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Auxiliary Marine Machinery

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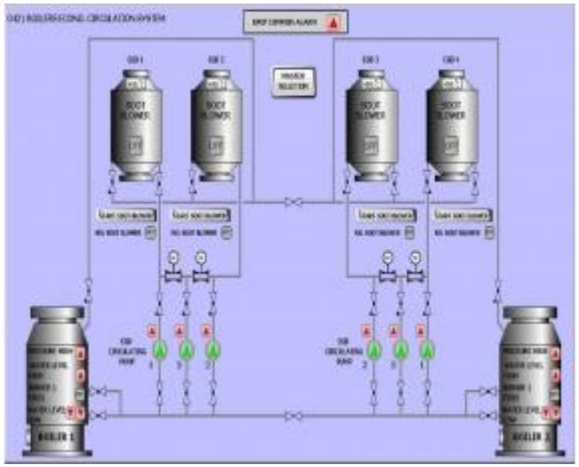
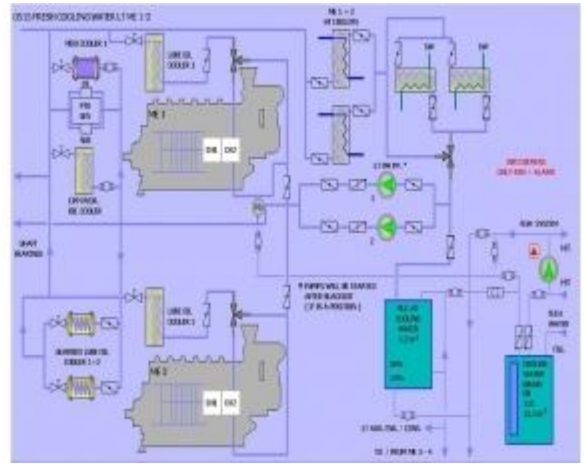
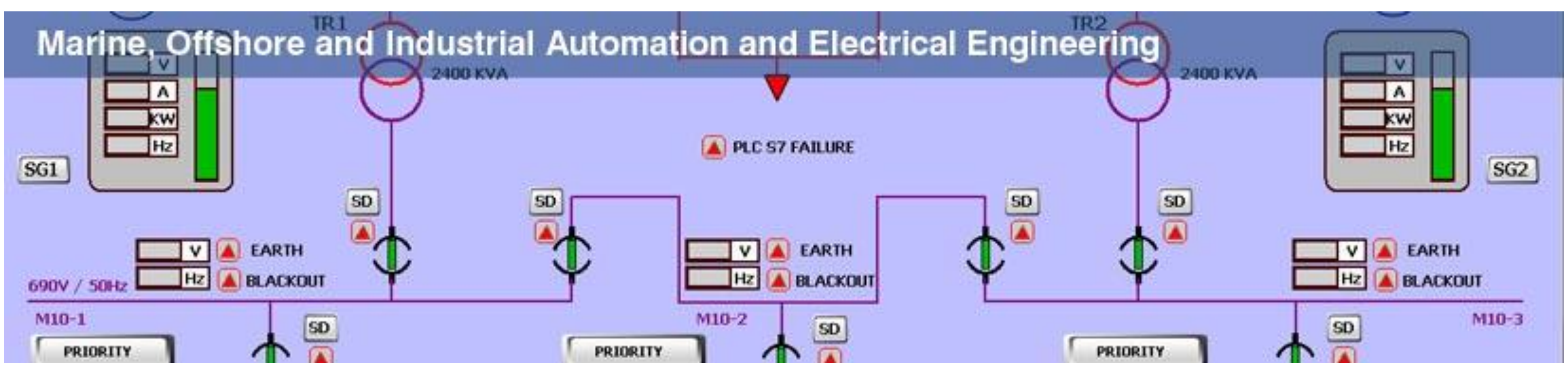
Auxiliary Marine Machinery

- Marine machinery is designed to ensure the proper functioning of a ship's main engines, piping systems, and equipment. Auxiliary marine machinery includes pumps, compressors, and blowers for circulating fuel and the fresh water and seawater used in cooling systems, for supplying air to the starting system of the main engine, for cooling refrigerated holds, and for air-conditioning various parts of the ship and for refrigeration machinery.
- Auxiliary marine machinery also includes separators for removing water and other contaminants from fuel and oil, steering machinery, capstans, windlasses, winches for anchoring, mooring, and cargo loading, and cranes.
- Other items include heat exchangers used to condense vapors and to heat and cool working fluids, such as water, oil, and air, filters for the seawater and fuel supplies, and separators for bilge water.






Marine, Offshore and Industrial Automation and Electrical Engineering
TR1
TR2
2400 KVA
2400 KVA
V
A
KW
Hz
SG1
SG2
PLC S7 FAILURE
SD
EARTH
BLACKOUT
690V / 50Hz
M10-1
M10-2
M10-3
PRIORITY

1. Marine auxiliary machinery - various installations on board

- Ships are large, complex vehicles which must be self-sustaining in their environment for long periods with a high degree of reliability. A ship is the product of two main areas of skill, those of the naval architect and the marine engineer.

  The naval architect is concerned with the hull, its construction, form, habitability and ability to endure its environment. The marine engineer is responsible for the various systems which propel and operate the ship. More specifically, this means the machinery required for propulsion, steering, anchoring and ship securing, cargo handling, air conditioning, power generation and its distribution. Some overlap in responsibilities occurs between naval architects and marine engineers in areas such as propeller design, the reduction of noise and vibration in the ship's structure, and engineering services provided to considerable areas of the ship.

- A ship might reasonably be divided into three distinct areas: the cargo-carrying holds or tanks, the accommodation and the machinery space. Depending upon the type each ship will assume varying proportions and functions. An oil tanker, for instance, will have the cargo-carrying region divided into tanks by two longitudinal bulkheads and several transverse bulkheads. There will be considerable quantities of cargo piping both above and below decks.

- The general cargo ship will have various cargo holds which are usually the full width of the vessel and formed by transverse bulkheads along the ship's length. Cargo handling equipment will be arranged on deck and there will be large hatch openings closed with steel hatch covers. The accommodation areas in each of these ship types will be sufficient to meet the requirements for the ship's crew, provide a navigating bridge area and a communications centre. The machinery space size will be decided by the particular machinery installed and the auxiliary equipment necessary.

  A passenger ship, however, would have a large accommodation area, since this might be considered the 'cargo space'. Machinery space requirements will probably be larger because of air conditioning equipment, stabilisers and other passenger related equipment.

2. Machinery arrangement

- Three principal types of machinery installation are to be found at sea today. Their individual merits change with technological advances and improvements and economic factors such as the change in oil prices. It is intended therefore only to describe the layouts from an engineering point of view. The three layouts involve the use of direct-coupled slow-speed diesel engines, medium-speed diesels with a gearbox, and the steam turbine with a gearbox drive to the propeller.

  A propeller, in order to operate efficiently, must rotate at a relatively low speed. Thus, regardless of the rotational speed of the prime mover, the propeller shaft must rotate at about 80 to 100 rev/min. The slow-speed diesel engine rotates at this low speed and the crankshaft is thus directly coupled to the propeller shafting. The medium-speed diesei engine operates in the range 250—750 rev/min and cannot therefore be dircci'f coupled to the propeller shaft. A gearbox is used to provide a low-speed drive for the propeller shaft. The steam turbine rotates at a very high speed, in the order of 6000 rev/min. Again, a gearbox must be used to provide a low-speed drive for the propeller shaft,

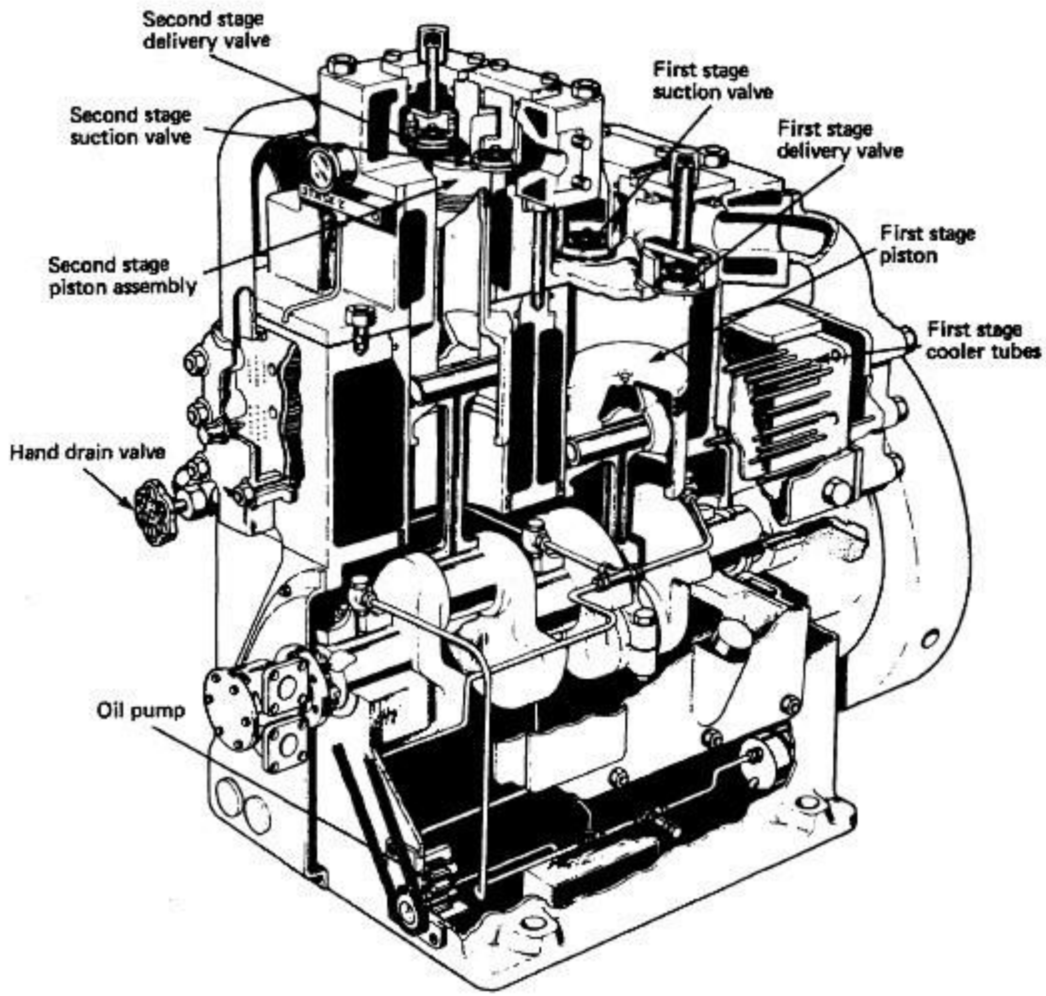
3. Air compressor arrangement - working principles and operational guideline

- **Use of compressed air for ships machinery**

  Compressed air has many uses on board ship, ranging from diesel engine starting to the cleaning of machinery during maintenance. The air pressures of 25 bar or more are usually provided in multi-stage machines. Here the air is compressed in the first stage, cooled and compressed to a higher pressure in the next stage, and so on. The two-stage crank machine is probably the most common.

  Air is drawn in on the suction stroke through the first-stage suction valve via the silencer/filter. The suction valve closes on the piston upstroke and the air is compressed. The compressed air, having reached its first-stage pressure, passes through the delivery valve to the first-stage cooler. The second-stage suction and compression now take place in a similar manner, achieving a much higher pressure in the smaller, second-stage cylinder.

- After passing through the second-stage delivery valve, the air is again cooled and delivered to the storage system. The machine has a rigid crankcase which provides support for the three crankshaft bearings. The cylinder block is located above and replaceable liners are fitted in the cylinder block. The running gear consists of pistons, connecting rods and the one-piece, two-throw crankshaft.



Two stage air compressor

- The first-stage cylinder head is located on the cylinder block and the second-stage cylinder head is mounted on the first: each of the heads carries its suction and delivery valves. A chain-driven rotary-gear pump provides lubricating oil to the main bearings and through internally drilled passages in the crankshaft to both connecting rod bearings. Cooling water is supplied either from an integral pump or the machinery space system. The water passes into the cylinder block which contains both stage coolers and then into the first and second stage cylinder heads.

  A water jacket safety valve prevents a build-up of pressure should a cooler tube burst and compressed air escape. Relief valves are fitted to the first and second-stage air outlets and are designed to lift at 10% excess pressure. A fusible plug is fitted after the second-stage cooler to limit delivered air temperature and thus protect the compressed-air reservoirs and pipework. Cooler drain valves are fitted to compressors. When these are open the machine is 'unloaded' and does not produce compressed air. A compressor when started must always be in the unloaded condition. This reduces the starting torque for the machine and clears out any accumulated moisture in the system. This moisture can affect lubrication and may produce oil/water emulsions which line the air pipelines and could lead to fires or explosions.

- To stop the compressor, the first and second-stage cooler drain valves should be opened and the machine run unloaded for two to three minutes. This unloaded running will clear the coolers of condensate. The compressor can now be stopped and the drains should be left open. The cooling water should be isolated if the machine is to be stopped for a long period.

  Automatic compressor operation is quite usual and involves certain additional equipment. An unloader must be fitted to ensure the machine starts unloaded, and once running at speed will load' and begin to produce compressed air. Various methods of unloading can be used but marine designs favour either depressors which hold the suction valve plates on their seats or a bypass which discharges to suction. Automatic drains must also be fitted to ensure the removal of moisture from the stage coolers. A non-return valve is usually fitted as close as possible to the discharge valve on a compressor to prevent return air flow: it is an essential fitting where unloaders are used.

4. Refrigeration system for cargo ships

- **Refrigeration process for cargo spaces and store rooms**

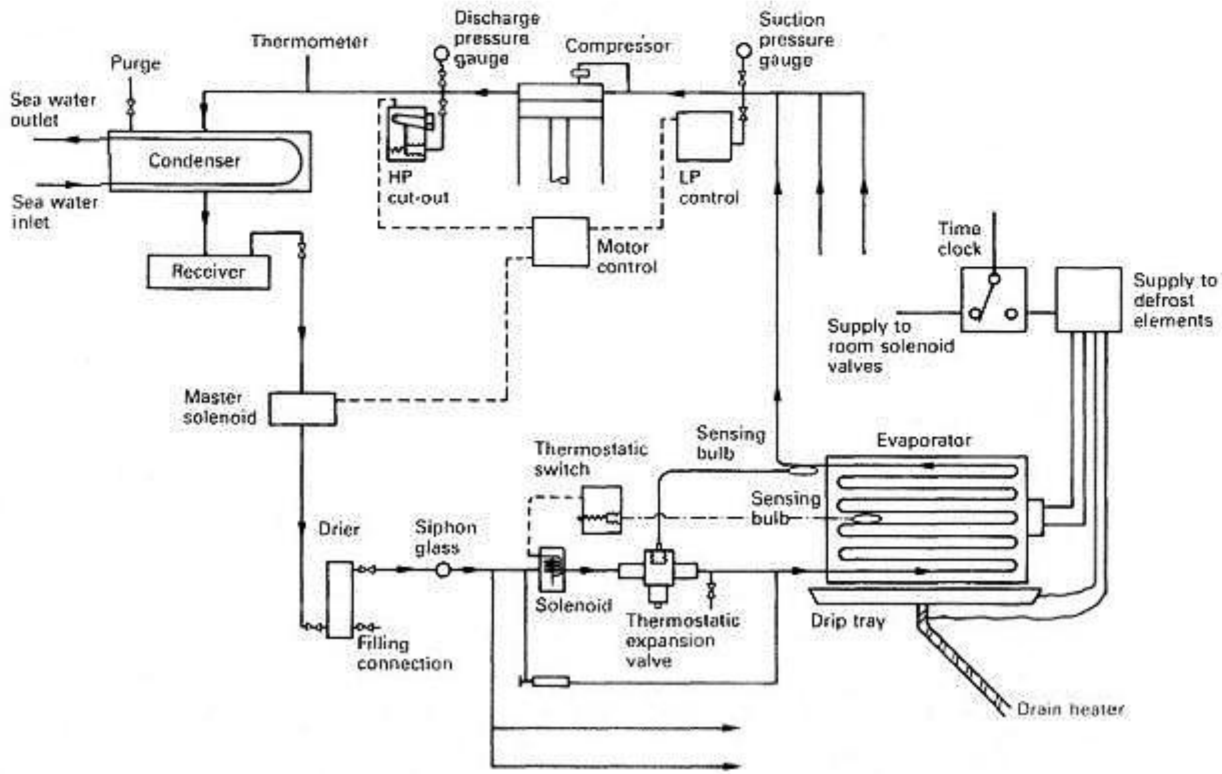
  Refrigeration is a process in which the temperature of a space or its contents is reduced to below that of their surroundings. Refrigeration of cargo spaces and storerooms employs a system of components to remove heat from the space being cooled. This heat is transferred to another body at a lower temperature. The cooling of air for air conditioning entails a similar process.

  Refrigerated cargo vessels usually require a system which provides for various spaces to be cooled to different temperatures. The arrangements adopted can be considered in three parts: the central primary refrigerating plant, the brine circulating system, and the air circulating system for cooling the cargo in the hold.

- An automatic direct expansion refrigeration system is shown in Figure below. The refrigerant flow through the chiller splits into four circuits, each with its own expansion valve. The four circuits are used to control the amount of evaporator surface, depending on the degree of condenser loading at the time, thus giving greater system flexibility. The large oil separator is a feature of screw compressor plants and the circuit for oil return is shown in the illustration.

  Each primary refrigerant circuit has its own evaporator within the brine chiller which results in totally independent gas systems. There will probably be three such systems on a cargo or container ship installation. Since they are totally independent each system can be set to control the outlet brine at different temperatures. Each brine temperature is identified by a colour and will have its own circulating pump. The cold brine is supplied to the cargo space air cooler and the flow of this brine is controlled by the temperature of the air leaving the cooler.

  The cooler in the cargo space is arranged for air circulation over it and then through the cargo before returning. An arrangement of fans and ducting direct the air to the cooler and below the cargo . The cargo is stacked on gratings which allow the passage of cooled air up through the cargo.


Discharge pressure gauge
Thermometer
Compressor
Suction pressure gauge
Purge
Sea water outlet
Condenser
Sea water inlet
HP cut-out
LP control
Receiver
Motor control
Time clock
Supply to defrost elements
Supply to room solenoid valves
Master solenoid
Sensing bulb
Evaporator
Thermostatic switch
Sensing bulb
Drier
Siphon glass
Solenoid
Thermostatic expansion valve
Drip tray
Filling connection
Drain heater

- For small refrigerated cargo spaces or provision rooms a direct expansion primary refrigerant system may be used . The twin circuit arrangement for each cooler (evaporator) provides flexibility and duplication in the event of one system failing. The back pressure valve maintains a minimum constant pressure or temperature in the evaporator when working a space in high-temperature conditions to prevent under-cooling of the cargo. If one space is operating at a low-temperature condition at the same time the back pressure valve would be bypassed. The liquid cooler illustrated in the diagram is necessary where an abnormal high static head has to be overcome between the machinery and the coolers. In this vessel the liquid is sub-cooled to prevent it flashing off before reaching the thermostatk expansion valve

- Vessels designed for specific refrigerated container trades have built-in ducting systems. These can be in two forms: a horizontal finger duct system in which up to 48 containers are fed from one cooler situated in the wings of the ship or, alternatively, a vertical duct system in which each stack of containers has its own duct and cooler. This type of system is employed for standard containers having two port holes in the wall opposite the loading doors. Air is delivered into the bottom opening and, after passing through a plenum, rises through a floor grating over the cargo and returns via another section of the plenum to the top port. The connection between the duct arid containers is made by couplings which are pneumatically controlled.

5. Coolers

- **Coolers at sea**
  Coolers at sea fall into two groups, shell and tube type coolers and the plate type. Both are considered below.

  Shell and tube type coolers

  In the shell and tube design a tube bundle or stack is fitted into a shell . The end plates are sealed at either end of the shell and provision is made at one end for expansion. The tubes are sealed into the tube plate at either end and provide a passageway for the cooling liquid. Headers or water boxes surround the tube plates and enclose the shell.

  They are arranged for either a single pass or, as in Figure below, for a double pass of cooling liquid. The tube bundle has baffles fitted which serve to direct the liquid to be cooled up and down over the tubes as it passes along the cooler. The joint arrangements at the tube plate ends are different. At the fixed end, gaskets are fitted between either side of the tube plate and the shell and end cover.
- At the other end, the tube plate is free to move with seals fitted either side of a safety expansion ring. Should either liquid leak past the seal it will pass out of the cooler and be visible. There will be no intermixing or contamination.

Plate type heat exchangers

- The plate-type heat exchanger is made up of a number of pressed plates surrounded by seals and held together in a frame . The inlet and outlet branches for each liquid are attached to one end plate. The arrangement of seals between the plates provides passageways between adjacent plates for the cooling liquid and the hot liquid . The plates have various designs of corrugations to aid heat transfer and provide support for the large, flat surface. A double seal arrangement is provided at each branch point with a drain hole to detect leakage and prevent intermixing or contamination.

6. Centrifugal pumps

Centrifugal pump principles and working procedure

A pump is a machine used to raise liquids from a low point to a high point. In a centrifugal pump liquid enters the centre or eye of the impeller and flows radially out between the vanes, its velocity being increased by the impeller rotation. A diffuser or volute is then used to convert most of the kinetic energy in the liquid into pressure.

The arrangement of a centrifugal pump is shown diagrammatically in figure below

A vertical, single stage, single entry, centrifugal pump for general marine duties is shown in Figure here. The main frame and casing, together with a motor support bracket, house the pumping element assembly. The pumping element is made up of a top cover, a pump shaft, an impeller, a bearing bush and a sealing arrangement around the shaft.

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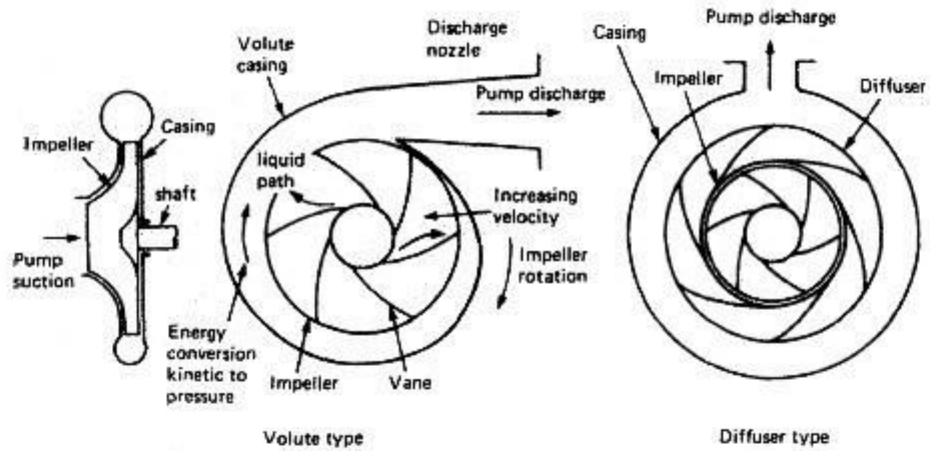
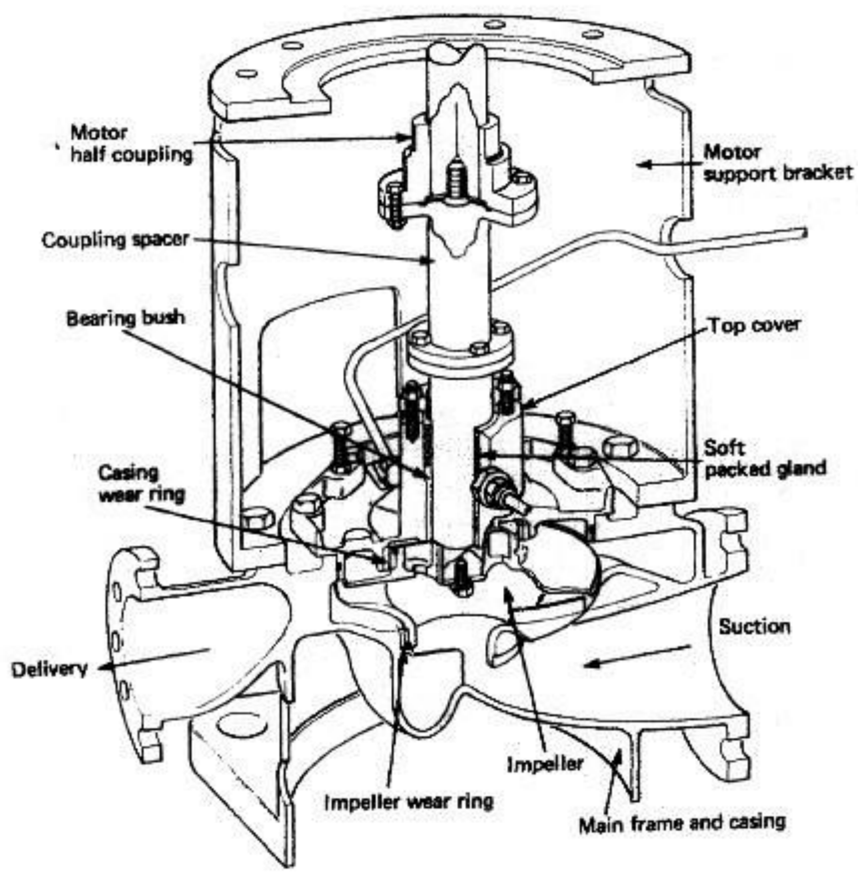
The sealing arrangement may be a packed gland or a mechanical seal and the bearing lubrication system will vary according to the type of seal. Replaceable wear rings are fitted to the impeller and the casing.

Centrifugal pumping operation



- The motor support bracket has two large apertures to provide access to the pumping element, and a coupling spacer is fitted between the motor and pump shaft to enable the removal of the pumping element without disturbing the motor.



Single entry centrifugal pum

- A diffuser is fitted to high-pressure centrifugal pumps. This is a ring fixed to the casing, around the impeller, in which there are passages formed by vanes. The passages widen out in the direction of liquid flow and act to convert the kinetic energy of the liquid into pressure energy. Hydraulic balance arrangements are also usual. Some of the high-pressure discharge liquid is directed against a drum or piston arrangement to balance the discharge liquid pressure on the impeller and thus maintain it in an equilibrium position.

6. Emergency power supply for ships machinery operation

- **Use of emergency generator**

  In the event of a main generating system failure an emergency supply of electricity is required for essential services. This can be supplied by batteries, but most merchant ships have an emergency generator. The unit is diesel driven and located outside of the machinery space .

  The emergency generator must be rated to provide power for the driving motors of the emergency bilge pump, fire pumps, steering gear, watertight doors and possibly fire fighting equipment. Emergency lighting for occupied areas, navigation lights, communications systems and alarm systems must also be supplied. Where electrical control devices are used in the operation of main machinery, these too may require a supply from the emergency generator.

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A switchboard in the emergency generator room supplies these various loads . It is not usual for an emergency generator to require paralleling, so no equipment is provided for this purpose. Automatic start up of the emergency generator at a low voltage value is usual on modern installations.

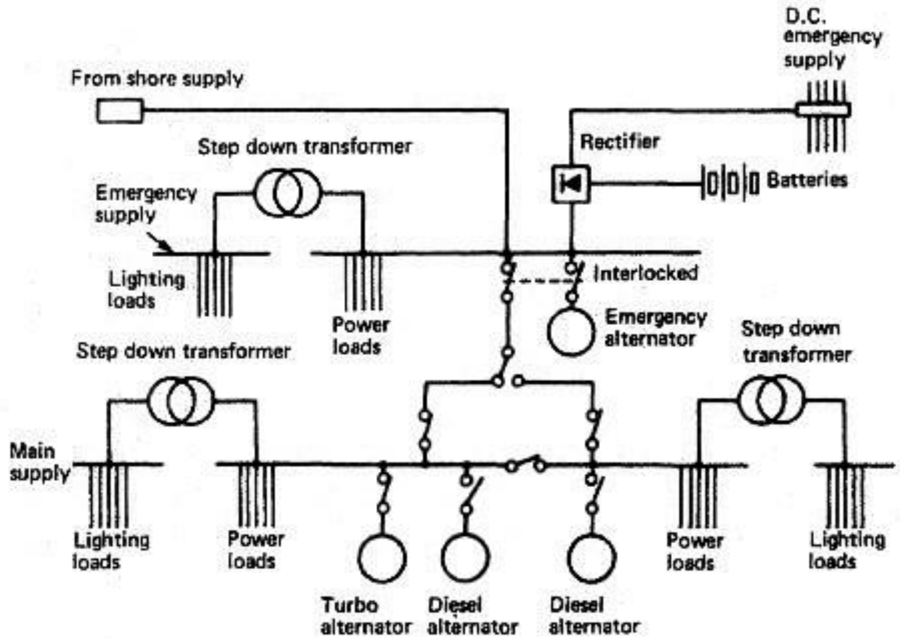

Fig: A.C. distribution system

- **Emergency Generator Operation**

  To ensure reliable operation in the event of an emergency, the emergency generator/alternator set, if fitted, is to be run up (on load if possible) weekly. Prior to this test, oil, water and fuel levels must be checked. Where possible, the prime mover is to be started by a simulated power failure. These tests and their results are to be recorded in the Engine Room Log Book. Tests should include:- Starting by alternative means such as back up batteries, hydraulic or hand starters - recorded at least bi-weekly.
- Interlocks, if fitted, such as to cooling flaps should be checked at this time.
- Where a load test requires the emergency switchboard to be blacked out, this should be carried out at least once every 3 months. This will involve blackout of the ESB by manually disconnecting it from the MSB and observing the auto start and paralleling sequence.

  "Black-out Tests" must be subject to a risk assessment and critical operations checklist to ensure all electronic equipment connected to the ESB is properly shut down prior to the blackout, and that any other risks have been assessed. The test should be carried out alongside or at anchor.

- Once running, the generator load should be increased to the maximum practical load for at least 15 minutes and all electrical load, relevant temperature and pressure readings records.

  All maintenance carried out on emergency generator sets is to be in accordance with the manufacturer's instructions. Suitable frost precautions must be taken with water cooled engines. On air-cooled engines the air path is to be maintained unrestricted with venting arrangements clear of obstruction and free to operate.

  Any faults or defects in the emergency generator/alternator, its prime mover and associated equipment, must be rectified and immediately reported to the appropriate management office. Where the above requirement cannot be complied with the shore advice must be consulted and a suitable alternative procedure developed.

7. Auxiliary Engines (Diesel Alternator)

- The engines used to drive the generators/alternators are the vessels primary source of power. This must always be taken into account in establishing priorities with regard to the operation, maintenance, and ordering of spares.

  It is essential that the manufacturer's instructions are closely followed with regard to maintenance and overhaul of critical components such as connecting rods, bottom end bolts, shell bearings, pistons. All maintenance, overhauls and repairs must be fully and accurately recorded. Any accidental over speed, overheating, blackout or major failure must be notified to the relevant Management office. During "Standby" for manoeuvring periods, a minimum of two generators/alternators are to be on load.

- The instructions given for main machinery are also applicable to auxiliary engines, generally the routine inspections must be carried out at much more frequent periods. The crankcase inspection is most important and must be carried out after a machine is shut down following a long run. Maintenance completed on the diesel generators is to be recorded on the "Maintenance Report Diesel Generators" .

  The lubricating oil in the engine system must be treated with the same care as the oil in the main engine system but with auxiliary engines there is usually more risk of fuel contamination and special care must be given in this respect.

  Oil cleaning arrangement such as filters or similar equipment must be kept in use the whole time the engine is working. If for any reason this equipment is not kept in use while an engine is running a note must be made in the log book that the equipment was not used and the reason given for not using it. The auxiliary diesel engine alarms and shutdowns are to be tested at monthly intervals and the relevant details noted in the Work Book. An entry should be made in the Machinery Log Book whenever such tests have been carried out.

- consulted regarding the deck requirements in port. The reduction in the number of auxiliary engines will not only result in fuel saving but primarily a reduction in auxiliary maintenance and will allow better engine performance. It must be stressed that in emergency situations, the possibility of a blackout must not delay the decision to shut down dangerous machinery.

  When the vessel is in confined waters the above should not apply as enough auxiliary engines should be run to provide an ample supply of power to cope with any such emergency.

  When not being maintained, all non-running engines should be kept in STAND BY condition to allow quick starting in cases of emergency. Regular checks should be made by an Engineer Officer to ensure that the cylinders of these engines are clear of water or fuel. Diesel engines should be barred over once a day. Serious damage may be caused by water leaking from defective turbo-blower casings into the cylinders via the exhaust manifolds. Water accumulation may also occur from leaking cylinder heads or cylinder liners. Fuel may also accumulate from leaking fuel combustion equipment.

  Drain cocks in exhaust and inlet manifolds are to remain open when machines are at rest and should be regularly tested and proved clear of blockages, especially prior to stopping machines. Every month, each main diesel generator is to be load tested and figures recorded. The load test is to be carried out at the maximum sustainable load, the limits being taken from the parameters in the makers manual. This load is to be maintained for one hour before readings are taken.

- During the load test , the engine should be brought up to 100% load for a few seconds, or long enough to prove that it can sustain this power/frequency during starting of machinery or in an short term emergency. If the continuous load achieved is less than 90% of the rated load of the engine, or the 100% test is not possible then an explanation must be sent to the superintendent with the reason for the low load achieved, and clearly stating which is the limiting parameter(s) and with a plan to correct the situation.

  Either mechanical indicators, peak pressure gauges or ideally, electronic indicators should be used to record cylinder conditions.

  It is essential that power balance between cylinders is maintained by proper analysis of cylinder conditions and that maintenance and adjustments are carried out to maintain operating conditions as close as possible to the design figures.

  Results should be compared to the previous set of results and to the test bed (shop trial) results in order to determine if adjustments or maintenance are required. During the load test, attention should be paid to the electrical power factor (i.e reactive load) balance achieved by all of the generators on load as this gives a good indication of the condition of the AVR's. A monthly report on the "Auxiliary Machinery" should be completed and returned to the Managing Office.

8. Steering gear

- **Ships steering gear information**

  Every ocean going cargo ship need to be provided with a main steering gear and an auxiliary steering gear unless the main steering gear comprises two or more identical power units. The main steering gear is to be capable of putting the rudder over from 35° on one side to 35° on the other side with the ship at its deepest draft and running ahead at maximum service speed, and under the same conditions from 35° on either side to 30° on the other side in not more than 28 seconds. It is to be power operated where necessary to meet the above conditions and where the stock diameter exceeds 120mm.

  The auxiliary steering gear is to be capable of putting the rudder over 15° on one side to 15° on the other side in not more than 60 seconds with the ship at its deepest draft and running ahead at half the maximum service speed or 7 knots whichever is greater. Power operated auxiliary steering gear is required if necessary to meet the forgoing requirement or where the rudder stock diameter exceeds 230 mm.

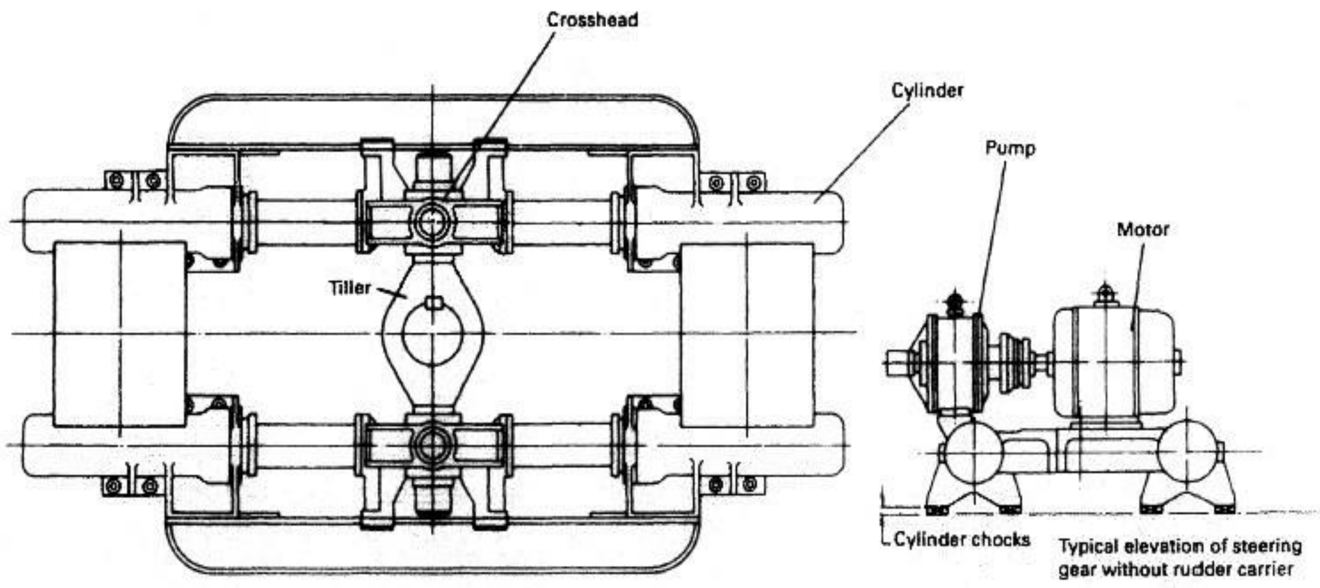

Fig: Typical 4 ram steering gear arrangement for cargo ships

- Steering gear control for power operated main and auxiliary steering gears is from the bridge and steering gear compartment, the auxiliary steering gear control being independent of the main steering gear control (but not duplication of the wheel or steering lever).

  Steering gear on ocean-going ships is generally of the electro-hydraulic type.

  Where the rudder stock is greater than 230 mm an alternative power supply is to be provided automatically from the ship's emergency power supply or from an independent source of power located in the steering gear compartment.

  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, control equipment, a power unit and a transmission to the rudder stock. The control equipment conveys a signal of 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, the steering gear, is the means by which the movement of the rudder is accomplished.

- Steering gears can be arranged with hydraulic control equipment known as a 'telemeter', or with electrical control equipment. The power unit may in turn be hydraulic or electrically operated. Each of these units will be considered in turn, with the hydraulic unit pump being considered first. 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.

  Generally, work should not be done on steering gear when a ship is under way. If it is necessary to work on steering gear when the vessel is at sea, the ship should be stopped and suitable steps taken to immobilise the rudder by closing the valves on the hydraulic cylinders or by other appropriate and effective means.

9. Unmanned machinery space operations on board cargo ship

- Personnel should never enter or remain in an unmanned machinery space alone, unless they have received permission from, or been instructed by the engineer officer in charge at the time. They may only be sent to carry out a specific task which they may be expected to complete in a comparatively short time.

  Before entering the space, at regular intervals whilst in the space and on leaving the space, they must report by telephone, or other means provided, to the duty deck officer. Before they enter the space the method of reporting should be clearly explained. Consideration should be given in appropriate instances to using a `permit-to-work' .

- If it is the engineer officer in charge who enters the machinery space alone, he too should report to the deck officer.

  Notice of safety precautions to be observed by personnel working in unmanned machinery spaces should be clearly displayed at all entrances to the space. Warning should be given that in unmanned machinery spaces there is a likelihood of machinery suddenly starting up.

  Unmanned machinery spaces should be adequately illuminated at all times.

  When machinery is under bridge control, the bridge should always be advised when a change in machinery setting is contemplated by the engine room staff, and before a reversion to engine room control of the machinery.

- **Unmanned machinery space checks**

  On any ship certified for unmanned operation, the machinery spaces may be unattended for a maximum period of 16 consecutive hours. No vessel is to operate with the machinery spaces unmanned in the following circumstances: During preparation for departure .
- During manoeuvring/standby operation.
- At sea or at anchor when the Master or the Chief Engineer requires the Engine Room to be manned due to adverse weather, traffic etc.
- When the cargo handling plant places a high and variable load on the electrical or steam generating plant.
- When port regulations prohibit any unmanned engine room.
- With any fire, major alarm, or safety system inoperative, including any fire detection system zones isolated.
- If any propulsion equipment back up provision is inoperative.
- With any major control or communication system inoperative.
- If the bridge console is inoperative.
- Before the Chief Engineers specific instructions for operating in the unmanned condition have been complied with.

Before Going UMS

- Before going UMS, the Duty Engineer must ensure that all day service tanks for fuel, cylinder oil and header tanks for cooling water, lubricating oil, etc are full. An inspection of all active and operational machinery and systems in all the machinery spaces, particularly for fuel and lubricating oil leakage, is to be carried out. That the main engine is on bridge Control
- Check that all bilges and seawalls are empty.
- Test Oil Mist Detector alarm on M.E , test bilge wells High Levels Alarms , test Boiler High/Low/Cut out alarms where applicable
- Check that bilge pump is in auto position.
- Check that Emergency DG is in stand-by position.
- Check that Stand-by DG is on auto-start.
- Check that steering gear motors are in stand-by position.
- Check that all stand-by pumps are on auto-start.
- Check that OWS overboard valve is secured (OWS stopped when E/R unmanned and if not automatic discharge).
- Check that all fire loops are activated.
- Check whether all watertight and weather doors/openings are closed.
- Check that the Purifier Room and Steering Gear door is closed

- Check cabin / public rooms alarms prior to the engine room being unmanned.
- Inform bridge and confirm UMS before leaving E/R
- Check that all flammable liquids are in sealed canisters.
- Check that all oil spills etc have been cleaned up.
- Check that all waste, rags and other cleaning materials are stowed away.
- Check that all Engine Room gear, spare parts etc are properly secured.
- Check that all alarms are active.
- Check that all fire detection sensors are active.
- Check that all fire doors are closed.
- Test the "Deadman" alarm and Engineer's Call Alarms, ensuring they are sounding in public rooms, Bridge, Cargo Offices and appropriate cabins.

- **Entering / Leaving the Engine Room During Unmanned Period**

  The Duty Engineer Officer must report to the Bridge when he is entering and leaving the Machinery Spaces.
  Whenever the duty engineer is required to enter the machinery spaces during UMS periods, including attendance for evening rounds and to respond to alarms, the "Deadman" alarm system is to be operated, where fitted. On vessels without a "Deadman" alarm system, the duty engineer must contact the bridge every 15 minutes to verify his safety.

  In the case of an alarm, the Duty Engineer Officer must verify the cause of the alarm, and take necessary measures to rectify the cause. If necessary he is to call another Engineer Officer.
  In the case of fire, flooding, serious machinery or electrical generation malfunction or similar threat to safety, the Duty Engineer Officer must call the Bridge and the Chief Engineer.
  Two full log entries of the engine room machinery parameters are to be made during the 8 hr manned period, and one log entry for the unmanned period.
  The Chief Engineer is to issue standing instructions specific to the vessel detailing the operation of the machinery during the unmanned period.
  Means are to be adopted to ensure that entry into unmanned machinery spaces outside normal working hours is restricted to the Duty Engineer and any other persons as authorised by the Chief Engineer. Access doors are to carry appropriately worded "Entry Prohibited" signs indicating the times during which the special restrictions are applicable.

10. Engine room safety

- **Safety precautions**

  Merchant Shipping regulations require every dangerous part of a ship's machinery to be securely guarded unless it is so positioned or constructed that it is as safe as if it were securely guarded or is otherwise safeguarded.

  All steam pipes, exhaust pipes and fittings which by their location and temperature present a hazard, should be adequately lagged or otherwise shielded. The insulation of hot surfaces should be properly maintained, particularly in the vicinity of oil systems.

  Personnel required to work in machinery spaces which have high noise levels should wear suitable hearing protectors .

  Where a high noise level in a machinery space, or the wearing of ear protectors, may mask an audible alarm, a visual alarm of suitable intensity should be provided, where practicable, to attract attention and indicate that an audible alarm is sounding. This should preferably take the form of a light or lights with rotating reflectors. Guidance may be found in the IMO Code on Alarms and Indicators.

- The source of any oil leakage should be located and repaired as soon as practicable.

  Waste oil should not be allowed to accumulate in the bilges or on tank tops. Any leakage of fuel, lubricating and hydraulic oil should be disposed of in accordance with Oil Pollution Regulations at the earliest opportunity. Tank tops and bilges should, wherever practicable, be painted a light colour and kept clean and well-illuminated in the vicinity of pressure oil pipes so that leaks may be readily located.

  Great caution is required when filling any settling or other oil tank to prevent it overflowing, especially in an engine room where exhaust pipes or other hot surfaces are directly below. Manholes or other openings in the tanks should always be secured so that should a tank be overfilled the oil is directed to a safe place through the overflow arrangements.

  Particular care should be taken when filling tanks which have their sounding pipes in the machinery spaces to ensure that weighted cocks are closed. In no case should a weighted cock on a fuel or lubricated oil tank sounding pipe or on a fuel, lubricating or hydraulic oil tank gauge be secured in the open position.

- Engine room bilges should at all times be kept clear of rubbish and other substances so that mud-boxes are not blocked and the bilges may be readily and easily pumped.

  Remote controls fitted for stopping machinery or pumps or for operating oil-tank quick-closing valves in the event of fire, should be tested regularly to ensure that they are functioning satisfactorily. This also applies to the controls on fuel storage daily service tanks (other than double bottoms) and lubricating oil tanks.

  Cleaning solvents should always be used in accordance with manufacturers' instructions and in an area that is well ventilated.

  Care should be taken to ensure that spare gear is properly stowed and items of machinery under overhaul safely secured so that they do not break loose and cause injury or damage even in the heaviest weather.