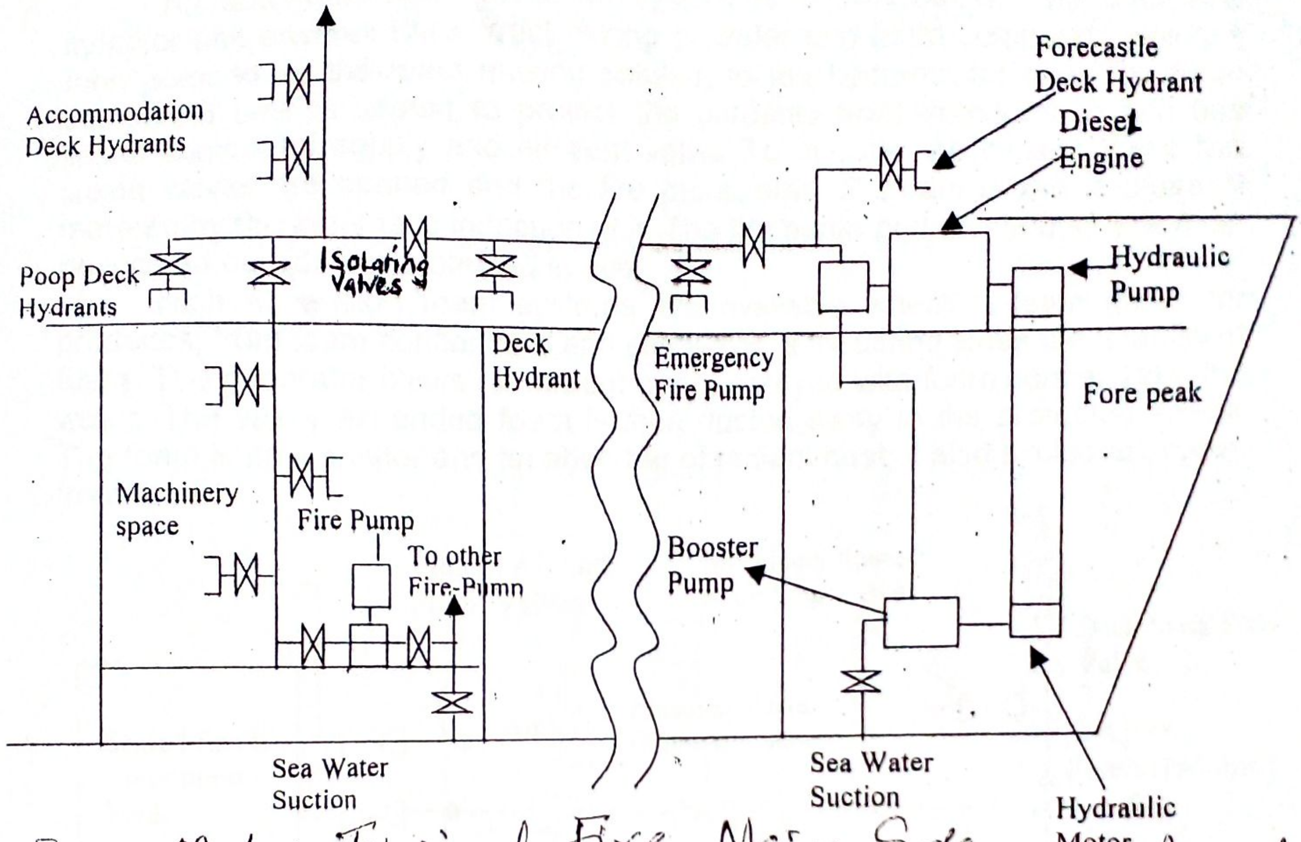


Fig 12.1 : Typical Fire Main System On-board

FIRE MAIN

A system of hydrant outlets, each with an isolating valve is located around the ship, and hoses with appropriate snap-in connectors are strategically located together with nozzle. These nozzles are usually of jet/spray type providing either type of discharge as required. All the working areas of the ship are thus covered, and a constant supply of sea water can be brought to bear at any point to fight a fire.

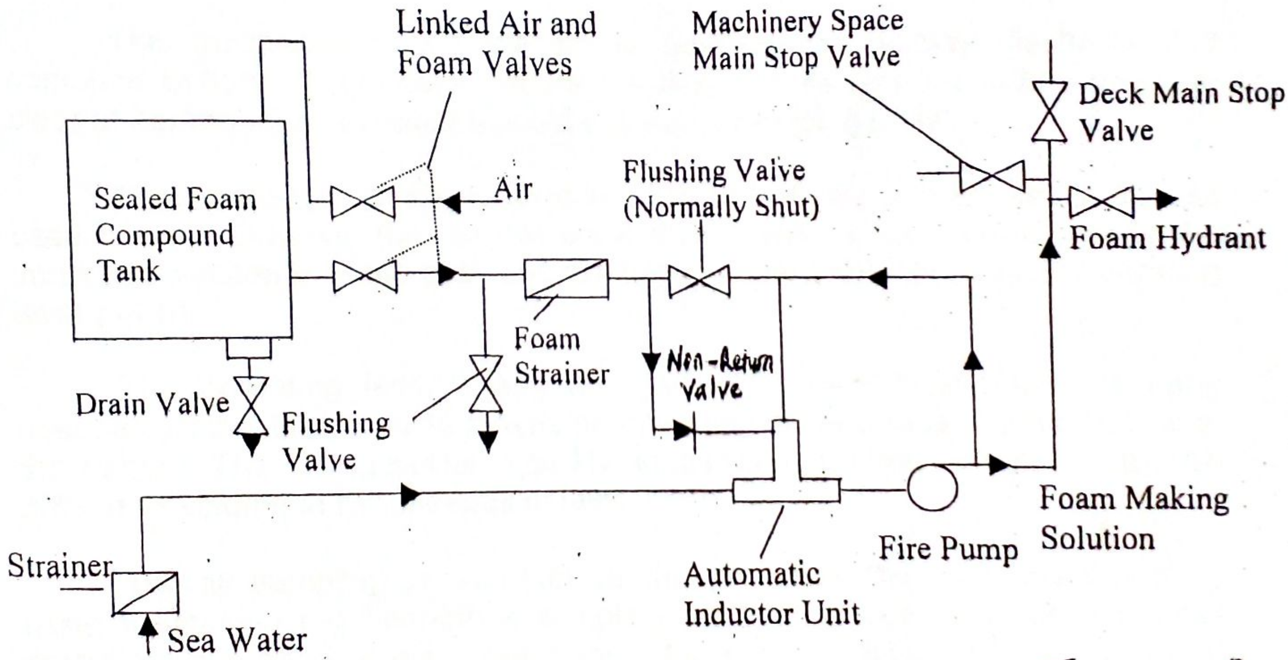
While sea water is best used as a cooling agent to fight class A fires, it is possible, if all else-fails, to use it to fight class B fires. The fit/spring nozzle would be adjusted to provide a fine water spray which could be sprayed over the fire to cool it without spreading.

b) **FOAM SYSTEMS:** Foam spreading systems are designed to suit the particular ship's requirements with regard to quantity of foam, areas to be protected, etc. Mechanical foam is the usual substance used, being produced by mixing foam making liquid with large quantities of water. Violent agitation of the mixture in air creates air bubbles in the foam.

in Fig 12:1

An automatic foam induction system is shown below. The automatic inductor unit ensures the correct mixing of water and foam compound which is then pumped as the foam making solution to the hydrants for use. The foam compound tank is sealed to protect the contents from deterioration and has linked compound supply and air vent valve. To operate the system these two linked valves are opened and the fire pump started. Foam mixed is carefully metered by the automatic induction unit. The fire pump and compound tank must be located outside the protected space.

High expansion foam systems are available where a foam generator produces, from foam concentrate and sea water, a thousand times the quantity of foam. The generator blows air through a net sprayed with foam concentrate and water. The vastly expanded foam is then ducted away to the protected space. The foam is an insulator and an absorber of radiant heat; it also excludes oxygen from the fire.



A Fig 12:2: Automatic Foam Compound Induction System

Fig 12:2: **AUTOMATIC FORM COMPOUND INDUCTION SYSTEM**

c) **CARBON DIOXIDE INDUCTION SYSTEM:** A carbon dioxide flooding system is used to displace the oxygen in the protected space and thus extinguish the fire. The carbon dioxide is stored as a liquid under pressure in cylinders or in low pressure refrigerated tanks.

The volume of space to be protected determines the number of cylinders and tanks required. A common battery of cylinder may be used to protect both holds and machinery space.

The cargo space is normally arranged for smoke detection, alarm and CO_2 flooding. Small air is drawn from each hold by a small fan and each pipe is identified for its particular hold. If smoke is drawn from one of the holds it will set off an alarm. The smoke is also passed into the wheel house where it can be detected by personnel on watch.

The location of the fire can be identified in this cabinet and the hold distribution valve below the cabinet is operated. This valve shuts off the sampling pipe from the cabinet and opens it to the carbon dioxide main leading from the cylinder battery. A chart will indicate the number of cylinders of gas to be released into the space and this is done by a hand operated lever.

The machinery space system is designed to quickly discharge the complete battery of cylinders. Before the gas is released, the space must be clear of personnel and sealed against entry or exhausting of air.

The discharge valve is located in a locked cabinet, with the key in a glass case nearby. Opening the cabinet sounds an alarm to warn personnel of the imminent discharge of the gas. The discharge valve is opened and an operating lever pulled.

The operating lever opens two gas bottles which pressurize a gang release cylinder that, in turn, moves an operating cable to open all the bottles in the battery. The CO_2 gas then quickly floods the machinery space, filling it to 30% of its volume in two minutes or less.

The air sampling system can be checked when the holds are empty by using a smoking rag beneath a sampling point. Flow indicators, usually small propellers, are fitted at the outlet points of the smoke detecting pipes as visual check and as an assurance that the pipes are clear. To check for leakage the gas cylinders can be weighted or have their liquid levels measured by a special unit.

d) **HALON SYSTEM:** Halon 1301 (BTM) and Halon 1211 (BCF) are two halogenated hydrocarbon gases with special extinguishing properties. Unlike other extinguishing agents which cool the fire or displace oxygen, the

Halon gases inhibit the actual flame reaction. As a result of its low vapour pressure when liquefied Halon can be stored in low pressure containers. Alternatively, if a standard carbon dioxide cylinder is used, then approximately three times as much gas can be stores, An additional advantage is that the atmosphere in a Halon flooded space is not toxic, although some highly irritant gases are produced in the extinguishing process.

A Halon storage system would be very similar to one using CO2 except that fewer cylinders would be required. The liquefied Halon is usually pressurized in the cylinders with Nitrogen in order to increase the speed of discharge. Bulk storage tanks of Halon gas are also used with cylinders of carbon dioxide and compressed air being used to operate the control system.

12

STEERING GEARS

The rudder is used to steer the ship. The turning action is largely dependent on the area of the rudder, which is usually of the order of one-sixtieth to one-seventieth of the length multiply by depth of the ship. The ratio of the depth to width of a rudder is known as the aspect ratio and is usually in the region of 2.

Stream-lined rudder of a double-plate construction are fitted to all modern ships and are further described by the arrangement about their axis. A rudder with all of its area aft of the turning axis is known as 'unbalanced'. A rudder with a small part of its area forward of the tuning axis is known as 'semi-balanced'. When more than 25% of the rudder is forward of the turning axis there is no torque on the rudder stock at certain angles and such an arrangement is therefore known as 'balanced rudder'.

The steering gear provides a movement of the rudder in response to a signal from the bridge. The total system may be considered made up of three parts.

a) Control equipment
b) A power unit
c) A transmission to the rudder stock

The control equipment conveys a signal of the desired rudder angle from the bridge and activates the power unit and transmission system until the desired angle is reached. The power unit provides the force when required and with immediate effect, to move the rudder to the desired angle. The transmission system of the steering gear is the means by which the movement of the rudder is accomplished.

Certain requirements must currently be met by a ship's steering system. There must be two independent means of steering, although where two identical power units are provided an auxiliary unit is not required. The power and torque capability must be such that the rudder can be swung from 35° one side to 35° the other side with the ship at maximum speed, and also the time to swing from 35° one side to 35° the other side must not exceed 28 seconds. The system must be protected from shock loading and have pipe-work which is exclusive to it as well as be constructed from approved materials. Control of the steering gear must be provided in the steering gear compartment.

Tankers of 10,000 ton gross tonnage and upwards must have two independent steering gear control systems which are operated from the bridge. Where one fails, changeover to the other must be immediate and achieved from the bridge position. The steering gear itself must comprise two independent systems where a failure of one results in an automatic changeover to the other within 45 seconds. Any of these failures should result in audible and visual alarms on the bridge.

Steering gears can be arranged with hydraulic control equipment known as "telemotor', or with electrical control equipment. The power unit may in turn be hydraulic or electrically operated. A pump is required in the hydraulic system which can immediately pump fluid in order to provide a hydraulic force that will move the rudder. Instant response does not allow time for the pump to be switched on and therefore a constantly running pump is required which pumps fluid only when required. A variable delivery pump provides this facility.

The variable delivery pump may be:

a) The radial cylinder type
b) The swash plate axial – cylinder type or
c) The shipper pad axial – cylinder type.

These are all positive displacement pumps capable of delivery in either direction.

STEERING GEAR TESTING — CREEP TEST

Prior to a ship's departure from any port, the steering gear should be tested to ensure satisfactory operation. These tests should include:

1) Operation of the main steering gear.
2) Operation of the auxiliary steering gear or use of the second pump which acts as the auxiliary.
3) Operation of the remote control (telemotor) system or system from the main bridge steering position.
4) Operation of the steering gear using the emergency power supply.
5) The rudder angle indicator reading with respect to the actual rudder angle should be checked.
6) The alarms fitted to the remote system and the steering gear power

During these tests the rudder should be moved through its full travel in both directions and the various equipment items, linkages etc., visually inspected for damage or wear. The communication system between the bridge and the steering gear compartment should also be operated.