SEAFARERS TRAINING CENTER INC

RATING FORMING PART OF AN ENGINEERING WATCH

In accordance to the standard of training, Certification and Watchkeeping for Seafarers 1978, as amended

SCOPE

This course aims to provide the training for candidates RATING FORMING PART OF AN ENGINE WATCH, in accordance with the Regulation III/4, Section A-III/4 and Table A-III/4 of the STCW 78 Convention, as amended.

OBJECTIVE

This is the minimum standards of competence in ***RATING FORMING PART OF AN ENGINE WATCH***, a trainee will be competent to take appropriate measures for the safety of personnel and of the ship and to use fire appliances correctly. The trainee will also have a knowledge of ***RATING FORMING PART OF AN ENGINE WATCH***.

ENTRY STANDARS

The course is open to all seafarers. All trainees must be certified by a doctor to be in good health.

COURSE CERTIFICATE

Completion of the course and demonstration of competence, a document will be issued certifying that the holder has met the standard of competence.

COURSE INTAKE LIMITATIONS

The maximum number of trainees attending each session will be 25 persons.

Practice will be done on board a ship or simulator.

Staff Requirements

COURSE	MODEL IMO	LOAD TIME	INSTALLATION	EQUIPMENT	INSTRUCTOR
RATINGS FORMING PART OF A ENGINE WATCH	Regulation III/4, Sección A-III/4 y Tabla A-III/4	30 hours	Classroom for theoretical and ship for practice.	Ship/Simulator	1. Course rating forming part of an engine watch. 2. Course Instructor 6.09

COURSE OUTLINE

COURSE OUTLINE	APRPROXIMATE TIME (HOURS)
KNOWLEDGE, UNDERSTANDING AND PROFICIENCY.	**LECTURE, DEMOSTRATIONS AND PRACTICAL EXERCISES.**
1. Terms using in ship and engine room spaces.	8.0
2. Marine Engines	8.0
3. Electricity generators	4.0
4. Engine watchkeeping	4.0
5. Engine Room or Simulator (PRACTICE)	6.0
Total	**30.0**

COURSE TIMETABLE

This course has 30 hours and 6 hours are practice.

PERIOD/ Day	1st. PERIOD (2.0 Hours)	2nd. PERIOD (2.0 Hours)	3rt. PERIOD (2.0 Hours)	4Th. PERIOD (2.0 Hours)
Day 1	Terms using in ship and engine room spaces.	Terms using in ship and engine room spaces.	Terms using in ships and engine room spaces.	Terms using in ships and engine room spaces.
Day 2	Marine engines.	Marine engines	Marine engines	Marine engines
Day 3	Electricity generators	Electricity generators	Engine watchkeeping	Engine watchkeeping
Day 4	Engine room or Simulator (practice)	Engine room or Simulator (practice)	Engine room or Simulator (practice)	-

1.– TERMS USING IN SHIPS AND ENGINE ROOM SPACES

A **ship** is a large watercraft that travels the world's oceans and other sufficiently deep waterways, carrying passengers or goods, or in support of specialized missions, such as defense, research and fishing. Historically, a "ship" was a sailing vessel with at least three square-rigged masts and a full bowsprit. Ships are generally distinguished from boats, based on size, shape, load capacity, and tradition.

Ships have been important contributors to human migration and commerce. They have supported the spread of colonization and the slave trade, but have also served scientific, cultural, and humanitarian needs. After the 15th century, new crops that had come from and to the Americas via the European seafarers significantly contributed to the world population growth.[1] Ship transport is responsible for the largest portion of world commerce.

As of 2016, there were more than 49,000 merchant ships, totaling almost 1.8 billion dead weight tons. Of these 28% were oil tankers, 43% were bulk carriers, and 13% were container ships.[2] Military forces operate vessels for naval warfare and to transport and support forces ashore. As of 2016, among the world's 104 navies, Korean People's Navy of North Korea had the most surface vessels (967), followed by People's Liberation Army Navy of China (714), the United States Navy (415), Islamic Republic of Iran Navy (398), and Russian Navy (352). The top 50 navies had a median fleet of 88 surface vessels each, according to various sources.[3]

MARLINESPIKE SEAMANSHIP

Marlinespike seamanship is a general term that cover all phases of rope work. It includes the care, handing, knotting and splicing of both fiber and wire rope of all sizes.

NATURAL FIBER ROPE

Under this heading come Manila, sisal, hemp, coir, cotton, and flax. let takes its name from the species of plant from whose fiber ¡t is made. Fiber rope is impregnated with oil when manufactured which adds about 10 percent to its actual weight. The oil lengthens the life of the rope by keeping out heat and moisture. As the oil leaves it, the rope tends to deteriorate more rapid1y. The strength of fiber rope becomes less with use and a used rope is deceptive. Unlike a wire rope the strands do not wear fiat, thereby giving a visible sign. of weakness. The fibers stretch and untwist but this does not plainly indicate weakness. Do not place a maximum. strain on a rope which has been under a load for a long period, or has been close to the breaking point. Rope safety decreases rapid1y with constant use, depending upon the working conditions and amount of strain.

Manila is a hard fiber which comes from the bark of the abaca plant. it is the most important natural rope in the world. It grows almost exclusively in the Philippines and takes its name from the port from which it is exported. It possesses a lightness, strength, and durability with which no other natural fiber can compare. It is glossy, has a brilliant sheen, and is smooth and pliable. Saltwater has little effect on it, and therefore ¡t is used almost exclusively for marine cordage. Until the advent of synthetic fibers ¡t was used primarily for mooring lines, and ¡t still finds considerable use aboard ship.

The abaca plant and the banana plant are very closely related and resemble each other in appearance and habits of growth. The plant is a large tree-Like herb 15 to 20 feet high. The stalk is from 6 to 22 feet in length and from 6 to 18 inches in diameter. The bark is formed in rib-bonelike strips of fiber over a fleshy core. The fiber is removed, cleaned and dried. and then baled for shipment to the mill. Manila fiber absorbs ofis and preservatives direct1y into the fiber. Consequently it resists deterioration from bacterial rot for a long time.

Sisal is made from a hard fíber obtained from the leaves of Agave sisalana. lt is sometimes known as sisal hemp, but is entirely different from true hemp. True sisal comes mainly from East Africa, the Dutch West Indies. and Haiti. Henequen is sometimes called Yucatan or Cuban sisal but this is not correct. Sisal fibers are white to yellowish-white in color. Un1ike Manila, sisal lacks gloss, is stiff and harsh to the touch, and is easily injured by exposure to the weather. The length. of the fiber is 2 to 4 feet as opposed to 6 to 10 for Manila. It is only about 80 percent as strong as Manila. During World War II when Manila was not available, sisal was substituted. Because of its stiffness and tendency to kink, seamen breathed a sigh of relief when Manila came back on the market. Aboard ship today it is little used except as small stuff although some finds its way aboard yachts. Sisal fiber takes only a surface coating of oil or preservatives. These leach out rapid1y.

Hemp comes from the Cannabis sativa plant. There is only one true species of hemp but considerable confusion arises about its correct name because there are many other somewhat similar fiber-producing plants. The commercial fibers obtained from them are frequently and incorrectly called hemp. Several of these are Manila hemp, sisal hemp, New Zealand hemp, and Mauritius hemp. Hemp is grown in the United States, USSR, Italy, France, and Korea. It was probably the first fiber used for manufacturing rope in this country in Boston about 1640. Hemp fiber is coarse and about 80 percent as strong as Manila, but is used for entirely different purposes. It was formerly used for standing rigging, and still may be used on the ratlines of the few remaining square riggers where its stiffness is an asset. When tarred it stands up well in wet weather. In the present day, however, most all hemp is made up as marline and is used extensively in the bos'n's locker where small stuff is appropriate.

Coir rope is made from coconut husk fiber and is a buoyant rope that does not become waterlogged. It has about half the strength of Manila. It was formerly used on tugs for lashing lighters and barges together, but has fallen into disuse and today is almost unknown in the maritime industry.

Cotton and flax ropes, are made of common cotton and flax, respectively. Only smaller sizes are used aboard ship. Cotton signal halyards and lead lines are common. Flax cordage was commonly used for boltrope on sai1s because of its soft and flexible qualities. It has now largely been replaced by synthetics, but some flax sail twine may still be found.

Flax is extremely strong when wet. It gains approximately 100 percent tensile strength over dry strength. Its wet strength is comparable to that of nylon. Flax and hemp ropes are very stable and have low elongation and elasticity comparable to Manila.

CONSTRUCTION

Rope is made by first twisting fibers into yarns or threads, then twisting the yarns into, strands, and finally twisting the strands together to form the finished rope. As the rope is built up, each part successively is twisted in an opposite direction; thus, when the yarns are twisted in a right hand direction, the strands are twisted left handed and the rope is twisted right handed. This forms a right handed plain laid rope. If three or more of these right handed plain laid ropes are used as strands to form another rope, it will be a left handed hawser, or cable laid rope.
When a rope has four or more strands, it is customary to put a core or line in the center to retain the rounded form of its exterior. This core or line is called the heart.
Rope is designated as right laid or left laid according to the direction in which the strands are twisted. To determine which way the rope is laid, look along the rope and if the strands advance to the right or in a clockwise direction, the rope is right laid; if the strands advance to the left or in a counterclockwise direction, the rope, is left laid.
Lay means the amount and direction of the twist put into a rope expressed as hard laid, common or regular laid, soft laid, boltrope, sail maker's lay. Generally speaking, the softer the lay, the stronger the rope; the harder the lay, the more resistant to chafing.
The average line is made of three strands which can be separated into yarns or threads, so it is called 6 thread, 9 thread, 12 thread, etc. Line is measured by thread up to, 21 thread in the Merchant Marine. All line after this is measured by its circumference. Line larger than 5 inches in circumference is commonly called hawser.

SMALL CORDAGE

Small stuff is the common term for a line 13/4 inches in circumference or less. It is generally designated by the number of threads of which it is made, 24_thread stuff being the largest. Aside from being known by the number of threads, various kinds of small stuff have their own names, such as:
Spun yarn is the cheapest and most commonly used for seizing, serving, etc., where neatness is not important. It is laid up loosely and left handed and is 2, 3, or 4 stranded. It is tarred.
Marline has the same uses as spun yarn but makes a neater job. It is 2_stranded and laid up left handed. Untarred marline is used for sennit, a braided cord or fabric made of plaited yarns. Tarred yacht marline is used in rigging lofts.

SYNTHETIC FIBER ROPE
Natural fibers were mentioned first in this chapter because until comparatively recently they were the only fibers available. They still have many uses aboard ship.
After World War II, rope made out of petroleum products appeared and began to replace Manila for use in mooring lines. The introduction of these

This is one reason why products like Esterlene have been developed. The high melting point of the polyester cover protects the low melting point of the polypropylene core yarns.

It is a legend to never stand in the bight of a line, and this bears repeating. The reason is obvious, but accidents happen when seamen are hurried, tired, careless, or angry. The woods are full of one-legged seamen who know better. For this reason the Navy recommends the use of a separate safety observer for mooring operations. In the merchant service The licensed officer in charge of a mooring station must be vigilant to insure that through carelessness his men do not subject themselves to a hazard.

CARE AND HANDLING

To open a new coil of natural fiber rope, loosen the burlap coyer, saving the lashings, and lay the coil on the flat side with the inside end near the deck. Then reach down through the eye (the opening in the center of the coil) and draw the tagged end up and out of the coil. As it comes out, it should uncoil counterclockwise. Do not uncoil from the outside or take the end from the top of the coil because kinks will result. Rope manufacturers recommend that lashings around the coil be cut from inside the eye and the burlap covering left on the coil. Deck storekeepers will find that this will keep their coils of rope in shape and keep the storeroom more orderly.
Synthetics will probably come aboard on a reel in the same manner as wire, differing from Manila which comes in a coil covered with burlap. To guard against kinking, synthetic rope should be unreeled in the same manner as wire. The reel should be mounted on a reel-holder. Synthetics, given a chance, will kink at the first opportunity, and the result is loss of strength and damage as serious as when it happens with wire.
Natural fiber rope shrinks in length when wet as the fibers swell. A rope taut when dry should be slacked off in wet weather to prevent it from parting under the added strain. Even a heavy dew at night will penetrate an oil line that the oil has left and may create a dangerous situation.
Natural fibers are subject to deterioration from heat, sunlight, and mildew rot. They also are damaged by chemicals, acids, alkalies, paints, soaps, and vegetable oils. Do not store when wet. Store in a well ventilated, cool, and dark area. If stowed topside they should be under an overhang and covered with canvas or other waterproof material. Most synthetic fibers are affected by sunlight, fluorescent light, and chemicals. Do not stow nylon in strong sunlight for extended periods. 1t should be covered. Keep away from temperatures above 250 degrees Fahrenheit and strong chemicals. Synthetics can be stowed wet if necessary. Polyester and polypropylene are not damaged by sunlight.
Should dark red, brown, or black spots be noted between the strands of natural fiber rope, and a sour, musty, or acidic odor be detected, the rope is no longer useful. Rotting rope should not be stored near new rope.
Both natural and synthetic fiber rope should be kept clear of rusty iron surfaces. Although this is more injurious to natural fiber, rusting iron can result in the loss of 40 percent of nylon's breaking strain in one month. Rust stains which can he removed with soap have no adverse affect on rope strength. Rope containing rust stains which cannot be removed should be taken out of heavy service.
The age of natural fiber rope is important. If over five years old, it is not safe for heavy use. lf Manila or sisal feel harsh, dry, or dead, the quality of the rope is doubtful. An accumulation of grease also affects rope strength_

Wet synthetic fiber hawsers under heavy strain will wring out steam like water vapor. This is normal under safe working loads and helps cool fibers.
A hock1e in a synthetic rope should he cut out as it reduces breaking strength by approximately 30 percent. The portion of a rope containing cuts also should be removed.
Rope should be parceled with canvas to protect it from chafing at any point where it rubs against a heavy object.
An old rule a prudent seaman still observes states that not more than 116 the breaking strain should be placed on an old line and not more than 1/4 the breaking strain on a new line.

COILING
For a straight coil lay a circular bight of secured end on deck and lay additional bights on top of it, using up the entire amount of line. Keep out kinks and turns. Capsize entire coil and it will be clear for running.
To flemish down a line, make a small circle of free end and continue to lay down circles around it until all the line is down and resembles a coiled clock spring. This is the neatest method.
To fake down a rope lay out the free end in a straight line, then turn back a loop to form a close fiat coil and continue to lay fiat coils with the ends on top of ends of preceding coil. Always coil a line with the lay.
Right-handed rope should always be coiled "with the sun," that is in a clockwise direction.
Left handed rope should always be coiled "against the sun," that is in a counterclockwise direction.
To remove turns in a line, coil down against the lay, bring lower end up through the center of the coil and then coil down clockwise. If there are many turns in the rope, coil small, if few, coil large.

STRENGTH OF ROPE

Whenever the question arises as to how strong rope is or what weight it can withstand, the best means of finding out is to go to the manufacturer's specifications.
Manufacturers may vary in systems of size measure, methods of listing tensile strengths (minimum, approximate average, plus or minus 10 per cent), and linear density weights. lt is important to understand that total fiber content in any so called "size" of a rope in hawser sizes is the total function of its strength. The weight or linear density of amount of fiber that can be circumscribed. within a circumference of a rope determines the strength of that; size.
If no appropriate table can be found, the following empirical formula is surprisingly accurate. It is for Manila only, but nylon is about two and a half times as strong as Manila. Thus the formula can be used by multiplying the result by 2 1/2 or 2.5. The Coast Guard requires that candidates for licenses be able to utilize this formula. In any case, whichever method is used, it is important to note that rope which is not new, not stored properly, or otherwise abused, is less strong than when it left the factory. It will be less strong, therefore, than shown by the tables or formulas.

DEFINITTONS AND ABBREVIATIONS
B = Breaking Strain (same as tensile strength), in terms of long tons or pounds, as specified.

SWL or P = Safe Working Load = safety requires that less stress be placed on the rope or wire than is required to break it, otherwise gear would frequently be carried away with resulting loss of life and property. If the SWL of Manila is used as 20 percent of B, and B of a 5 inch Manila is 20,250 pounds, then the SVVL will be 4.050 pounds.
SF = Safety Factor = the relationship between the Breaking Strain and the Safé Working Load. If the SWL of Manila is taken as 20 percent of B, the SF is 5.

EMPIRICAL FORMULAS

$B = \frac{c^2}{2.5}$ or $B = 90O\,c^2$

where B = Breaking Strain in long tons (2,240 pounds 1 long ton)
and C = Circumference of rope

where B = Breaking Strain in pounds
and C = Circumference in inches

$SWL = \frac{B}{SF}$ In this formula both SWL and B must be in the same units. If SWL is in tons, B must be in tons. lf SWL, is in pounds, B must be in pounds.

Example: Using the preceding formulas, what is the Breaking Strain for 5 inch Manila in pounds?

$B = 90O\,C^2 = 900 \times 5^2 = 900 \times 25 = 22,500$ pounds

Note that this is about 10 percent more than the 20,200 pounds.

Suppose we wished to know the Safe Working Load of this line using a Safety Factor of 5:

SWL = B/SF=22,500/5 = 4,500 pounds

Example: Using the preceding formulas, what is the Breaking Strain for 3 inch Manila in tons? What would be the Safe Working Load if a Safety Factor of 6 were used? (The greater the SF, the safer you are.)

$B = \frac{C^2}{2.5} = \frac{3^2}{2.5} = 3.6$ long tons

SWL = B/SF = 3.6/6 = 0.6 long tons

KNOTS AND SPLICES

The safety of a vessel and its crew frequently depends on the knots and Splices used in joining lines together. For this reason no man can consider himself a seaman until he has mastered the methods of quickly and properly tying those knots and making those splices commonly used.

The Cornell Manual for Lifeboatmen, Able Seamen, and Qualified members of Engine Department sets forth the requirements for able seamen and lists the "principal knots, bends, splices, and hitches" which the candidate for A.B. must know. In the list which follows, those knots requiring particular attention are indicated by an asterisk.

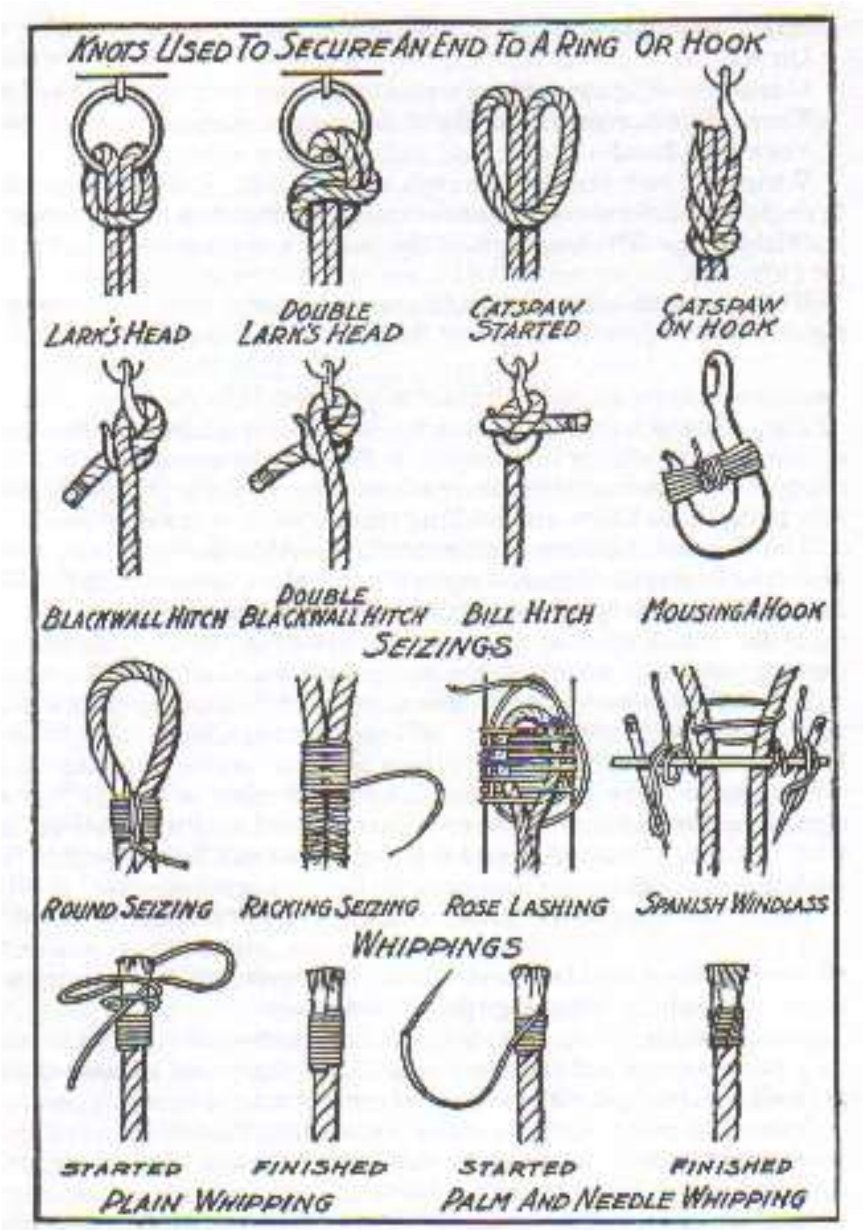
The seaman should also be able to make the following splices in Manila rope: eye, short, and long. In addition, he should be able to tie other knots, including some of the various wall and crown, and should also be able to splice wire cables, as well as make other splices in Manila. He should be able to make proper mousings and seizings, and be familiar _with methods of parceling and serving. He should be throughlv familiar with the use of the sail maker's palm, fid, and marlinespike «

The illustrations and descriptions here are of the most widely known and useful knots. The illustrations have been planned so that a minimum of description is required and it should be possible to make most of the knots by carefully following the presentations.

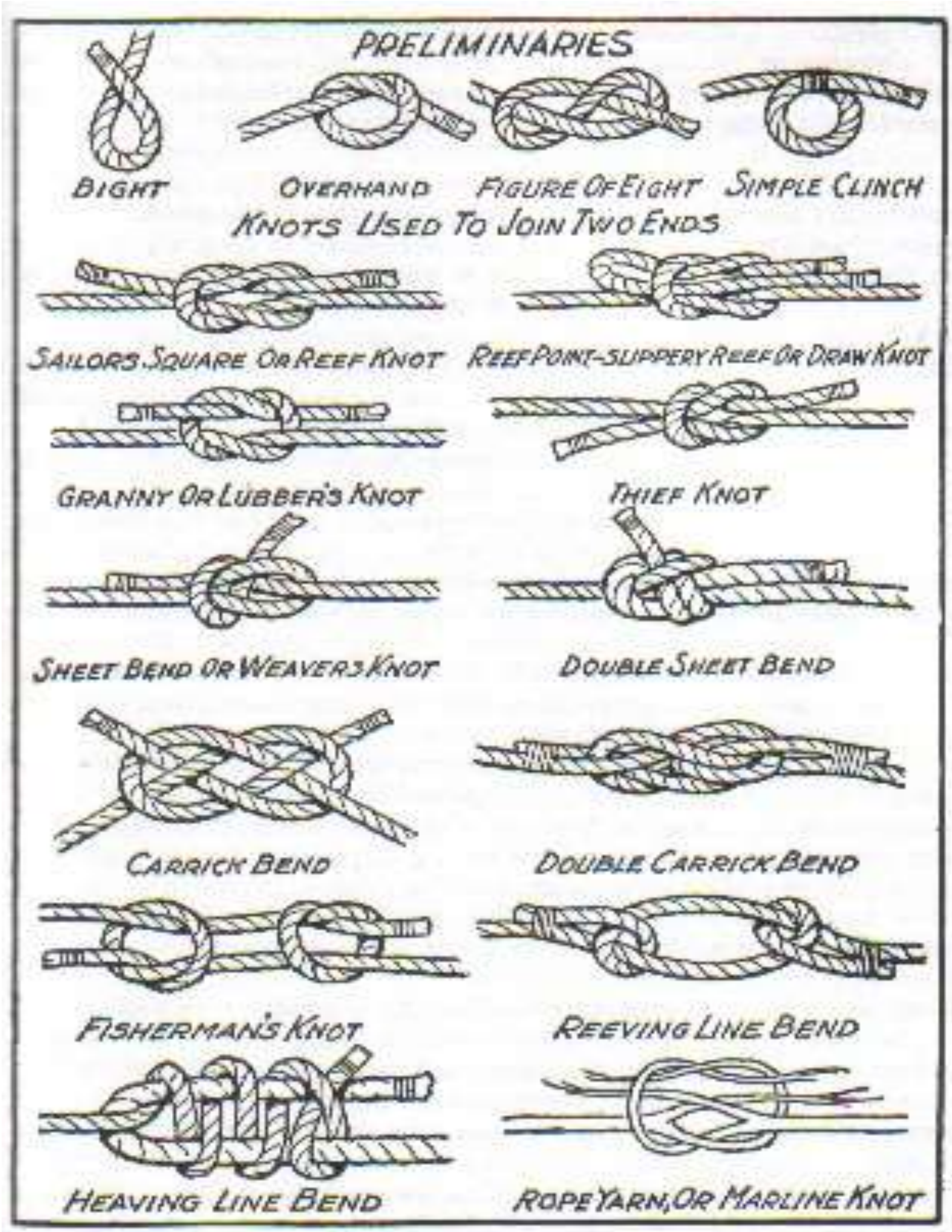
For clearness the knots are shown in their open state, that is, before they have been pulled taut, and hence some knots will, when pulled tight, present a somewhat different appearance than the drawings show.

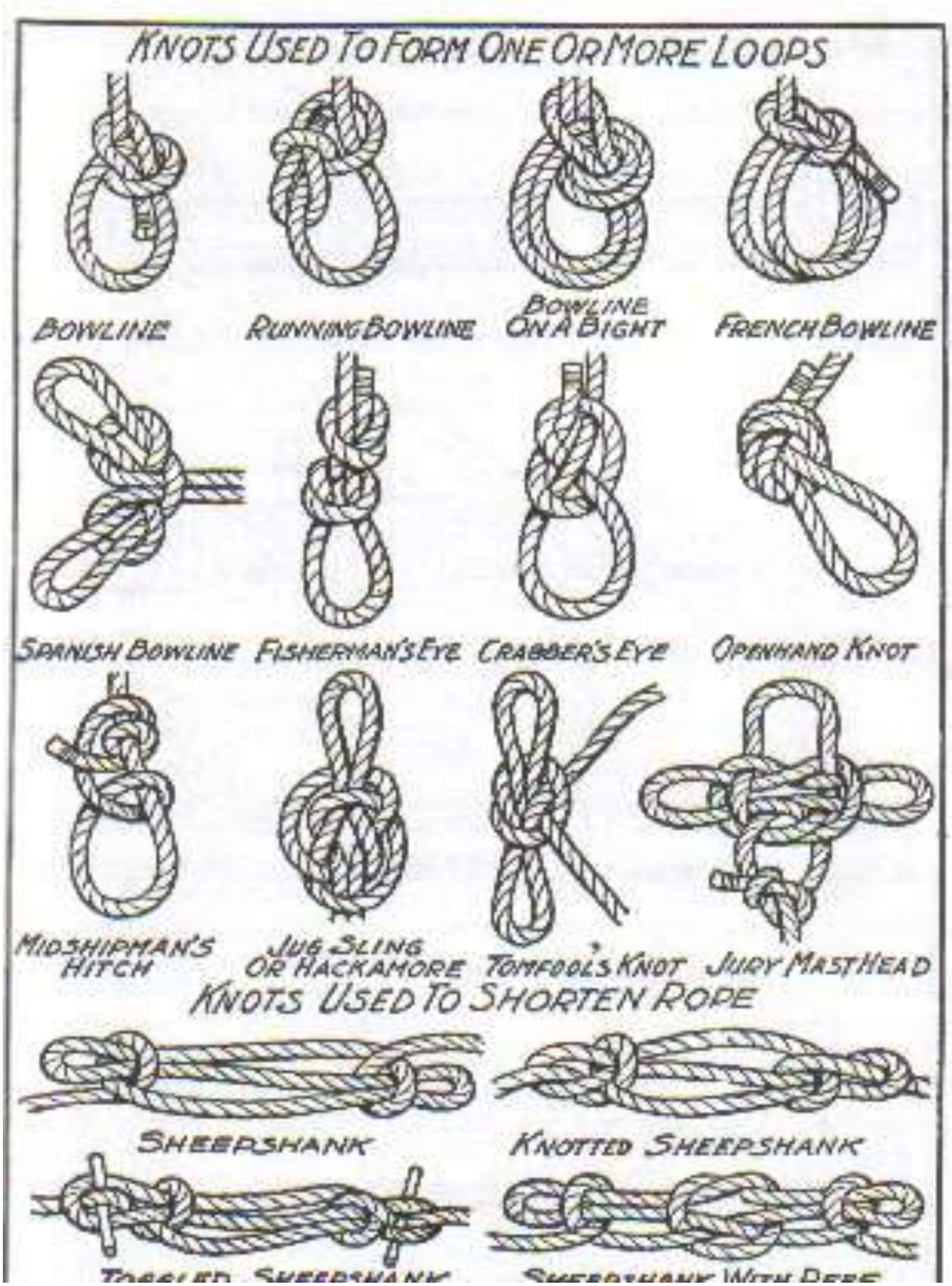
There are many instances of a knot being known by more than one name, especially when used for different purposes. Where possible, this has been noted. Many knots are made in slight1y different ways by different classes of people using them. The illustrations in this book generally show the most universally accepted forms so far as it has been possible to determine them.

In learning to make these knots a 6_foot length of 9_thread Manila rope =ay be used, with the ends whipped as shown in Figure 1_5. The Manila rope may be a little hard to handle at first, but since Manila rope will be the type most often encountered in actual practice, it is just as well to become accustomed to its use. It is also advisable to practice tying knots in awkward positions and in the dark, as this may be necessary aboard ship.

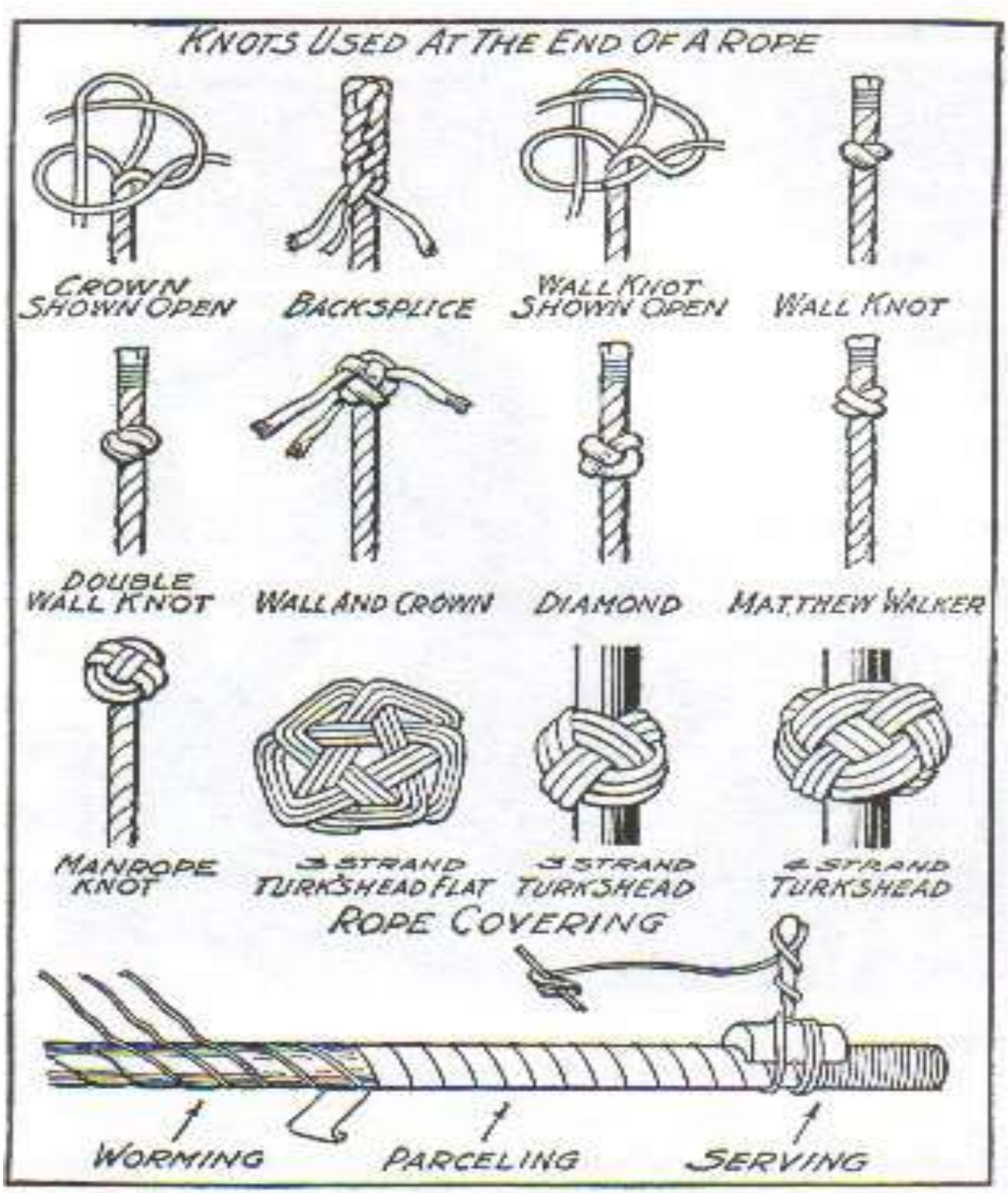


KNOTS USED TO SECURE AN END TO A RING OR HOOK
LARK'S HEAD
DOUBLE LARK'S HEAD
CATSPAW STARTED
CATSPAW ON HOOK
BLACKWALL HITCH
DOUBLE BLACKWALL HITCH
BILL HITCH
MOUSING A HOOK
SEIZINGS
ROUND SEIZING
RACKING SEIZING
ROSE LASHING
SPANISH WINDLASS
WHIPPINGS
STARTED
FINISHED
STARTED
FINISHED
PLAIN WHIPPING
PALM AND NEEDLE WHIPPING


PRELIMINARIES
BIGHT
OVERHAND
FIGURE OF EIGHT
SIMPLE CLINCH
KNOTS USED TO JOIN TWO ENDS
SAILORS SQUARE OR REEF KNOT
REEF POINT-SLIPPERY REEF OR DRAW KNOT
GRANNY OR LUBBER'S KNOT
THIEF KNOT
SHEET BEND OR WEAVERS KNOT
DOUBLE SHEET BEND
CARRICK BEND
DOUBLE CARRICK BEND
FISHERMAN'S KNOT
REEVING LINE BEND
HEAVING LINE BEND
ROPE YARN, OR MARLINE KNOT



KNOTS USED TO FORM ONE OR MORE LOOPS
BOWLINE
RUNNING BOWLINE
BOWLINE ON A BIGHT
FRENCH BOWLINE
SPANISH BOWLINE
FISHERMAN'S EYE
CRABBER'S EYE
OPENHAND KNOT
MIDSHIPMAN'S HITCH
JUG SLING OR HACKAMORE
TOMFOOL'S KNOT
JURY MAST HEAD
KNOTS USED TO SHORTEN ROPE
SHEEPSHANK
KNOTTED SHEEPSHANK



SPLICING

It is very often desirable to join two rope ends together in a neater manner than can be accomplished by the use of knots. For this purpose various methods of "splicing" are employed. Another reason for this type of joining is the fact that a well made splice very nearly approaches the strength. of the rope itself, whereas even the best knots do not.

Small ropes can be spliced by opening the strands with the fingers. For the larger ropes use a marlinespike or fid.

Short Splice*_Unlay for a sufficient distance, the strands of the two rope ends to be spliced. Then intertwine the strands as shown at the left in the next figure. Fasten the, ends temporarily in this position by passing a rope yarn. or string securely around the outside of the joining. The actual splicing is now ready to begin. This is accomplished by passing or "tucking" each strand over and under its companions in the opposing rope end. After this has been done with all six strands, one round of "tucks" has been made. To hold well a short splice must usually be composed of three or more rounds of "tucks."

The Long Splice* is useful when it is necessary to have a joining less bulky than the short splice. To make this splice, unlay the two rope ends for quite a distance and put the ends together in the same manner as in the short splice, but do not tie them. Now unlay one of the strands still further and follow the space left between the remaining two with a strand from the other rope end. This strand should be twisted into the space so that, after twisting has been accomplished the rope appears as it did originally, but instead of consisting of three strands from the same rope, it now is made up of two strands from one rope and one from the other rope. Do this same thing again with the other four strands, unlaying one and following the space made with the opposing strand from the other rope end. The rope should now appear as in the illustration. Make overhand knots with each set of strand ends. Next part the ends of each strand, tucking one half under and over the adjacent strands on one side of the knot and the remainder under and over the adjacent strands on the other side of the knot.

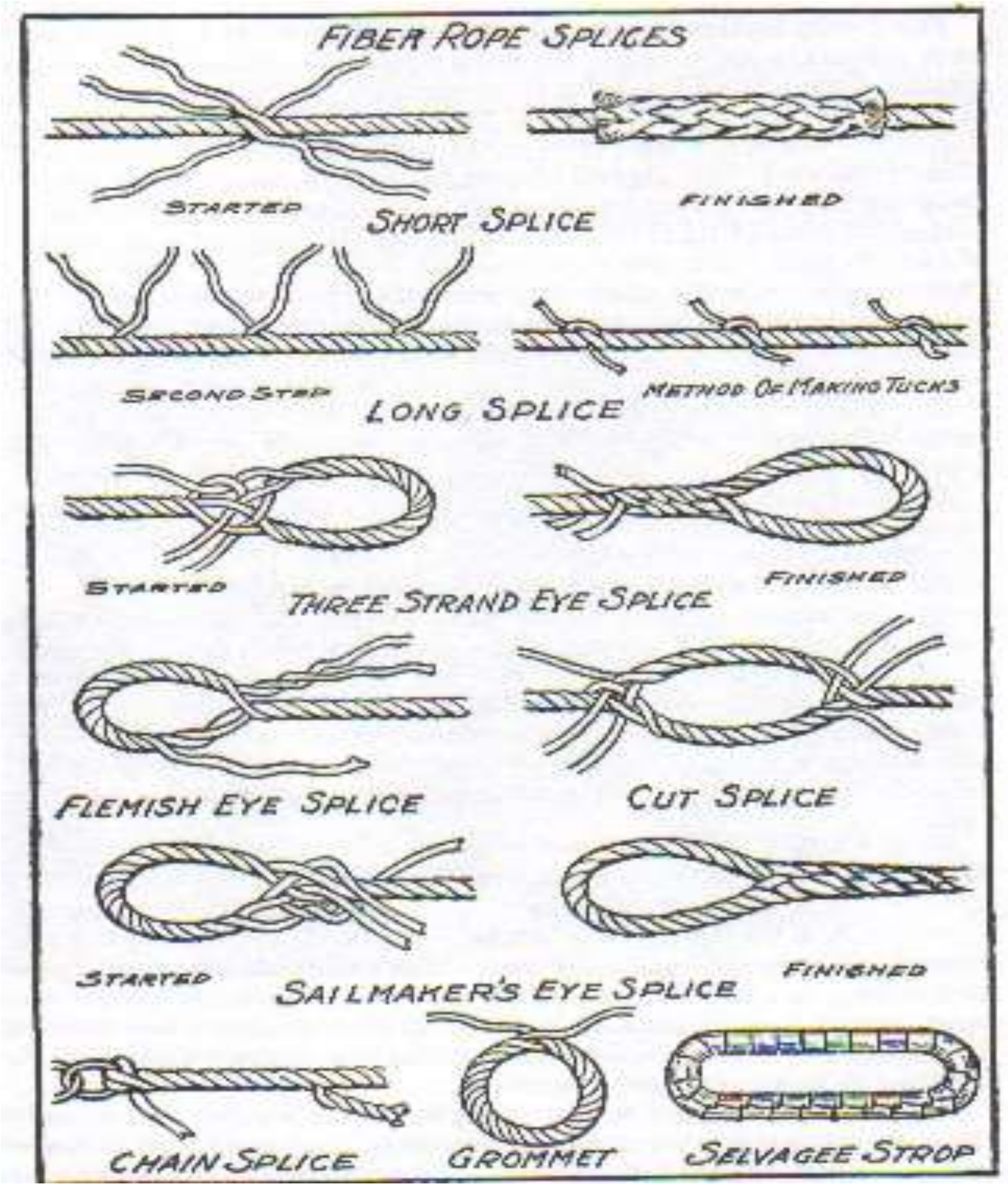
Three-Strand Eye Splice*- Unlay the rope 12 to 24 inches, depending on size of rope. Form the eye of desired size by bending the crotch of the strands back onto, standing part with eye toward you. Now with center strands up and the other two strands on either side, tuck center strand under the strand direct1y below it; left-hand strand passes over the strand under which the first strand was tucked and then under the next strand. Turn the splice over and twist the last strand with the lay to tighten the yarn and tuck it under the remaining strand. Remember that all strands are tucked from right to left. After you have taken full tucks with the three strands, tuck each of them over and under twice more. If splice is to be served, ¡t is well to, cut out one third of the yarns before making the last tucks.

Four-Strand Eye Splice-First or left strand tucks under two (first tuck only); other strands each under one. Direction of tucks from right to, left.

Flemish Eye Splice To make a Flemish eye splice first unlay all strands a short distance, and then unlay one strand further. Form an eye by bending the two strands back to the point where the single strand has been unlaid. Lay up the single strand in its own groove but in the opposite direction. Finish the splice by tucking the three strands in the same manner as in an ordinary eye, splice.

The Cut Splice is made by placing the two ropes side by side and splicing the ends into each other's standing parts as in an eye splice. If a special size eye is desired, take the measurement from throat to, throat. (This splice is used for a quick joining of two ends of a parted wire hawser.) Always see that the two sides of the eye are equal in length.

Sail maker's Eye Splice-In making the sail maker’s eye splice the first, tuck is made in the same manner as an ordinary eye splice and then each strand is tucked around and around the strands of the standing part, with the lay of the rope. The splice should be tapered by cutting out a portion of each. strand at each. tuck after the first.



WIRE AND WIRE SPLICING

WIRE ROPE was introduced into use aboard ship about one hundred years ago. Wire rope, made from steel, comes in a variety of sizes depending upon its intended function. It is made up of a number of individual wires twisted together uniformly around a core of wire or fiber.

Tensile strength and quality of wire depends largely upon the carbon
content of the wire. The kind of wire rope used is of two general classes Improved Plow Steel and Extra Improved Plow Steel. Improved Plow Steel has a carbon content of about 0.70 percent to 0.80 percent; and Extra Improved Plow Steel has a carbon content of about 0.70 percent to 0.85 percent. However, since the carbon content varies with the manufacturer, these figures are representative.

Flexibility, as well as tensile strength, depends upon the number and size of wires in each strand and the number of strands in the rope. A 6xl9 rope has 6 strands with 19 wires in each strand. A 6x37 wire rope has the same diameter, but the individual wires are far smaller. Consequently the wire rope itself is more flexible. Most wire rope used aboard ship is six-strand.

CORES

All wire rope has a core around which the strands are laid up. The core may be natural or synthetic fiber, wire strand, or independent wire rope. Whatever type core is used, its purpose is to support the strands which are laid up around it.

Fiber core, which may be synthetic, Manila, sisal, or hemp, provides a necessary foundation, adding to the flexibility and elasticity of the rope. In addition, when manufactured, the core is permeated with a lubricant which helps to keep the entire rope lubricated. If flexibility is not an important factor, or if the rope is to be used where high operating temperatures are expected, or additional strength is desired, a wire core may be used.

LAY

The term "lay" is used two ways. The first describes the appearance or instruction of wire rope according to direction of the spiral. The second describes the length or distance it takes for an individual strand to make a complete spiral of the rope. Thus, if a strand takes 18 inches to make a complete revolution, the length of the lay is 18 inches.

LAY AS A UNIT OF MEASURE

Showing how "one rope lay" is the lengthwise distance in which a strand makes one
complete turn around the rope.

Although there are several ways in which wire may be laid up, the, most common is right-regular lay. In right-regular lay the, individual wires are laid up in the strands to the left (or in a direction opposite to the direction in which the strands rotate around the axis of the rope), and the strands are laid up to the right. This has the effect of causing the individual wires to point along the axis of the rope. A left-regular lay wire rope shows the individual wires lined up with the axis of the rope, but laid up to the right in individual strands, while the strands are laid up to the left.

Lang lay is the reverse of regular lay. In lang lay both the individual wires and the strands rotate in the same direction. This makes it appear that the individual wires make an angle of about 45 degrees or more with the axis of the rope. However, lang lay is rarely found aboard ship. Finally, there is a reverse lay in which the, wire rope is composed of alternate regular and lang lay strands. This type also is seldom seen.

WIRE ROPE SIZE

Unlike fiber rope which is measured by its circumference, wire is measured by its diameter.

PREFORMED WIRE ROPE

Wire rope is either "preformed" or "non-preformed." If the rope is pre-formed, the wires and strands have been pre-shaped to conform to the curvature which they will take in the finished rope. This helps eliminate locked-up stress and strain which exists in non-preformed rope, and reduces the tendency to kink. Pre-forming also reduces the tendency of the rope to rotate about its own axis. Preformed rope is easier to splice. A most important advantage of preformed rope is that its tendency to unlay or fly apart violently when cut is greatly reduced. Although non-preformed wire is still used, 95 percent of all wire rope sold for shipboard use is now preformed. Originally more expensive than non-preformed, its cost is now almost comparable. There is no difference in the appearance of preformed and non-preformed wire. The difference cannot be determined until the wire is cut. Preformed or not, a seizing should be placed on the wire before cutting.

GALVANIZING

To protect it against salt water and weather, wire rope may be galvanized (zinc coated). This process, however, tends to make the rope stiffer and to reduce its strength by about 10 percent. Galvanized wire is generally used for standing rigging or towing hawsers because it will lose its zinc coating if constantly run through blocks.

CHARACTERISTICS AND USE OF WIRE ROPE

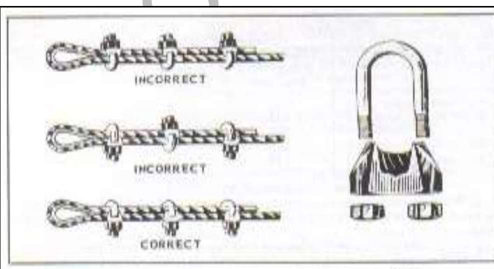


Figure 2-5. Right and wrong way to use wire clips. Courtesy: U.S. Navy.

Note that the correct way of using clips is to place the U-bolts on the short or dead end of the rope. This is because the live or stress-bearing end of the rope should be protected against crushing and abuse. The bearing seats and extended prongs of the body offer such protection. As a safety measure it is wise to check all clips after an hour's running time and at regular intervals because rope tends to compress and the clips to loosen under operating conditions. If clips have been installed on the same rope for a long time, they should be removed and the rope underneath examined for the presence of broken wires. If any broken wires are found, the damaged part should be cut out and a new connection made.

TOOLS FOR WIRE ROPE SPLICING

1. Two "T" shaped splicing pins.
2. Two round splicing pins.
3. One tapered spike for opening the strands and taking out the hemp center.
4. A knife for cutting the hemp core.
5. A pair of wire cutters for cutting off ends of strands.
6. Two wooden mallets to hammer down any uneven surfaces.
7. A piece of hemp rope spliced endless.
8. A hickory stick about the size of an ordinary hammer handle, which will be used to untwist the strands, as shown in some of the following illustrations.

It will be noted that a tapered spike is shown on following pages. Many rope splicers prefer to use the "T" shaped splicing pin for this work.

HOW TO ATTACH A WIRE ROPE SOCKET

1. Measure from end of rope a length equal to basket of socket. Serve at this point with not less than three seizings. Cut out the hemp center but do not cut out wire rope or strand when used as a center. Open strands.
2. Separate wires in strands. Straighten by means of iron pipe. Cleanse all wires carefully with kerosene oil from ends to as near first serving as possible. Wipe dry.
3. Dip wires, for three quarters of the distance to the first seizing, into one half muriatic acid, one half water (use no stronger solution and take extreme care that acid does not touch any other part of the rope). Keep wire in long enough to be thoroughly cleaned. Wipe dry. Serve end so that socket covers all wires.
4. Then slip socket over wires. Cut top seizing wire and distribute all wires evenly in basket and flush with top. Be sure socket is in line with axis of rope. Place fire clay around bottom of socket.
5. Pour in molten zinc. Use only high grade zinc, preferably heated not above 830°F. Do not use babbitt or other antifriction metal. Remove all seizings except one nearest socket. Cool slowly.

BLOCKS AND TACKLES

BLOCKS are one of the most important fittings aboard ship. They are made of either wood or metal and their construction and use should be thorough1y understood. When being lowered away in a lifeboat, life and safety depend upon the blocks in the lifeboat falls.

The frame is also known as the shell. The opening between the shell and the top of the sheave is known as the swallow.

Blocks take their names from the number of sheaves; a single block has one sheave, a double block has two, and so on. They are identified by their shape or construction and also by the use or place they occupy aboard ship.

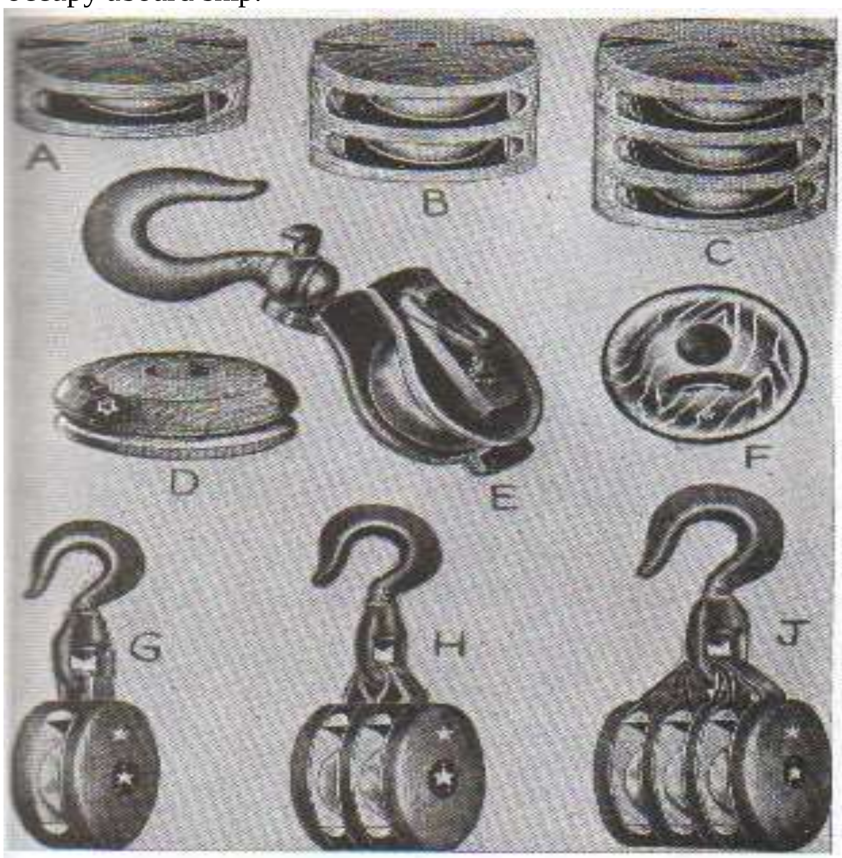


Figure 3-3. A., B., C. Single, double, and triple blocks for rope straps; D. Masthead truck; E. Snatch block; F. Masthead ball; G., H., J. Common iron strapped wood blocks.

TACKLES

A tackle or purchase is an assembly of ropes (falls) and blocks used to multiply power or to gain a better lead as in the use of a single whip, making it easier to handle light loads but gaining no power or mechanical advantage. If the whip is reversed and the block is attached to the weight to be moved, the whip is then called a runner (Figure 3-5, drawing A), and the power or mechanical advantage is doubled.

CARGO STOWAGE AND HANDLING

CARGO STOWAGE AND HANDLING

THE ASPIRING SEAMAN needs to be familiar with all types of cargo stowage and cargo handling. In recent times there has been a revolution in this aspect of marine service. The specialized carriers of today, with their diverse cargoes, methods of loading and stowage and necessary safety precautions, make this a complex task. Both seamen and officers aboard

Figure 5-1. Modern cargo loading operation. Barges being loaded aboard the stern of the S.S. *Almeria Lykes*. Courtesy: Lykes Bros. Steamship Co., Inc.

any particular ship need to understand thoroughly the cargo operations for that ship as well as any problems which may result from the differing types of cargo carried.

As in the past, the main objective of a merchant ship is to load, carry, and discharge cargo from one place to another safely and profitably. Although considerable responsibility falls on the operations department of a shipping company and on longshoremen, it is ultimately the ship's officers and crew who must insure that no damage occurs to the ship or the ship's cargo during these operations.

Today the modern merchant ship is usually a highly sophisticated, specialized carrier. To transport cargo containers of various types, several kinds of specialized ships have developed. First on the seas was the break-bulk ship with container capability. Then came the full container ship. For various types of trade in different areas of the world, further improvements on the container ship were introduced, including LASH, Seabee, and RO/RO, or Roll-on-Roll-off. Each of these cargo systems has its own problems which will be discussed.

Figure 5-2. Modern break-bulk ship with capability of handling containers on deck. This Lykes Lines ship has high capacity booms. Courtesy: Lykes Bros. Steamship Co., Inc.

THE CONTAINER SHIP

The container and container ship as they exist today have been the greatest single advance in the Merchant Marine since the shift from sail to steam. The military were the first to use containers. They utilized odd-sized conex (container-express) boxes as well as ammunition boxes similar in construction although smaller than the present containers. Larger boxes of standardized size evolved but most of them were carried on the decks of standard break-bulk ships. Securing these boxes was a problem, and loading them was difficult and time consuming. Finally, cargo gear was often not adequate to pick up a containerized load.

A few United States companies began to standardize the size of their containers and build or convert ships for carrying them. Container cells were installed in the holds with special gantry cranes designed for rapid and efficient handling of containers.

As the state of the art improved and facilities were developed in most large ports of the world, cranes were no longer put aboard ship. All loading and discharging was done by dockside crane. Again, the use of multiple cranes made the loading and discharge even faster.

From the beginning the rapid turn around time proved to be an economic windfall to the shipping company. Greatly reduced port costs enabled ships to make additional voyages. Although labor disputes caused concern, these problems were worked out through negotiation to the mutual advantage of the operator and the worker.

As containerization became more popular, other advantages were realized. International Size Standards were set so that containers could be easily interchanged from one ship to another. (The current International Size Standards are 8 feet x 8 feet x 20 feet, or 8 feet x 8 feet x 40 feet.) Most companies use these sizes or are converting to them. Shippers realized that the container system offered cargo far more Protection than break - bulk.

Loaded and sealed at the factory, the commodity stayed in its container with no further handling until it reached its consignee. Less breakage through handling resulted and pilferage was reduced. Reefer containers were also developed so that a container had its own refrigeration unit. A reefer cargo no longer poses a threat of loss during the loading operation. All that is necessary is to ensure that, the box is kept at its desired temperature during loading and until plugged in aboard ship.

The ease of loading and discharging containers and the increased security of the container has brought into being an entirely new cargo concept

known as the Intermodal Transportation, or Land Bridge system. Cargo bound from the Far East to New York no longer has to transit the Panama Canal. Instead, the container is loaded at the factory, trucked to the ship, loaded, transported across the ocean, unloaded onto a rail car, transported across the country, and delivered to its consignee. Much time is saved. Anyone who intends to follow a career in the Merchant Marine will profit from a special study of intermodal transportation.

The job of the ship's officers and seamen is somewhat different when working on a container ship. Individual items of cargo are no longer a problem since special cargo is already secure in a locked container. What is of prime importance to the container ship deck officer is that reefer containers are loaded within the proper temperature range and connected aboard ship. This operation must be checked routinely throughout the voyage. The ship's officers also insure that the proper boxes are loaded and discharged, noting the time operations start and stop. They are concerned about damage to the ship, ship's gear, cargo, and containers and inspect and accept for sea the lashing and securing of all containers.

With appropriate planning, a well - organized shore staff can greatly simplify and speed up the loading and discharging of a container ship. However, the master and crew are still responsible for the cargo while aboard ship and must take all necessary precautions to insure its safety. Damaged or lost cargo not only results in expensive insurance claims, but in the loss of a good customer.

LASH, SEABEE AND RO/RO

The container revolution in the dry cargo industry spurred the development of several new classes of ships.

The first used the container idea, enlarged upon it, and provided containers that could be transported by water rather than land after being discharged from the ship. The two most successful types of barge - carrying vessels are LASH (lighter aboard ship) and Seabee (named for "Can Do," Navy CB's). Both require large vessels designed to carry self - contained barges loaded astern. The prime difference in the two types is in the method of loading and stowage. LASH uses a large straddle crane which picks up the barge at the stern and rolls it on tracks to the cell where the barge is stowed. Seabee uses a large hydraulic elevator lift. The barge ¡S floated over the elevator which raises it, and then moves it to its designated stowage position. Of prime importance to this type of ship is the reliability of the barge loading gear. Since only one way exists to load and unload barges, a break - down gear can make the ship helpless. The hydraulic elevator has proved more reliable than the crane.
With use of the LASH and Seabee concept advantage can be taken of an extensive system of water ways minimizing port calls and port time for the mother ship. But markets should be studied carefully before a LASH ship is put into operation because in some trades barge transportation has the reputation of handling low value cargo. In some areas, this leads to putting conventional containers in barges or converting barge space to container space. Both of these operations are very costly.

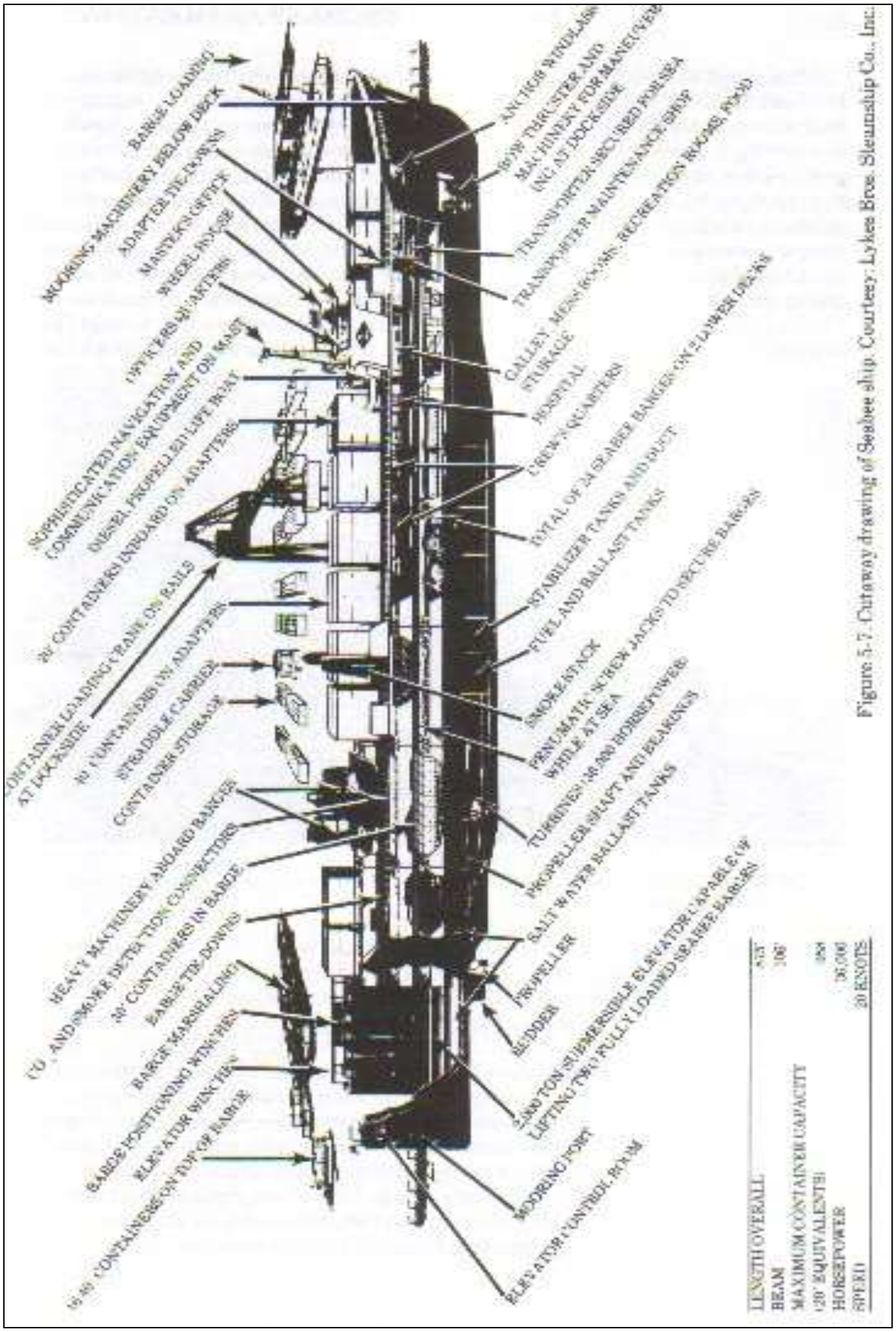


Figure 5-7. Cutaway drawing of Seabee ship. Courtesy: Lykes Bros. Steamship Co., Inc.

ANCHORS

Ship models found in ancient Egyptian tombs were equipped with crude anchors. Some of these ancient anchors were grooved or perforated stones and some were T-shaped stones. Wooden frames weighted with stones (killicks), another old type of anchor, were used for many years and until recently still in use in the Maritime Provinces of Canada.

In the early part of the 19th century the first modern anchor, featuring curved arms, was introduced. This anchor, sometimes called the admiralty or Navy anchor but now simply referred to as the old-fashioned anchor, became standard and was supplied to the British Navy in the 1850s. The American Navy and Merchant Marine used it for many years. Ton-for-ton its holding power is still unmatched by more modem designs.

An anchor will weigh roughly one to one and one-half pounds for each ton of a vessel´s displacement. An anchor works like a pick axe. When the pick is driven into the ground, it will require a tremendous amount of force to pull it loose with a straight pull on the handle. By lifting the handle, however, a leverage is obtained which breaks ¡t free. In the same way, an anchor holds because a long cable causes the pull on the anchor to be in line with the shank. When ¡t is desired to break the anchor free, the cable is taken in and this lifts the shank of the anchor, producing a leverage which loosens its hold.

TYPES OF ANCHORS

The old-fashioned anchor was in general use from the mid-19th century until shortly before World War I. It was stowed horizontally on the billboard or on the fo´c´sle. Obviously when hoisted it could not be pulled into the hawsepipe and it was necessary to "fish" and "cat” the anchor in order to secure it for sea. This was a tedious and time-consuming process. Another disadvantage was that one fluke would be buried in the sand or mud and the other would be protruding from the bottom-waiting to foul the anchor chain when the ship swung with the tide. For these reasons the old-fashioned anchor has dropped into disuse. It is now chiefly used as an ornament in front of maritime museums, at the main gate of naval bases, and in chapels whose congregations are largely made up of the seafaring community. Among the last old-fashioned anchors in general use on a ship of any size were those installed on the Coast Guard Training Ship Eagle, and these were replaced by patent anchors in the late 1950s. Old-fashioned anchors are still used for boat anchors and by yachtsmen for small craft. Occasionally, they are used in permanent moorings. Replicas are used as the insignia for merchant marine deck officers, midshipmen, and boatswains.

There are several types of patent anchors, sometimes called "stock1ess anchors" (one exception, the Danforth does have a "stock"). The patent anchor has many advantages over the old-fashioned anchor. It is easier to stow and less apt to foul.

The anchor shown in next figure is typical of what is used in the Merchant Marine or U.S. Navy. It is called the Baldt anchor and has excellent holding power, stows easily in the hawsepipe, and rarely fouls.

Other types of anchors are: The Gruson_Hein is an old German anchor which carries its flukes close to the shank. This is an advantage when swinging because one objection to the double fluke anchor is the tendency to cant as greater pressure comes on one fluke and then the other. The wider apart the flukes, the greater the canting effect.

The Danforth anchor combines the stock of the old-fashioned anchor and the flukes of the patent stock1ess anchor. It has excellent holding properties and is used as the stern anchor for navy landing ships and landing craft as well as on smaller vessels. It is excellent in a sticky or mud bottom.

The Northill anchor is lightweight. It was used in seaplanes and is popular among yachtsmen.

The Eells anchor is widely used in salvage operations. With an open back design, ¡t utilizes suction to increase its holding power in soft bottoms.

GROUND TACKLE

A comparatively new development of unusual design is the **Bruce** anchor which is of British manufacture. It is coming into use in offshore oil rigs and their supply vessels. It buries itself deeply, and has extremely high holding power. It requires low breakout force.

The **mushroom** anchor is excellent for permanent moorings, channel buoys and other navigational aids. It is also used for submarines. It takes firm hold and remains fixed under adverse conditions. As the anchor oscillates under strains, it buries itself deeper still.

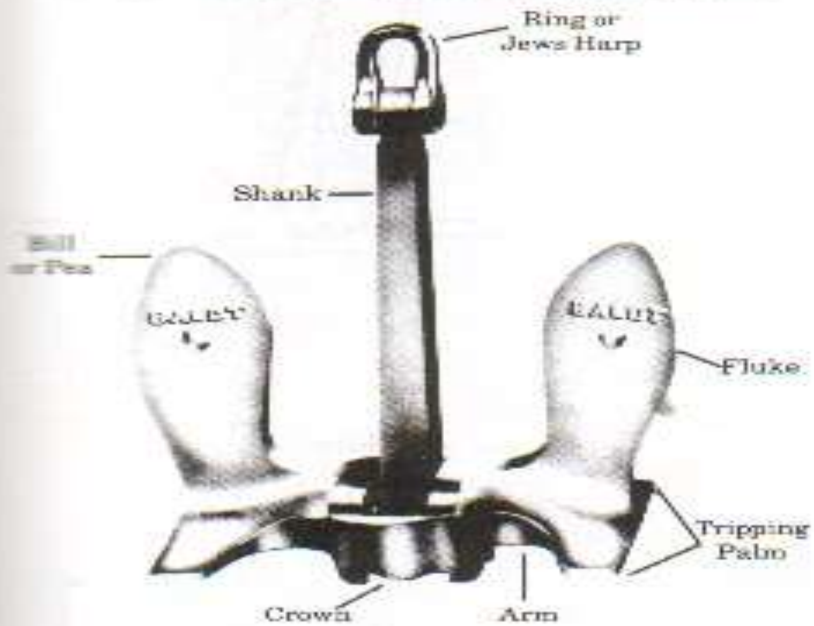


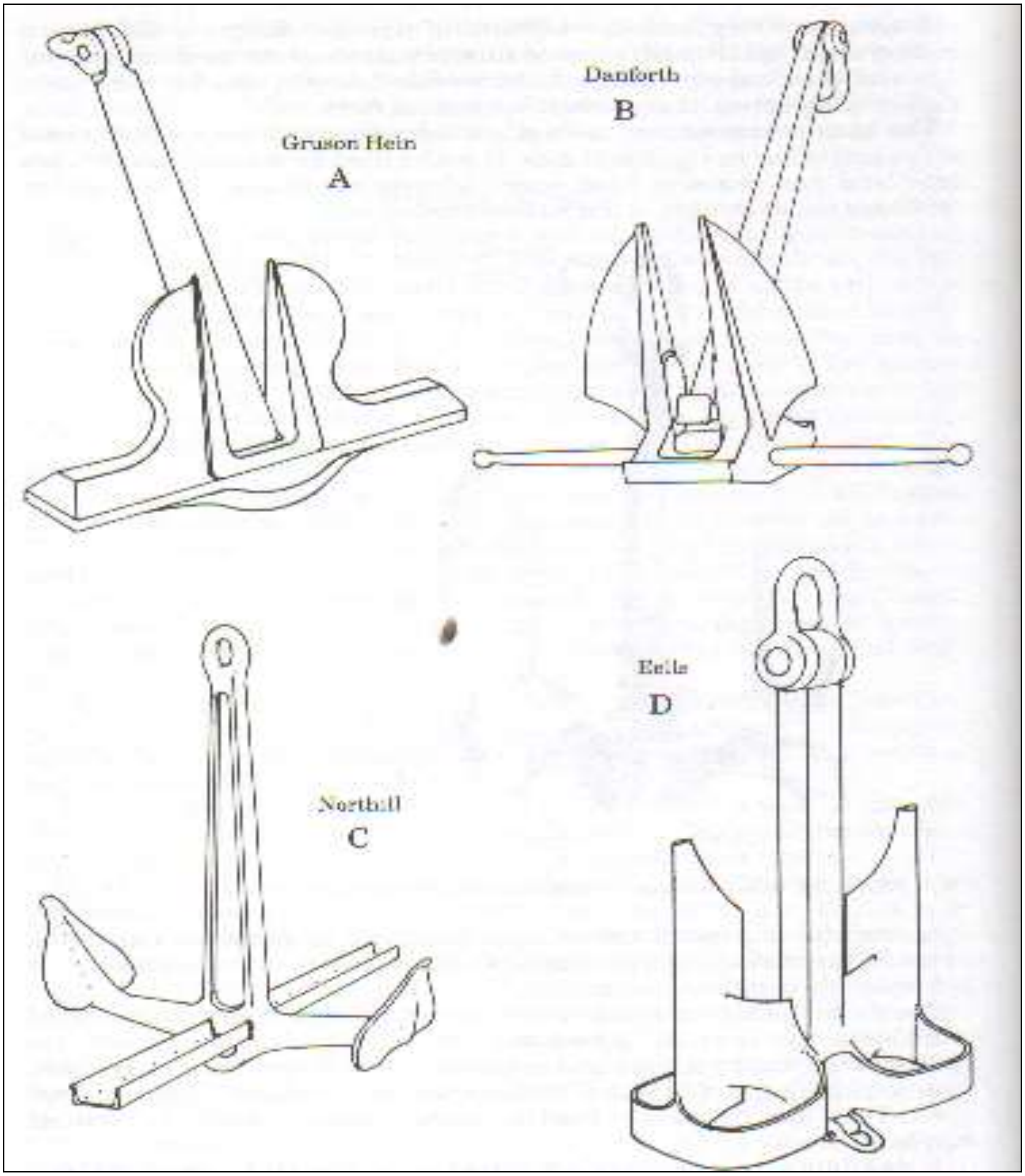
Figure 8-2. Baldt stockless anchor. Courtesy: Baldt, Inc.

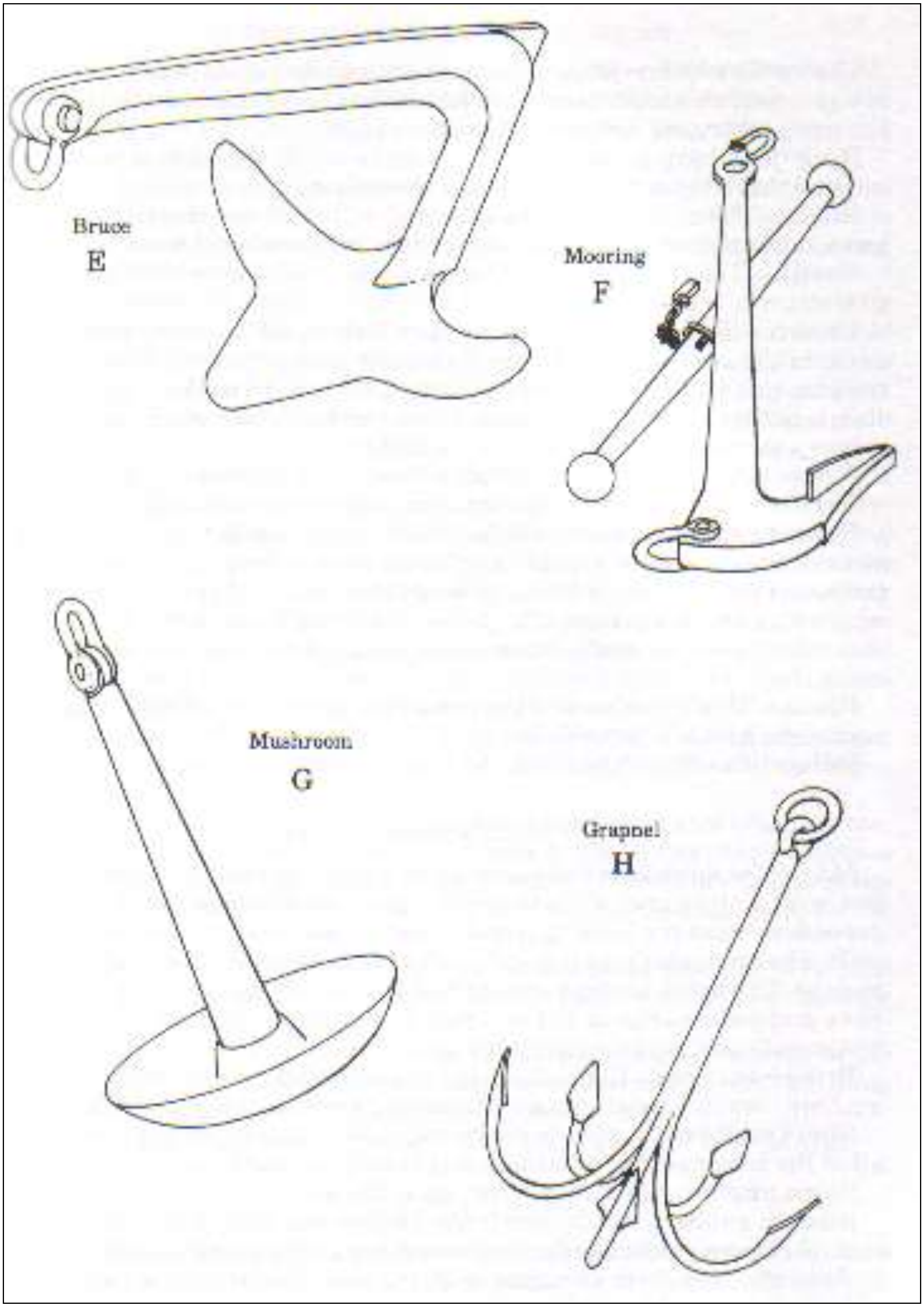
A **grapnel** is a small anchor used for dragging purposes, recovering items lost overboard, and picking up chains or cables lost on the bottom. It is frequently used as a boat anchor.

The **mooring** anchor is rarely seen in normal use, but is sometimes used as an ice anchor in arctic operations.

Mooring clumps are not anchors, but are used as anchors and should be mentioned. They are blocks of stone or concrete, and are fitted with iron eyes. They are frequently used to anchor mooring buoys or channel markers.

A **deadman**, any heavy object buried in the ground ashore to which a mooring line or wire can be run, can be an anchor. In ice operations it is a timber or other heavy object frozen in the ice from which a ship can be moored. Its use is preferred to a mooring or ice anchor.


Gruson Hein
A
Danforth
B
Northill
C
Eells
D


Bruce
E
Mooring
F
Mushroom
G
Grapnel
H

CARE OF ANCHOR CABLES

CARE OF ANCHOR CABLES

Ground tackle is very important to the safety of a ship and very expensive, therefore, it must be given the best of care. Links should be tested when anchor is weighed and at regular intervals the cable should be ranged (laid out) for inspection and overhauling. The shackle bolts, forelock pins, locking pins, lead rings and swivels must be examined for defects. The shots should be interchanged; the little ones at the bitter end should be transferred to the outboard and vice versa. This change of position of shots when carried out in a systematic manner will insure uniform wear of the entire cable.

The Navy method of examining chain links is to wash the chain with a hose while heaving in slowly. Each link is sounded with a hammer and if one is found with a false ring it is given a close inspection.

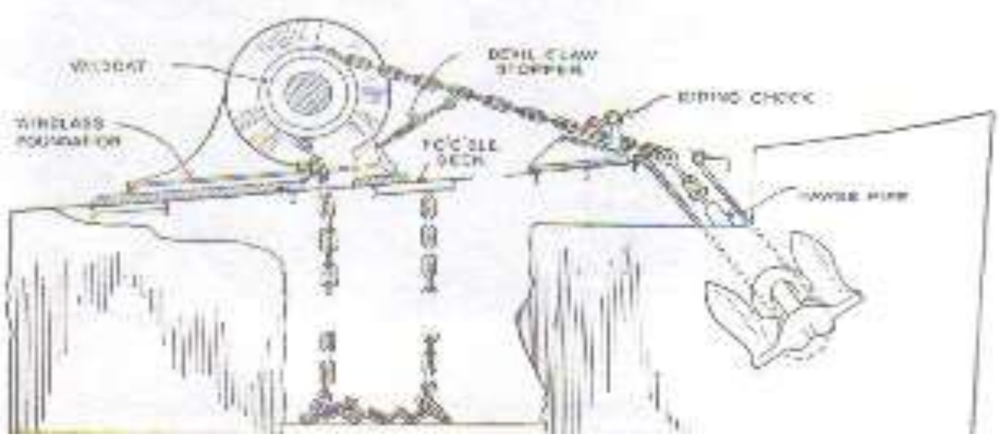
Any change in length of the chain should be noted. *The Naval Ships' Technical Manual* states that "the overall length of six links, measuring from every third link, shall be checked and a minus tolerance of one-eighth inch or a plus tolerance of three-quarter inch for each one inch of wire diameter shall be permitted."

One source of possible damage to the chain occurs when anchoring. As the anchor strikes the ground, the end links may drop forcefully on the jews harp. Over a long period of time this action may cause fractures in the links or in the jews harp. This kind of damage can be eliminated by securing a block of wood in the jews harp.

When it has not been practicable to range out the chain for an extended period, pour 5 to 10 gallons of fuel oil over it as it lies in the locker.

THE WINDLASS

The windlass is a machine used to raise the anchor. It consists primarily of an engine, which may be either steam or electric; the wildcat which is the gear used to grip the chain; suitable controls for connecting the wildcat to the engine, and brakes for controlling the wildcat when it is not engaged with the engine (Figure 8-10).



DEVIL CLAWS

In the Merchant Marine devil claws (Figure 8_12) are used as a stopper and consist of a metal claw attached to a turnbuck1e which in turn is secured at the base of the windlass. In operation, the devil claws are used when the vessel is leaving port and securing for sea. The claws are put on a link of chain and the turnbuck1e is set up, acting as a permanent stopper. The devil claws cannot be released under tension.

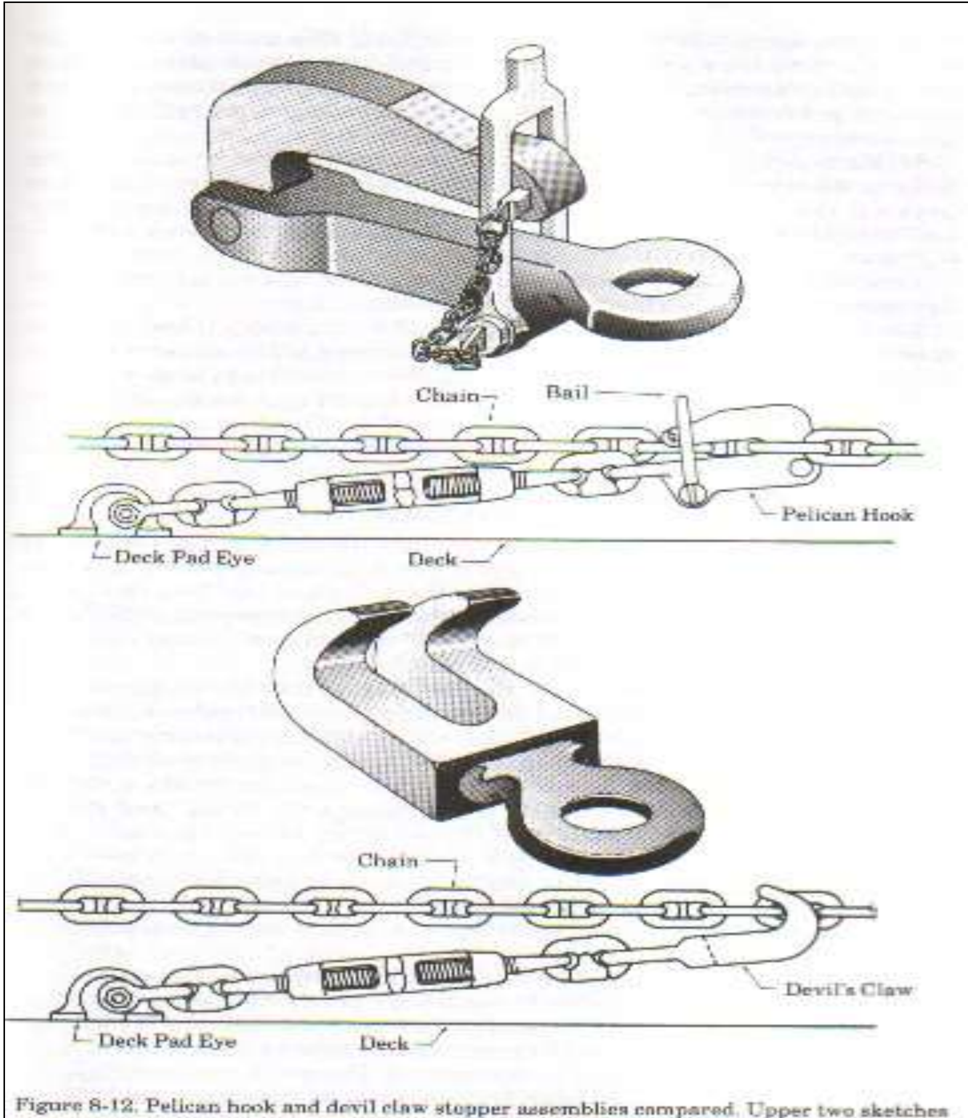


Figure 8-12. Pelican hook and devil claw stopper assemblies compared. Upper two sketches are pelican hook and pelican hook assembly. Lower sketches are devil claw and its assembly. Pelican hook can be released under tension, devil claw cannot. Navy uses pelican hook, Merchant Marine normally uses devil claw. Courtesy: Baldt, Inc.

INTERNATIONAL FLAGS

SINGLE LETTER SIGNALS

(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 harbor—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 pratique.
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 require 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 grounds, it means: "I am shooting nets".
29 COMMUNICATIONS

TANKERMAN GUIDE

The operation and setting of cargo valves during the loading of cargo is an important matter. The senior officer present should supervise the handling of all valves. The dock or terminal man should be given a "standby" order from 5 to 10 minutes before the loading is started, stopped,

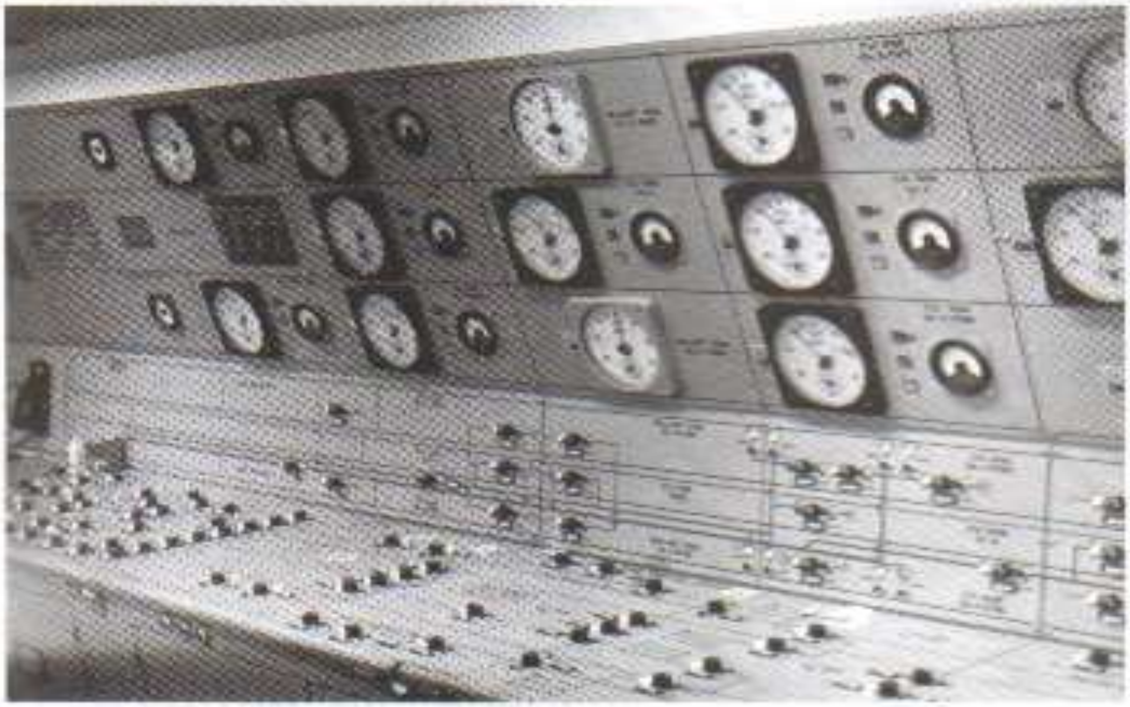


Figure 14-5. Control panel of *Exxon Benicia*. Control of cargo loading and discharging is from the control room. Status of all tanks is continuously shown on the panel. Photo: Mido. R.L. Schopp, California Maritime Academy.

or reduced in rate. The quick closing of a ship valve may result in bursting the loading hose or mechanical loading arm.

When setting cargo valves in the "open" position it is a good practice first to open the valve all the way, and then to close it about one-fourth turn in order to be certain that the valve is not jammed in the open position. When closing cargo valves it is a good practice to close them tight and then open them one or two turns and then close them tight again. By this means any scale or foreign substance which may have become lodged under the valve gate or disk, preventing it from seating tightly, will be washed clear. As each tank is topped off and its valve is closed, it is a good practice to check the liquid level in it during the time the remaining tanks are being finished to make certain that the valves are not leaking. In the loading of tank vessels the opening and closing of some tank valves change the rate of flow of oil into those tanks where the setting of the valves is not changed.

SHIP CONSTRUCTION AND STABILITY

SHIP CONSTRUCTION as we find it today is the result of centuries of experience. It has changed over the years more through a process of evolution than of revolution. Many superfluous parts have been eliminated. Structural members have been reduced in size and strength. New materials have been developed, and testing has refined the size as well as the shape.

Many advancements in mathematical sciences have led to more sophisticated ship designing by the naval architect. No longer is trial and error the only means of determination. Precise calculations often with the use of computers have greatly aided the naval architect in the advancement of modern ship design.

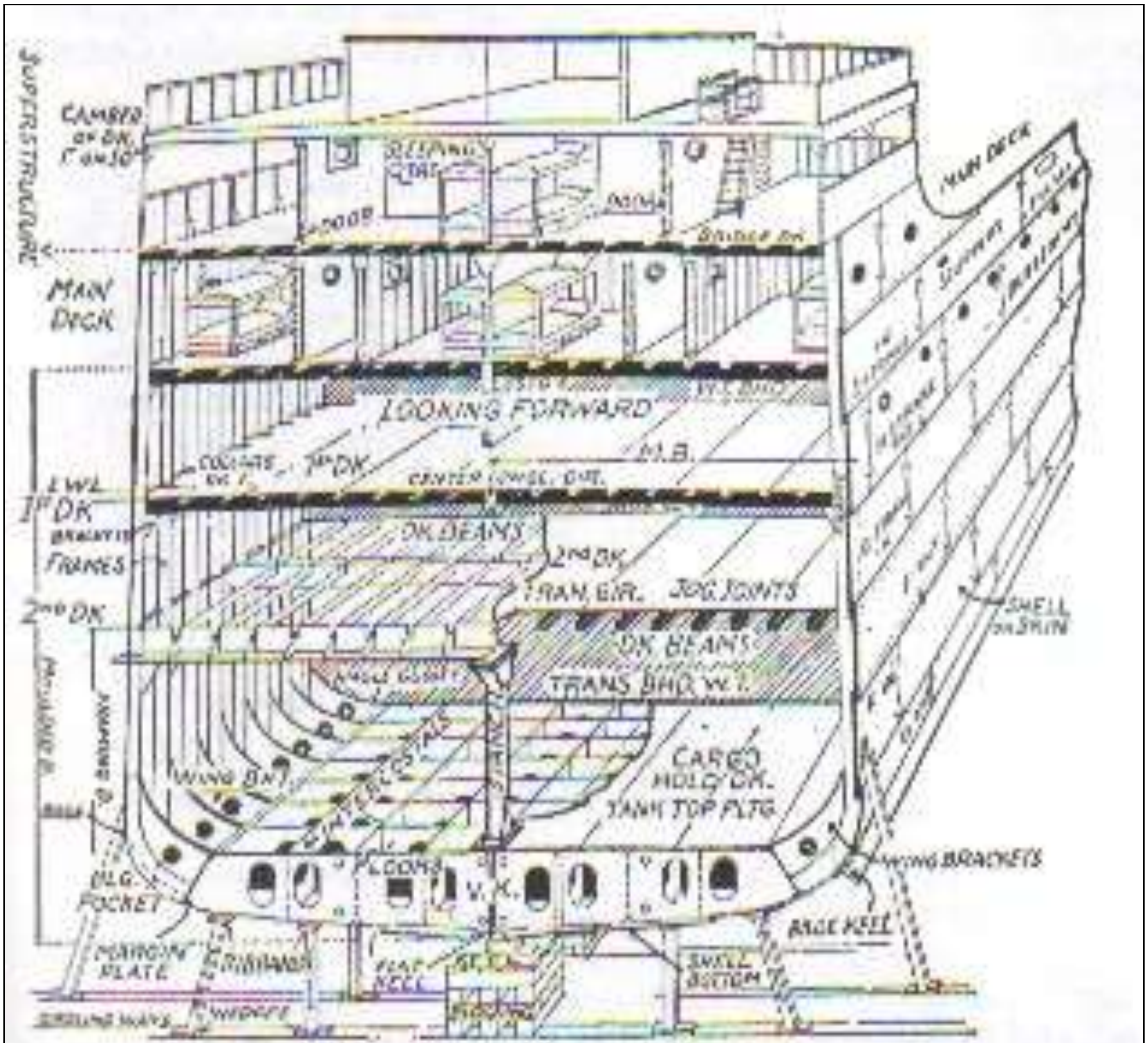
SHIP STRUCTURE

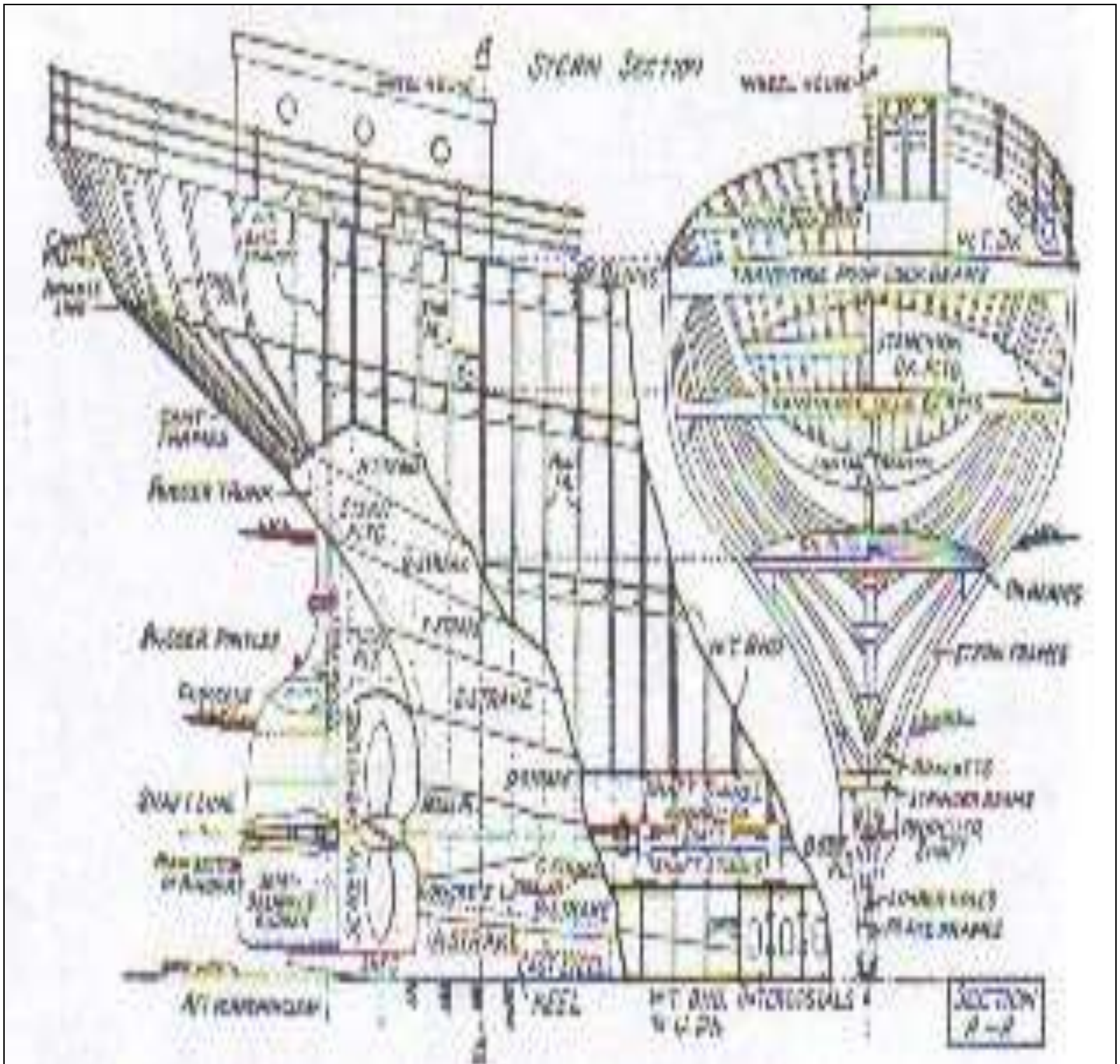
The main structure of a ship is composed of a multitude of parts that are introduced either for strength, watertightness, safety, or, equally important, function. Many new requirements for vessels have led to radical departures from past design criteria. Formerly, the basic ship was designed for the carriage of cargo where no space could be wasted and weight was kept as low as possible. Craft for specialized industries such as offshore drilling and mining, research, and fishing have lead to new innovations in ship design.

Generally speaking, the cargo ship may be considered as a huge box girder, the sides of which are composed of shell plating and the deck. These parts are, in turn, strengthened by such members as the keel, frames, beams, keelsons, stringers, girders, and pillars. An understanding of the function of each of the above parts is essential.

The keel is primarily the backbone about which a ship is built. It consists of a rigid fabrication of plates or beams which run fore and aft along the centerline of the ship. At the forward end of the keel is connected the stem and at the after end are the sternframes which support both the rudder and the propeller.

The frames are the ribs of the ship. Their lower ends are attached at intervals along the keel, and their upper ends are attached through brackets to the beams which support the deck. Internal bracing is provided by keelsons and stringers which run fore and aft. The frames must determine the form of the ship and support and stiffen the shell plating.


SUPERSTRUCTURE
MAIN DECK
LOOKING FORWARD
1st DK
2nd DK
FRAMES
DK BEAMS
TRAN. GIR.
TRANS BHD. W.T.
CARGO HOLD DK.
TANK TOP PLTG.
WING BKT.
FLOORS
V.K.
BLG. POCKET
WING BRACKETS
BILGE KEEL
SHELL OR SKIN
SHELL BOTTOM
FLAT KEEL
MAIN DECK



STERN SECTION
WHEEL HOUSE
CANT FRAMES
RUDDER TRUNK
RUDDER PINTLES
KEEL
SECTION A-A

LOAD LINE

A load line is a line that limits the maximum mean draft so that there will be sufficient freeboard and reserve buoyancy to insure the safety of the vessel. The position of the load line on American ships is determined by the American Bureau of Shipping and indicated on the sides of the hull by Plimsoll marks (Figure 15-4).

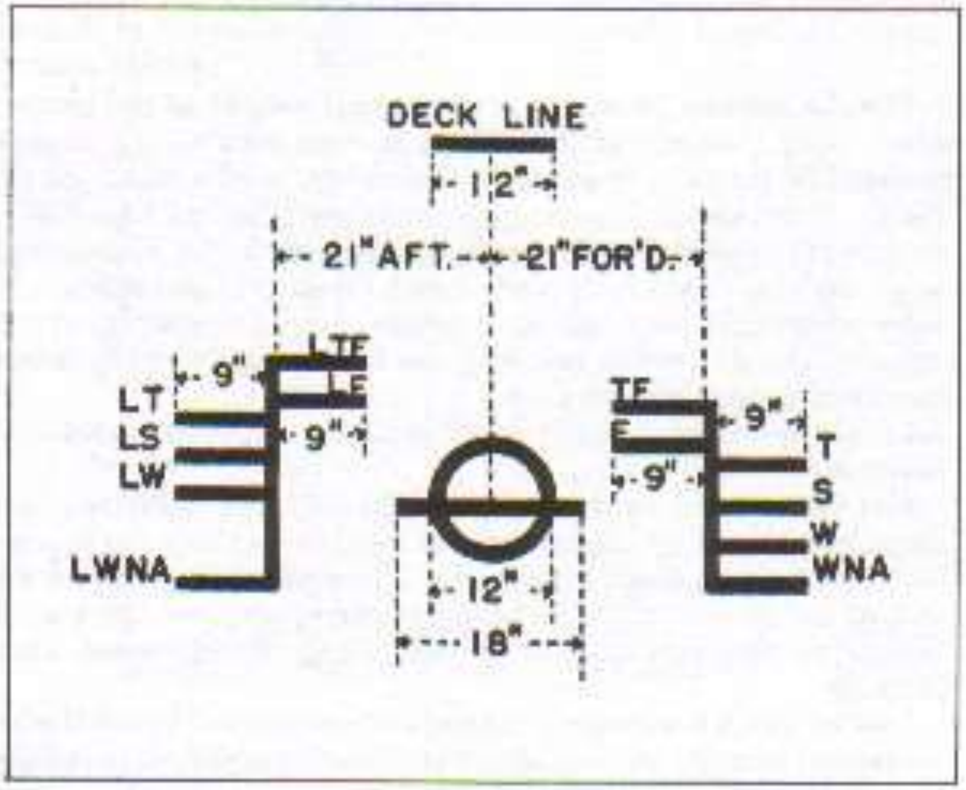


Figure 15-4. Standard load line.

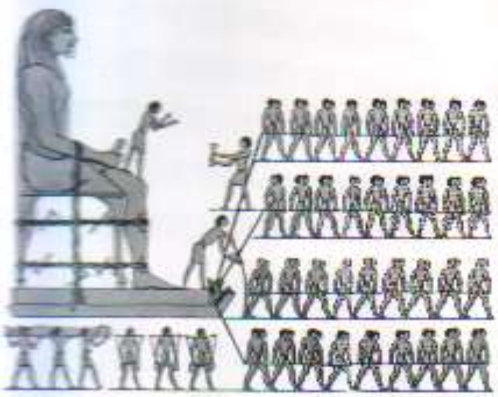
Plimsoll marks consist of a disk with a horizontal line through its center, indicating the summer load line, and a series of other horizontal lines indicating the load lines for various waters and seasons. The abbreviations used to mark these lines are as follows:

- **F** or **FW**—Fresh water.
- **IS**—Indian Ocean in summer.
- **WNA**—North Atlantic in winter.
- **S**—Summer in waters other than Indian Ocean.
- **W**—Winter in waters other than North Atlantic.
- **T**—Tropical waters.
- **TF**—Tropical fresh waters.

2. MARINE ENGINES

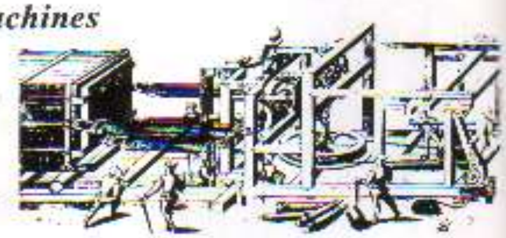
ENGINE HISTORY

1. A short history of motive power

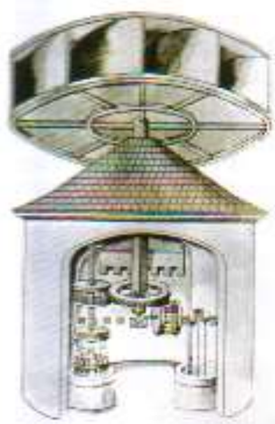


● *In the ancient past, human power was the only source of motive power.*

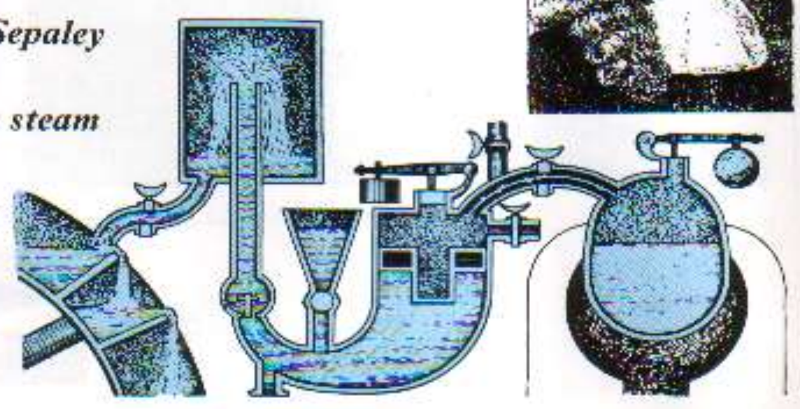
● *The use of the pulley made possible the use of machines instead of human power as the source of motive power.*

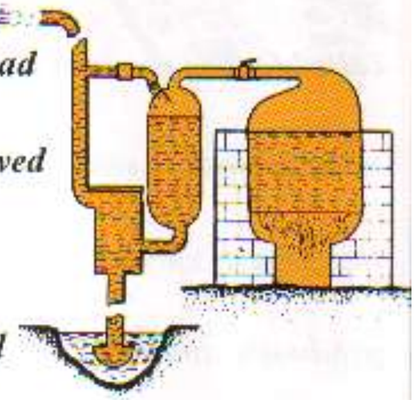


● *At the beginning of modern times, not only manpower, but also domesticated animals such as horses and cattle and water power came into use as a motive power source.*

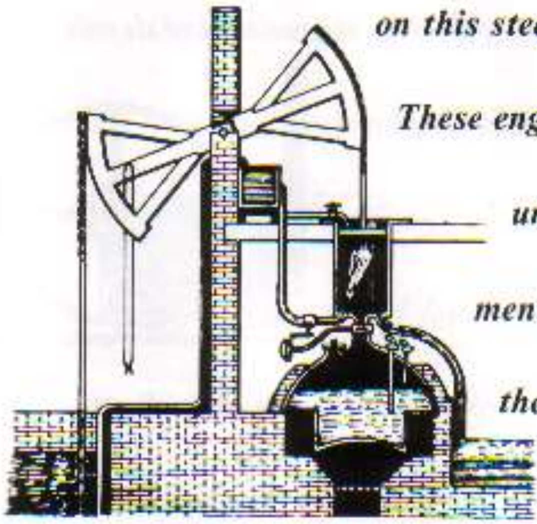


● *As civilization progressed, the steam engine was made by Papin in France. In 1698, Sepaley in England invented a steam engine to power pumps to remove water from mines.*

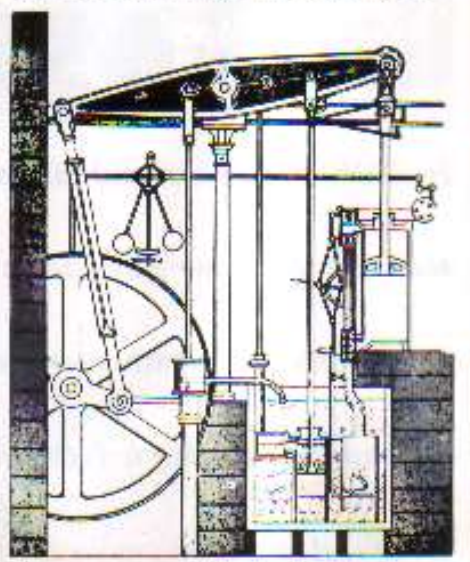




● But, the steam engine invented by Sepaley had some problems, and Newman in England improved on this steam engine.

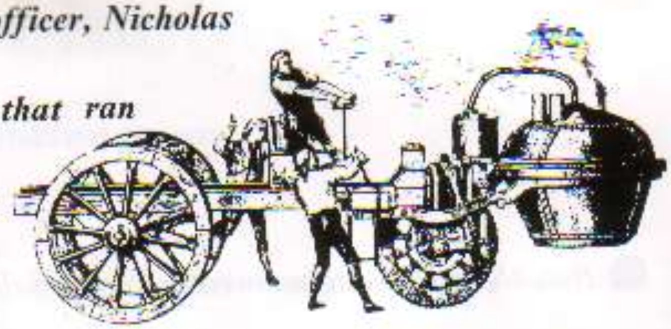


These engines were still uneconomical and needed more improvement. ● In England, James Watt added the separate condensor. The invention of the reciprocating (double action) engine made possible an increase in the power produced by the piston. This engine supplied the motive power for the industrial revolution.

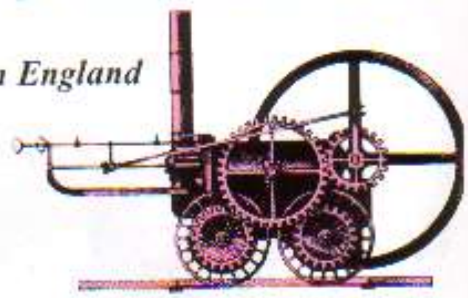


The steam engine invented by Watt lead to the machine age and various types of transportation using steam engines as the power source were born. These original steam engines were the basis for our present day excellent transportation engines.

● *In 1769, a French army officer, Nicholas Joseph Qunoe invented a car that ran on steam. The cars today called Qunoe received their name from this steam powered car. The people of that time thought this type of car was dangerous.*

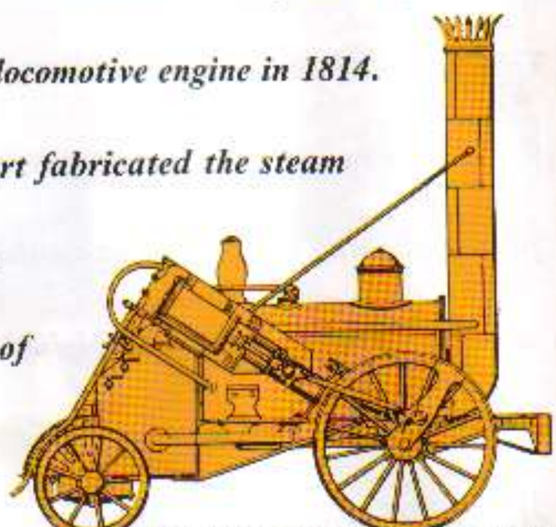


● *The steam engine developed gradually and in 1797, Richard Travisk in England made the first steam engine locomotive. Fifteen years after that, an Englishman, John Prenkinsop made a steam engine locomotive for the Middleton Mine Railroad.*



● *The most famous inventor of steam locomotive engines was George Stevenson in England. He succeeded in producing a steam locomotive engine in 1814.*

In 1829, Stevenson and his son Robert fabricated the steam locomotive engine named the rocket. This engine ran at an average speed of 32km per hour and led to our present day trains.



● *In 1860, Binotti made an electric motor. This was perhaps the first electric motor. Around this time the study of electricity became popular.* ● *On the other side of the world in Japan— When the government was under the political control of the Tokugawa Shogun, the main type of transportation was the so-called relay station network which incorporated horses and the palanquin.*

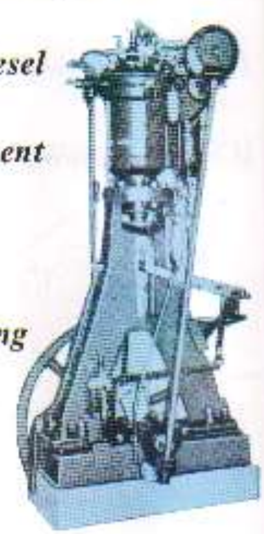
● *In the Meiji era, Japan changed a great deal. The country was once again opened to the world for trade and exchange of knowledge. The "rikisha" was built around 1869 by Yosuke Waizumi, Kosuke Takayama and Tokujiro Suzuki.*

Relay station transportation system

In the spring of 1870, it was given official permission to operate in Tokyo. When the riding carriage was first introduced into Japan, it's comfort and convenience were highly praised and this provided the idea for making the Rikisha. One hundred years before this steam powered cars were already running in Europe.

● *For coal burning steam engines, only a part of the heat produced from burning coal is used to heat up the water to produce steam but not all of the heat produced is used to drive the cylinders because of heat losses. Gas powered engines were made to solve this problem. The first gas engine was invented by Renior in France in 1860.* ● *The German Nicholas Otto added intake, compression, combustion, and exhaust cycles to this engine to produce the improved 4 cycle engine we know today.*

Gasoline engines and petroleum engines were made by using the 4 cycle principle. In 1876, Otto made a gasoline engine; in 1885 his apprentice Daimler made a 4 wheel gasoline powered car. ● *At the same time that Daimler was making cars, the German Karl Benz produced a three wheel gasoline powered car.* ● *In 1893, Dr. Rudolf Diesel, in Germany made the world's first diesel engine. The diesel engine has gone through many improvements and at present is widely produced as the most advanced power source. This engine has greatly contributed to society by providing comprehensive power for every type of industry in farm villages, fishing villages and cities.*



CLASSIFICATIONS OF MOTORS

All machines require power for operation. A machine which changes various forms of natural energy into mechanical energy or motive power Is called a prime mover.

(1) Water power uses the potential energy of falling water.

(2) Heat Power

a) Heat energy possessed by coal, o¡¡, natural gas, and

charcoal. b) Heat of the sun. c) Heat of the earth. d) Differences in temperature.

(3) Wind power uses the speed energy of the wind.

(4) Tide power uses the potential energy of the sea, movement of the ocean using the difference in the ebb and flow of the tide.

(5) Atomic Power

HEAT ENGINES

A heat engine is a motor which changes thermal energy into mechanical energy. The most important types of heat engines used today are:

Heat engine:
Internal combustion engine
Gas engine
Gasoline engine
Kerosene engine
Hot bulb engine
Diesel engine
Gas turbine
External combustion engine
Steam engine
Steam turbine

An internal combustion engine burns the fuel directly inside the engine; external combustion engines burn the fuel outside of the engine and the fuel is used as an indirect source of power.

INTERNAL COMBUSTION ENGINE

An internal combustion engine is a type of heat engine. Heat engines, as previously mentioned, change heat into mechanical energy, Le. fuel is burned to provide thermal (heat) energy. But, today, atomic power based on nuclear reaction is starting to be used. In order to continuously change heat energy into mechanical energy two heat reservoirs at different temperatures, one high and one low, and a heat transfer fluid (working fluid) are necessary. The' working fluid changes part of the heat received from the higher temperature heat source into mechanical energy and the unused heat is released in the lower temperature heat reservoir. The working fluid then returns to the higher temperature heat source and the cycle is repeated.

A simple classification of internal combustion engines:

(1) Classification by physical design.

a) reciprocating internal combustion engine b) gas turbine c) jet propulsion engine d) rotary combustion engine

(2) Classification by the type of fuel used

a) gas engine-combustion of a solid fuel in a gas generator with the generated gas utilized the fuel source. b) gasoline engine c) petroleum engine d) heavy oil engine

(3) Classification by thermo dynamic cycle

a) constant volume cyc1e (Otto cycle)-gasoline engine petroleum engine. b) constant pressure cyc1e (diesel cycle)-low speed diesel engine. c) synthetic cycle (sabathe cycle)~high speed diesel engines.

(4) Classification by mechanics

a) 2 cyc1e engine (2-stroke 1-cycJe engine) b) 4 cycle engine(4-stroke 11-cycle engine)
5) Classification by cooling system

a) air-cooled type b) water-cooled type c) special liquid cooling type, water mixture of ethylene glycol or glycerine. d) steam cooling type

(6) Classification by cylinder arrangernent

a) horizontal engine b) vertical engine c) slant engine d) radial engine e) in-line type f) V-type

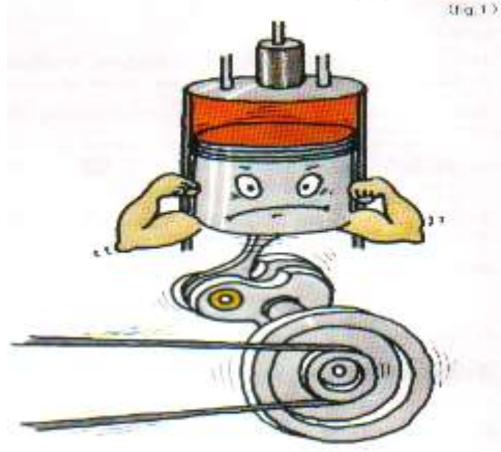
(7) Classification by ignition system

a) heat bulb engine b) electrical ignition system c) compression ignition system

OUTLINE OF THE DIESEL ENGINES
1. Piston engine principles

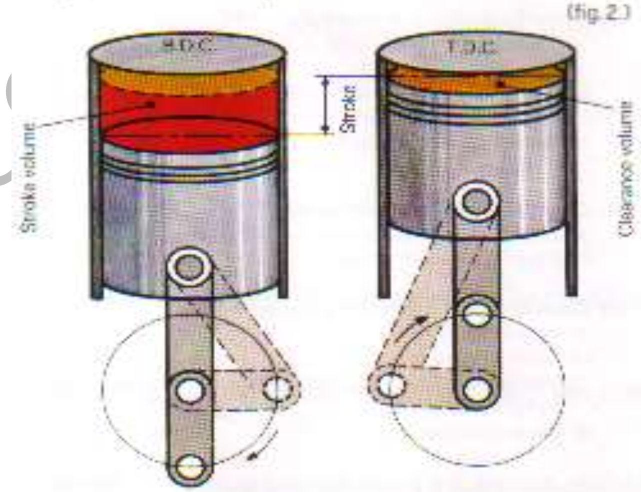
The basic working principle of the piston engine: air is drawn into the cy1inder and compressed; fuel is added when the air is drawn into the cylinder or after compression, and the air-fuel mixture is ignited and combustion takes place. The combusted gas expands and the heat energy of the gas is changed into mechanical energy; the exhaust fumes are pushed out of the cylinder. This process is then repeated. Normally compression and expansion is handled by the reciprocating piston in the cylinder. The four cycles of compression, combustion, expansion and (cooling) exhaust of the burned gases are done in the same cy1inder. To provide a tight fit between the piston and the cylinder wall the piston is fitted with rings (piston rings).

(fig.1)

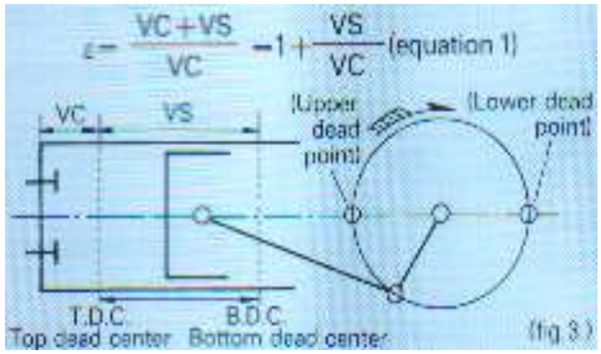


The position of a piston when the volume in the cylinder is at its minimum, as the piston goes through a reciprocating cycle. is called the top dead center (T.D.C.), and the volume is called the combustion chamber volume (clearance volume). The position when the cy1inder volume is at its maximum is called the bottom dead center (B.D.C.). The movement of the piston between these two dead points and the distance between them is called the stroke. The volume through which the piston moves is called the swept volume or displacement.

(fig.2)



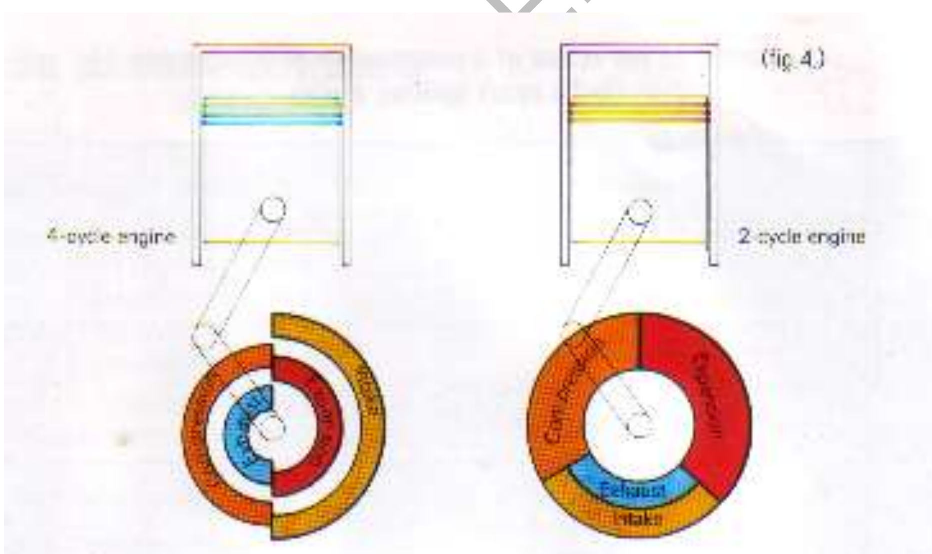
The word compression ratio means the degree of compression. lf the displacement (swept volume) is VS and the combustion chamber volume (clearance volume) is VC the compression ratio is represented as e



2 CICLE AND 4 CICLE ENGINES

In the crankshaft connecting rod and piston pin structure, the piston reciprocates one time for one revolution of the crankshaft; this is counted as two strokes. For positive displacement internal combustion engines, the complete power cycle requires two revolutions of the crankshaft, Le.

4 strokes of the piston; the proper designation is a 4 stroke 1 cycle engine, which is abbreviated to 4-cycle engine. Engines which complete one revolution of the crankshaft for one complete power cycle are called 2 stroke 1 cycle engines, abbreviated to 2-cycle engines.



3. Spark ignition engines and compression ignition engines

Positive displacement type internal combustion engines are classified according to the method of combustion ignition into "spark ignition engines" ~--id "compression ignition engines.- This system of classification is based on combustion which -,as a close relation to the performance of in.~-mal combustion engines. While both types belong to the family of positive displacement type internal combustion engines, they do differ informance.

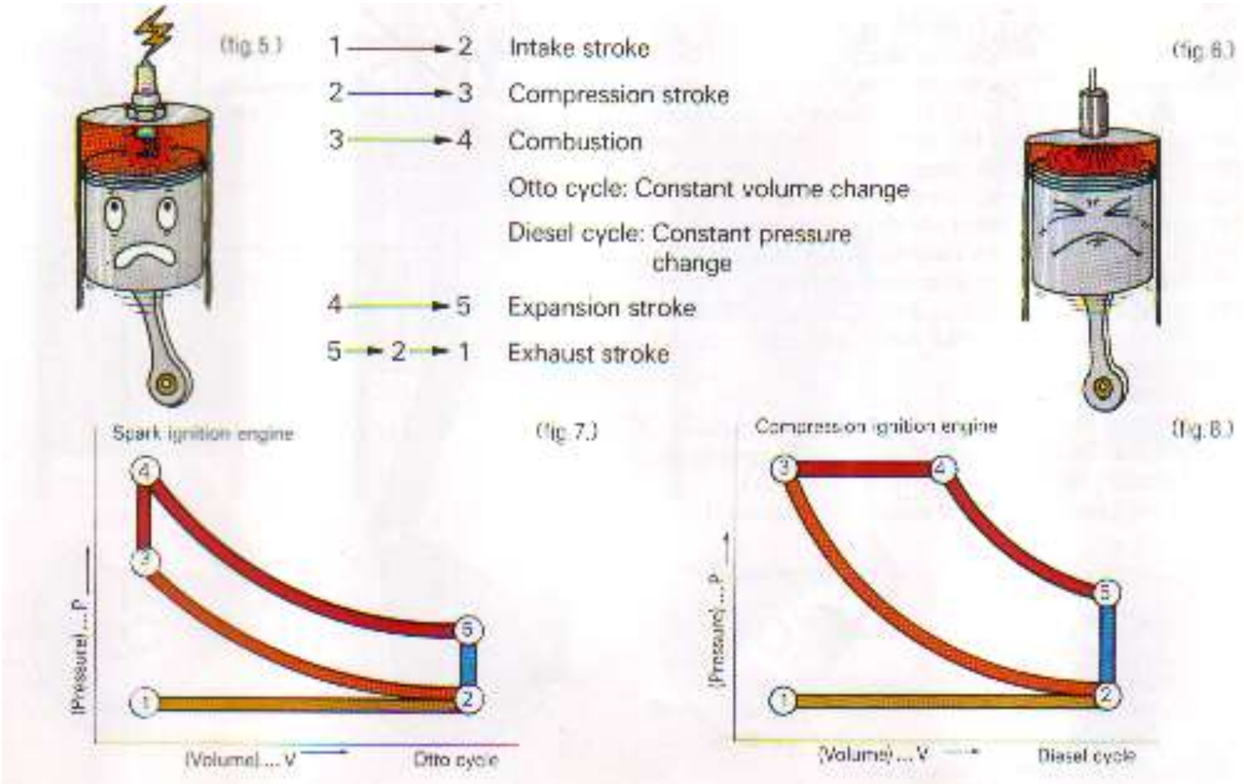
(1) Spark ignition engines

The spark ignition engine makes a spark jump through (spark discharge between the ignition plug electrodes) the nearly uniform fuel-air mixture Le. the combustion mixture begins to burn

when ¡t is touched by the electric spark and the whole mixture burns very rapid1y due to flame propagation.

(2) Compression ignition engines

In this type of engine the air is compressed to a very high pressure. Because of the high pressure the temperature of the air rises. A proper amount of fuel is injected into the compressed air and combustion takes place spontaneously.
A pressure-volume curve is used to show the change of pressure inside the cylinder. A spark ignition engine is called a constant volume (otto cycle) type engine and a compression ignition engine is called a constant pressure (diesel cycle) type engine.


(fig.5.)
1 → 2 Intake stroke
2 → 3 Compression stroke
3 → 4 Combustion
Otto cycle: Constant volume change
Diesel cycle: Constant pressure change
4 → 5 Expansion stroke
5 → 2 → 1 Exhaust stroke
(fig.6.)
Spark ignition engine
(fig.7.)
(Pressure) ... P
(Volume) ... V
Otto cycle
Compression ignition engine
(fig.8.)
(Pressure) ... P
(Volume) ... V
Diesel cycle

Compares the action of a compression ignition engine and a spark ignition engine

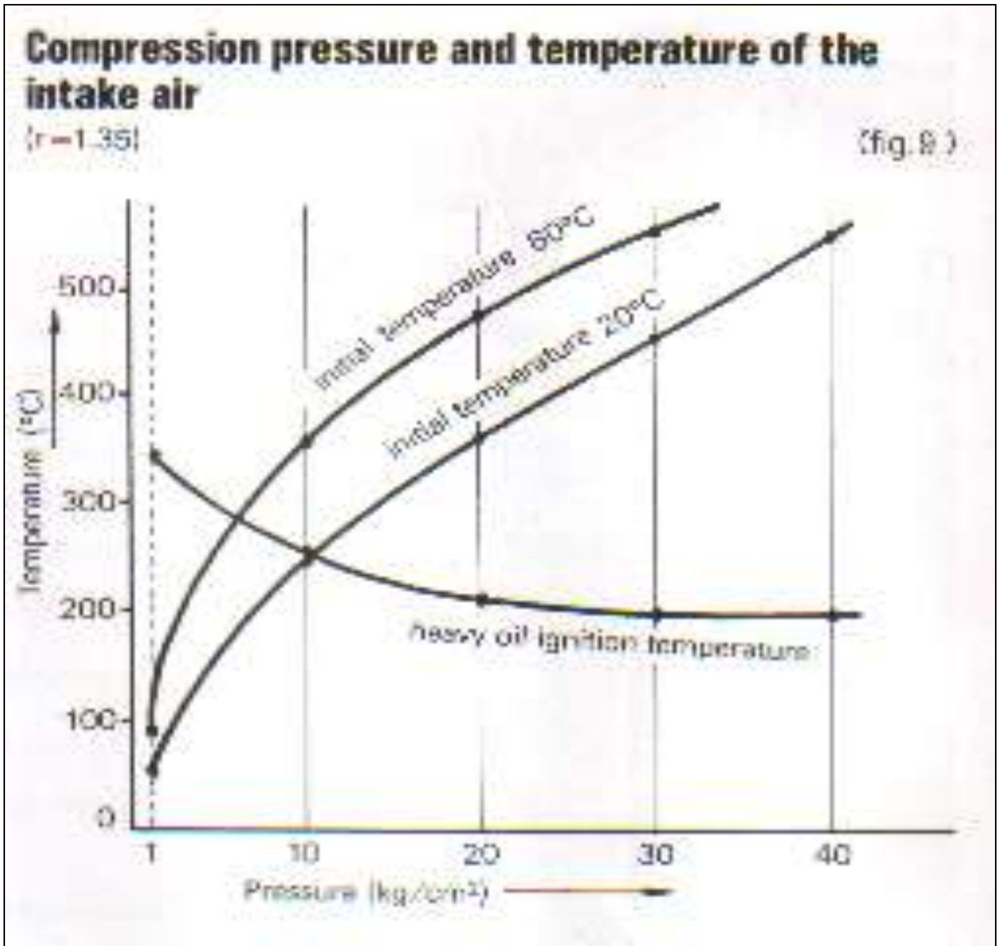
Stroke/Tipe	Diesel engine	Kerosene or gasoline engine
Intake	Intake of air only. Carburetor is not required,	Intake of air-fuel mixture. Carburetor is required
Compression	Compression ratio 20:1 Compression pressure 40-45kg /CM2 Compression temperature about 600°C ("red hot"- air)	Compression ratio 4-71 Compression pressure 7-10kg/cm2 Compression temperature 250°C-300°C
Expansion	Maximum 55-60kg/CM2 Large amount of heat instantaneous maximum temperature about 2000°C	20 kg /CM2 with a small amount of heat Instantaneous maximum temperature 1200T
Exhaust	Combustion chamber volume (clearance volume) is small Virtually complete a exhaust	Incomplete exhaust because of large combustion chamber volume

4. Outline of compression ignition

When air is compressed, it's pressure and temperature rise. lf the air is rapid1y compressed (adiabatic compression) heat will not be transmitted to the outside, and pressure and temperature, you know, will rise rapid1y as shown in Figure. If the accordance with Boyles law. lf the fuel is in the form of a fine mist or spray it will burn easily. When the fuel is sprayed into the hot compressed air spontaneous ignition, explosive combustion, will occur immediately and the temperature and pressure will quickly increase causing the gas to expand.

A motor using this type of system to generate power and also combining the piston and crank-shaft assembly into one system is a diesel engine as shown in Figure-9. lf the temperature before compression is high, the temperature after compression will increase remarkably. At the same time. if the pressure rises, the natural ignition temperature (flash point) of the fuel will go down and the fuel will burn, readily. Since the amount of fuel that can be combusted is determined by the quantity of air in the cy1inder, doing the following will increase the brake horsepower of a diesel engine.

a) Enlarge the cy1inder b) Use pre-pressurized air e) Increase the frequency of combustion per hour. + increase the engine revolutions (rpm), and also increasing the amount of air used.



Compression pressure and temperature of the intake air
(r=1.35)
(fig.9)
initial temperature 60°C
initial temperature 20°C
heavy oil ignition temperature
Temperature (°C)
0
100
200
300
400
500
Pressure (kg/cm²)
1
10
20
30
40

CYCLE DIESEL ENGINES
(1) Intake stroke

When the piston moves down from the top dead center position, the air intake valve opens and fresh air is drawn into the combustion chamber. While this is happening the exhaust valve is closed.

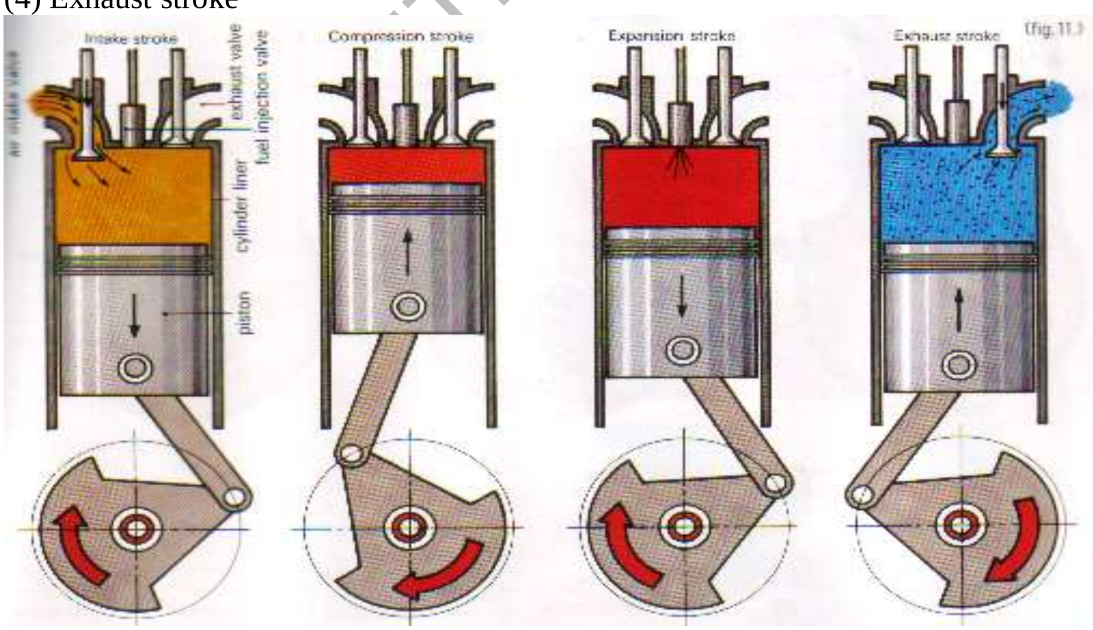
(2) Compression stroke

After completing the intake stroke, when the piston moves up from bottom dead center, the intake and the exhaust valves are both closed. The air is compressed by the piston and the pressure and temperature rise. The air at the end of the compression stroke is called "red hot air." With a compression ratio of 20: 1, the pressure will be about 40-45kg/ CM2 and the temperature about 600-5500C.

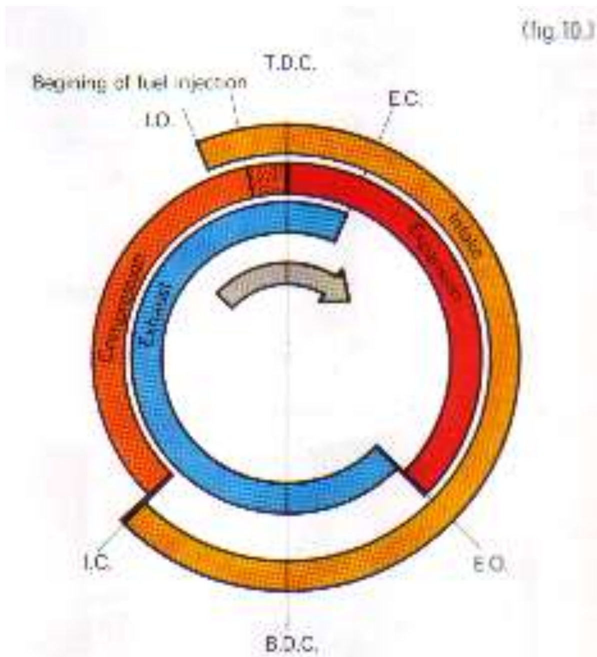
(3) Expansion stroke

When the piston approximately reaches top dead center of the compression stroke, the fuel in the form of a mist is injected into the chamber through the fuel injection valve. When the fuel comes in contact with the hot air spontaneous ignition takes place and the pressure and temperature increase quickly. The gas expands against the piston forcing it to move downward. The instantaneous temperature of the combustion gas at this time is 2000'C and the pressure is 55-60kg/em'. This is called the expansion stroke and is the stroke in which the heat energy of the fuel released by burning changes to mechanical energy.

(4) Exhaust stroke

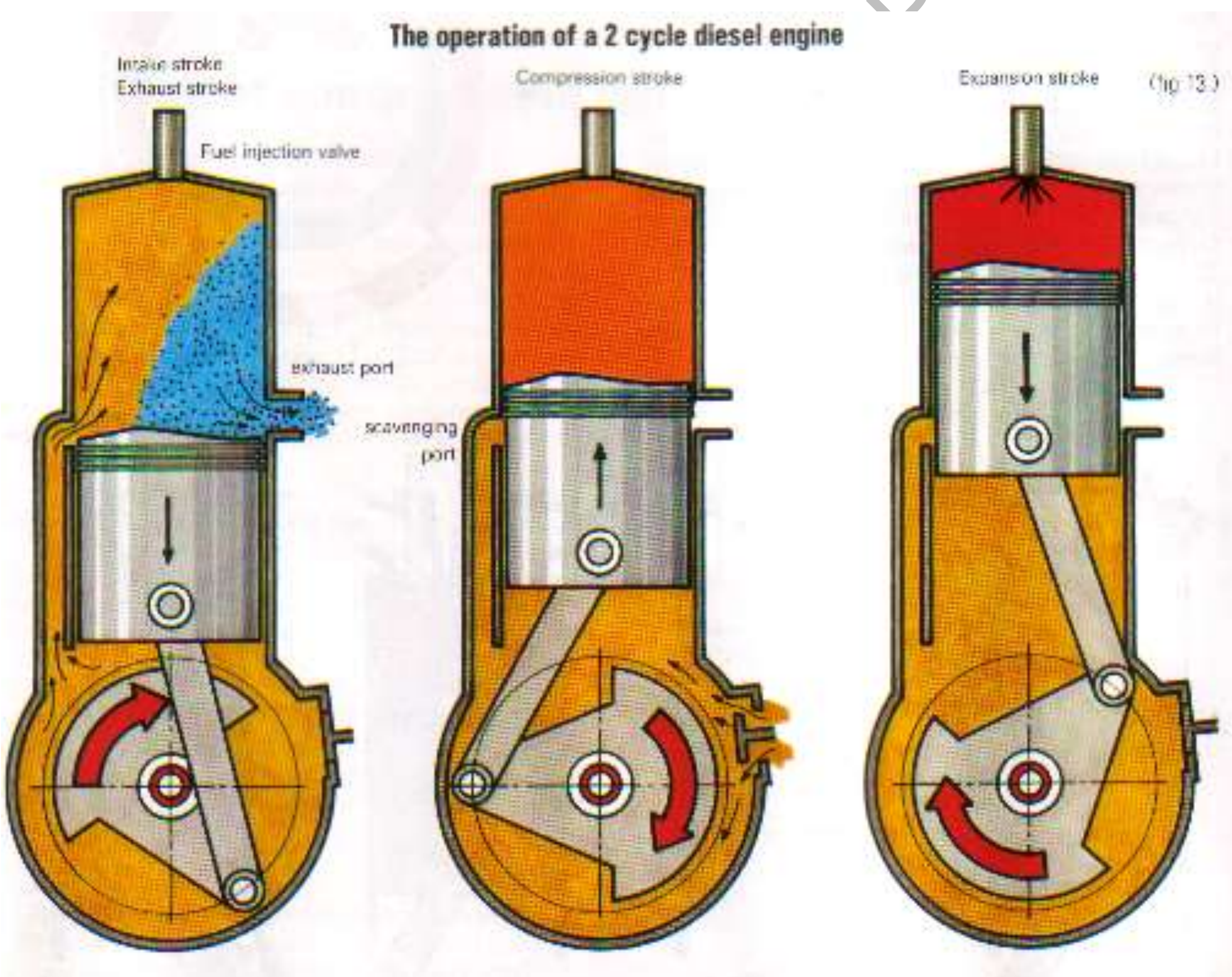


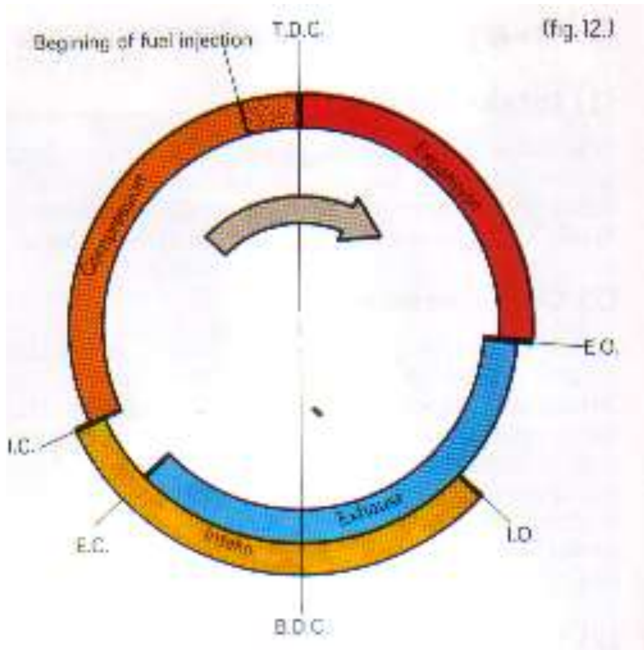
At the end of the expansion stroke, the exhaust valve opens and as the piston moves up again, the combusted gas is pushed out of the cylinder and expelled into the atmosphere.
When the piston reaches top dead center in this way, one cycle is completed and the piston is ready to begin the intake stroke again. A diesel engine which completes 1 cycle in 4 strokes is called a 4 cycle diesel engine.



2-cycle diesel engines

A 2 cycle engine performs the intake, compression, expansion and exhaust strokes in the time it takes the crankshaft to make one revolution. Because there are no independent intake and exhaust strokes, a special method is necessary to supply air to the cylinder. To briefly explain the working principle, the scavenging port opens as the piston moves downward and air for compression enters the cy1inder and flushes out the combustion gas through this port. Next, the piston moves up closing the exhaust port and compresses the air; the fuel is injected and ignites; the expanding combustion gas moves the piston and the crankshaft rotates. When the piston moves down the exhaust port is opened and the combustion gas is exhausted. In addition, the scavenging port opens and compressed air is fed into the cy1inder. For this type of engine, normally, a scavenging port is necessary.





DIESEL ENGINE PERFOMANCE

Cycle

A cyc1e is defined as a single complete execution of the various changes that a system undergoes, and is completed when it returns to its original position.

Constant volume cycle ...... Otto cycle) This is an engine in which the combustion takes places at constant volume conditions.
Exp. spark ignition engine.

Constant pressure cycle ...... Diesel cycle) This is an engine in which the combustion takes place at constant pressure conditions.
Exp. Diesel engines (low speed)

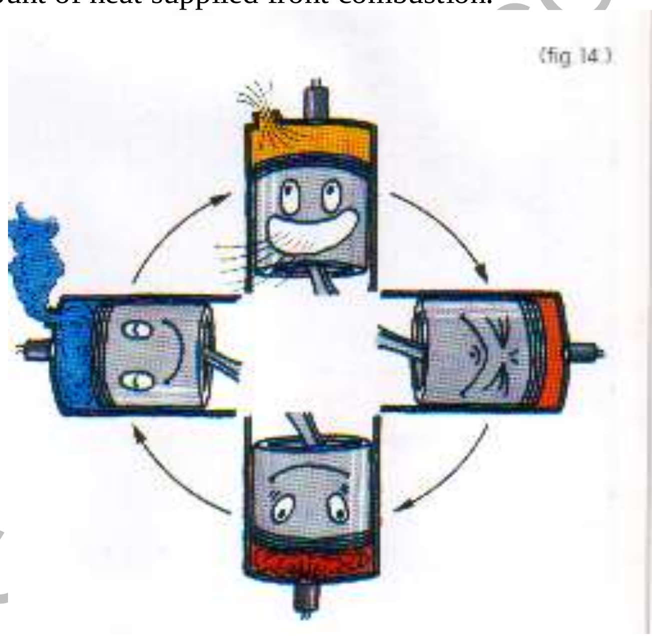
Synthetic cycle engine ...... Sabathe cycle) This is an engine in which the combustion takes place at constant volume and pressure conditions.
Exp. diesel engines (especially high speed)

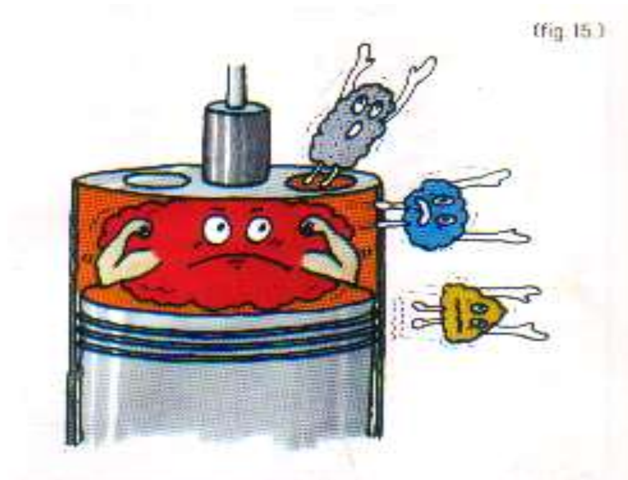
THERMAL EFFICIENCY

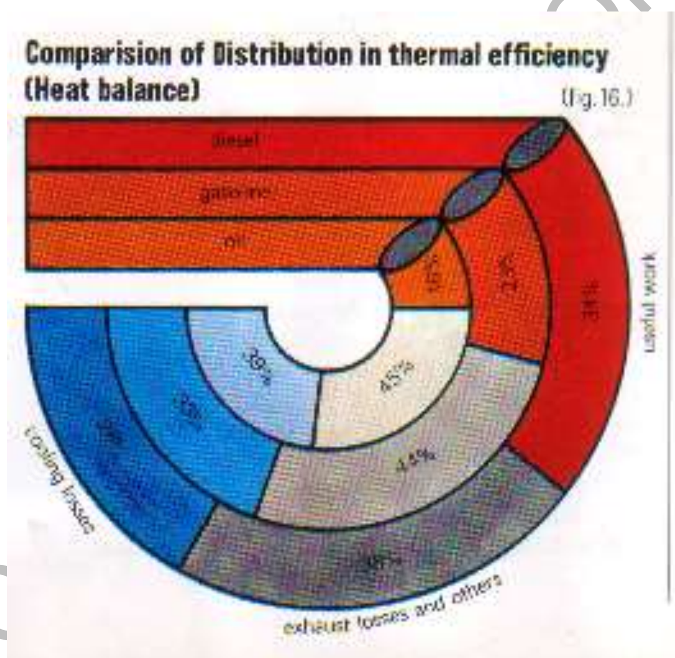
A machine which changes heat to mechanical work is called a heat engine. In an internal combustion engine, the fuel is burned in the cy1inder and the hot gas produced expands outward pushing the piston in front of it. In more direct terms, fuel combustion-heat-pressure-work, and in this way, the heat released by burning the fuel is changed to work. But not all of the heat produced becomes useful work. Some heat is lost through friction of engine parts, exhaust of burned gases, and cooling of engine parts. In simpler terms, the ratio of the useful heat and the lost heat is called thermal efficiency.

The larger the compression ratio, the better the thermal efficiency. As the heat supplied from combustion and increased pressure increases, the thermal efficiency will increase. Therefore, an engine should be operated at the highest temperature and pressure permitted for the engine.
Taking the heat released into the cylinder as 100 % when the fuel is completely combusted, Fig-16
Compares figures for the thermal efficiency (heat).

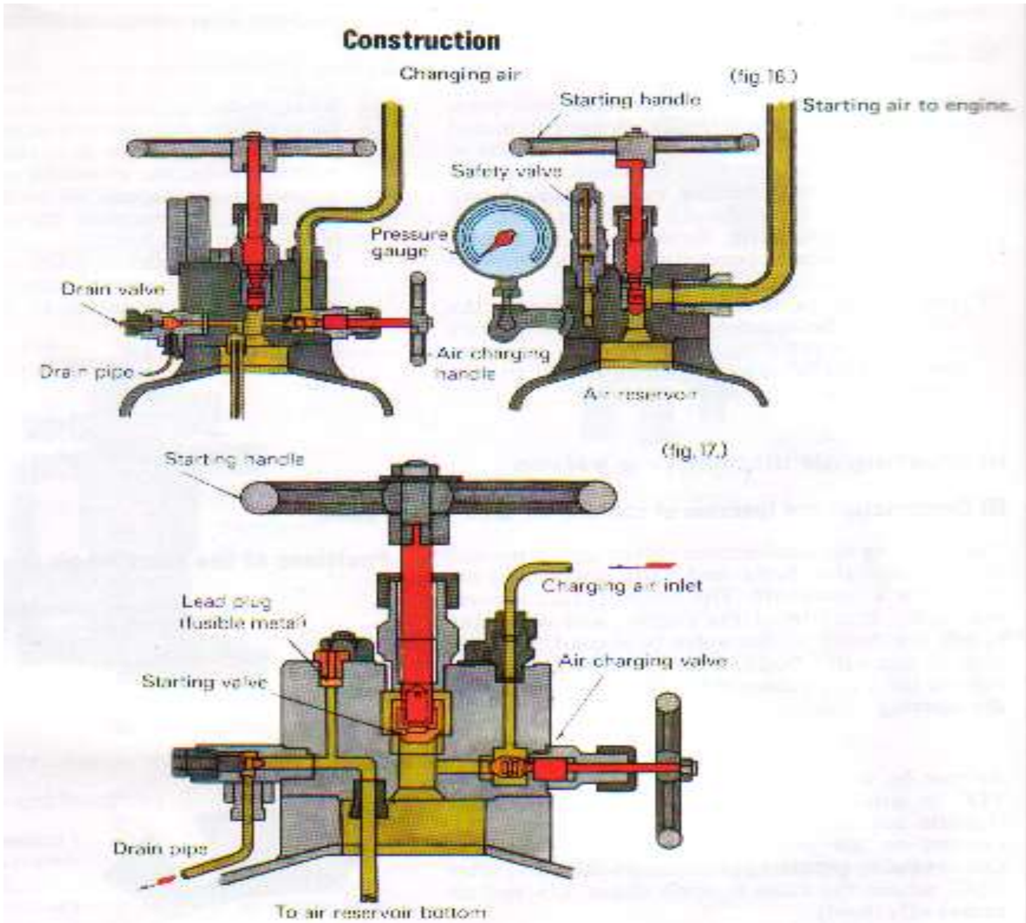
As shown by the figure, the thermal efficiency of diesel engines is very high. The reasons for this are:
(1) The compression ratio is high in comparison to other types of engines which makes the specific fuel consumption low.
(2) The combustion conditions are good.
To find the thermal efficiency from the specific fuel consumption the following calculations can be used. The net thermal efficiency is the ratio between the useful work that is delivered to the crankshaft and the amount of heat supplied front combustion.







Air reservoir and accessories
Mechanism



1) Air reservoir.

This is composed of a valve box with accessories attached, and an air tank. lt stores air used for starting at a pressure of up to 30 kg/cm'. The capacity differs slight1y according to the engine used.

2) Air reservoir starting valves (Starting handle)

Air used for starting is led outside by turning the starting handle and opening the valve. The handle has an idle turning position to enable quick opening and firm closing of the valve aided by an inertia force. This type of valve is called a hammer valve.

3) Air reservoir charging valves.

This valve supplies air into the air reservoir. Compressed air or combustion gas to be stored in the air reservoir is discharged from the charging valve of the engine and is controlled by this valve.

4) Drain valve.

This valve provides an outlet for accumulated condensation and moisture contained in the compressed air. A pipe is provided in the air reservoir which extends to the bottom of the engine. Be careful when installing it.

5) Safety valves.

A safety valve is provided in the charging air passage. It ensures air reservoir safety by keeping the pressure from becoming higher than the rated value during the charging operation; and it closes automatically when the pressure drops to the low pressure point.

lt is dangerous to set it higher than the rated value (32-33 kg/cm2).
6) Pressure gauges.
There are two methods for connecting pressure gauges.
The gauge is connected either to the front side of the charging valve or to the back side. The former method indicates pressure during charging and the latter indicates storage pressure. The former can also indicate storage pressure by opening the charging valve.
7) Lead plugs (Fusible metal)
lf the inner pressure and temperature of an air reservoir rises abnormally due to fire, etc., the lead alloy melts and discharges air.

Handling precautions

1) When removing the safety valve and pressure gauge, make sure that they are connected to the correct side (the front or back side of the charging valve). lf it is connected to the back side of the charging valve (inside the air reservoir), the air should be released before removing the valve. Release the air before making repairs or connecting the air reservoir attachments.
2) The safety valve is provided to ensure the safety of the reservoir in case pressure rises beyond the rated value and reaches a dangerous level. Therefore, never allow it to rise above the rated pressure.
3) When installing the air reservoir in a horizontal position, be sure not to damage the inner drain pipe. Position it so that it can be removed easily. No problems arise if the air reservoir is positioned vertically. lf it is laid down for service, note the direction of the inner drain pipe bend.
4) For single cy1inder engines, be careful not to install the air reservoir too close to the engine. Also pay attention to the length of the charging line.

Starting air distributing valves
Construction and function of starting air distribution valve

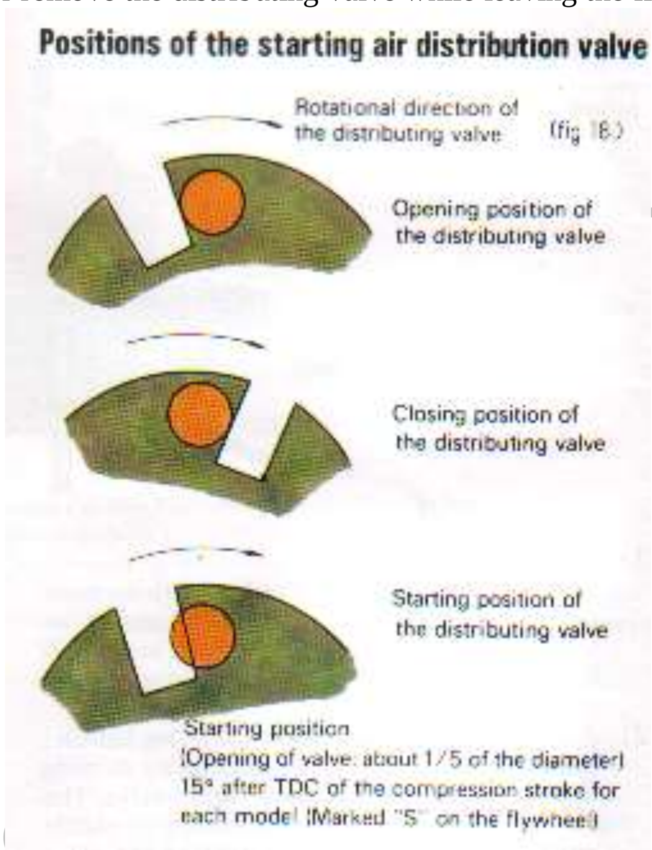
The starting air distribution valves are composed of a valve, valve body and valve cover, and are driven by a cam-shaft. The valves rotate according to the rotation of the engine, and when the notch (or hole) in the valve is aligned with the hole in the valve body, high pressure air located behind the valve passes through the hole and into the starting valve.

As can be seen from the figure, the opening at TDC is small and air passes slowly. Therefore throttle action and sufficient force can not be exerted on the piston top in a short time. For this reason the starting position is set at 15° after TDC, where the valve is open about 1/5 and air passes effectively.

Procedure for assembling the distributing valve

1 Align the set-marks of the distribution valve and cam-shaft; assemble.
2 If the set-marks are not clear, assemble in the following manner by utilizing the valve opening setting for starting (S mark on the flywheel):

a. Set the No. 1 cylinder at l5° after TDC of the compression stroke.
b. Set the distributing valve hole for the No. 1 cylinder so that it is 1/5 open in the direction of rotation.
c. Assemble the valve body while keeping the cam-shaft in its proper position.
Note:
lt is possible to attach or remove the distributing valve while leaving the flywheel intact.



Maintenance of the distributing valves

1) Do not neglect oiling. (Always oil before starting.)
2) Check timing and perform lapping as needed. (Use intake/exhaust valve lapping gears for this purpose).

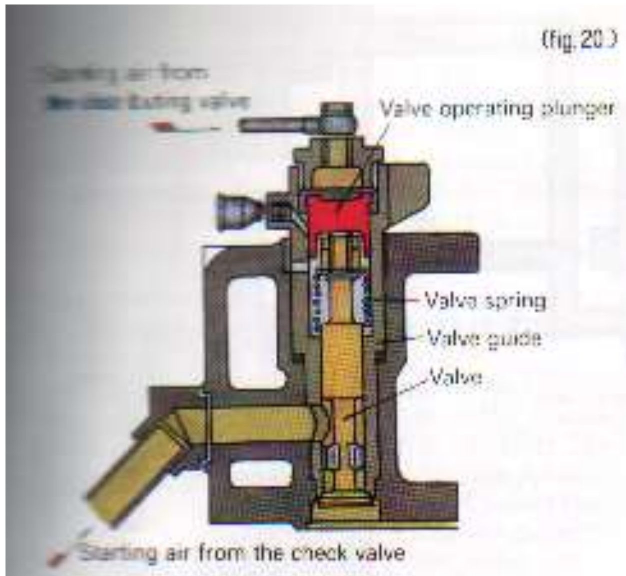
STARTING VALVES

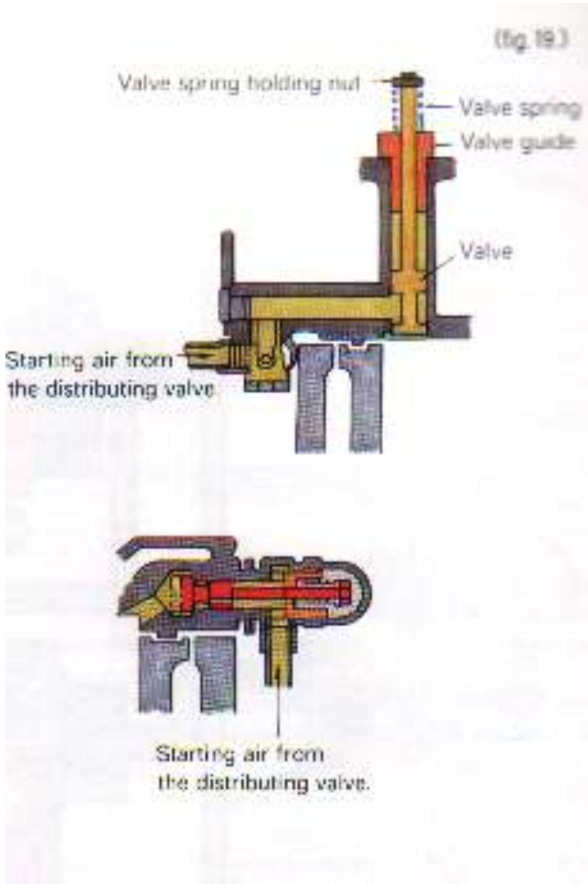
Construction and functions

The starting valve is composed of a body, valve, and valve spring (and an operating plunger for models M and R),and is attached to the cy1inder head. In the MS models, a part of the cylinder forms the valve seat.

The starting valve opens automatically due to me action of the starting air, and is closed by valve spring and the internal pressure of the cylinder. The model M valve is opened by the combined pressure of the starting air and the maneuvering air.

The starting air enters the cylinder through this valve and pushes down the piston to start the engine.





STARTING AIR CHECK VALVES AND STARTING MANEUVERING VALVES

Construction and functions

1) **Check valves**

The check valve is composed of a body, valve spring, and operating plunger. The air from the maneuvering valve activates the operating plunger, thereby opening the valve automatically and allowing air to pass from the air reservoir to the distributing valve. In models K, R, G, U and M, the check valve controls both the maneuvering air coming through the distributing valve to the starting valve top, and the starting air connected direct1y to the starting valve.

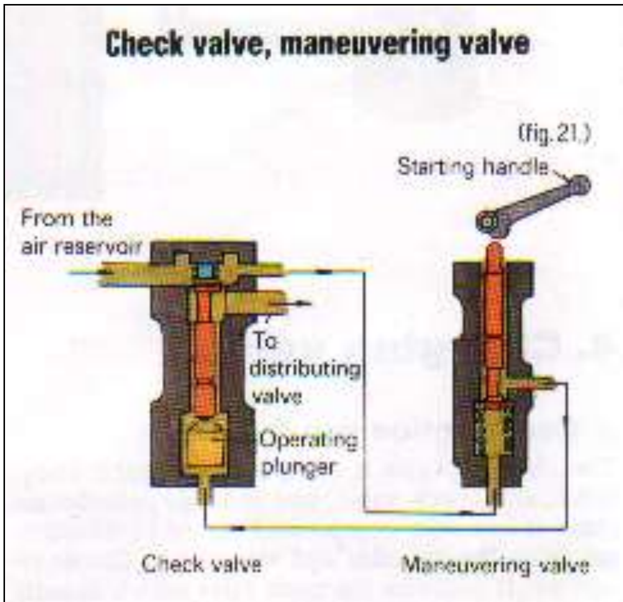
2) **Maneuvering valves**

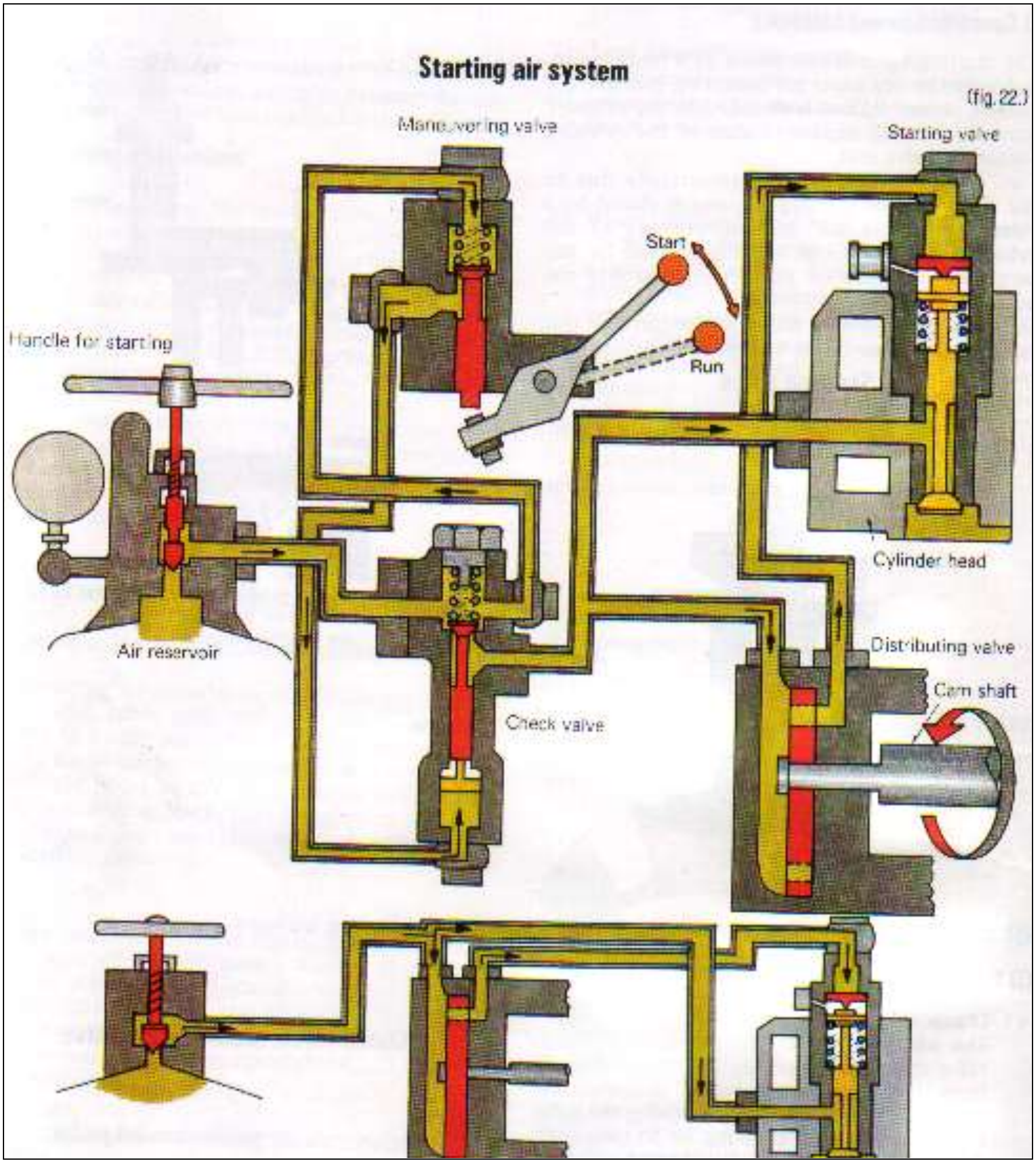
The maneuvering valve is composed of a body, valve, valve spring, and starting handle, and opens the check valve by leading a portion of the starting air to the operating plunger of the check valve. It is operated manually.

In engines with automatic starting systems this valve is operated by a solenoid.

Note:

Check valves and maneuvering valves should be occasionally opened, checked, and lapped.


Check valve, maneuvering valve
(fig. 21.)
Starting handle
From the air reservoir
To distributing valve
Operating plunger
Check valve
Maneuvering valve



Charging valve

Construction and functions

The charging valve is composed of a valve body, valve, and check valve, and in single cy1inder engines it removes compressed air or combustion gas from the cy1inder and stores it in the air reservoir. It includes the main valve which direct1y removes air or gas from the cylinder, and the check valve which prevents back flow from the air reservoir. As this valve is subjected to considerable heat, the valve body is cooled by water from the cy1inder cooling system. lt is recommended that the charging valve be cleaned and lapped every 10 charging hours to prevent seizure from overheating. Appropriate lapping tools are available.

Charging procedures

Check the pressure of the air reservoir after starting and be sure to charge it if the pressure is below 25 kg/cm2. Operate the engine
with no load or with only a light load when charging.
1) Push the fuel priming handle of the No. 1 cylinder up and idle the fuel injection pump.
(To charge compressed air only.)
On single cylinder engines the fuel injection pump is not idled to charge the combustion gas.
2) Open the charging valve of the air reservoir.
3) Open the charging valve of the engine and charge the compressed air. Charging is initiated by the above procedure and completed using the following procedures when the pressure approaches 30 kg/cm2.
4) Close the charging valve of the engine and tighten it by hitting the handle two or three times with the palm of your hand.
5) Close the charging valve of the air reservoir by firmly applying inertia force.
6) Slowly push down the fuel priming handle of the No. 1 cy1inder and restore operating conditions. (This procedure is not required on single cy1inder engines.)
Note:
After the charging valve of the air reservoir becomes cold, tighten it light1y once more.

Precautions when charging

(1) The charging effect will not be increased greatly by increasing either the valve opening or engine RPMs indiscriminately. The optimum opening and RPM should be determined from experience (400-500 rpm is recommended).
(2) On single cylinder engines be careful not to allow the combustion gas to burn the charging valve.
(Periodically open and close the valve.)
(3) To charge air using a hand operated air compression pump, remove the charging air line from the charging valve and connect it to the compression pump.
(4) Since the charging line gets very hot during the charging operation, be careful not to touch it.

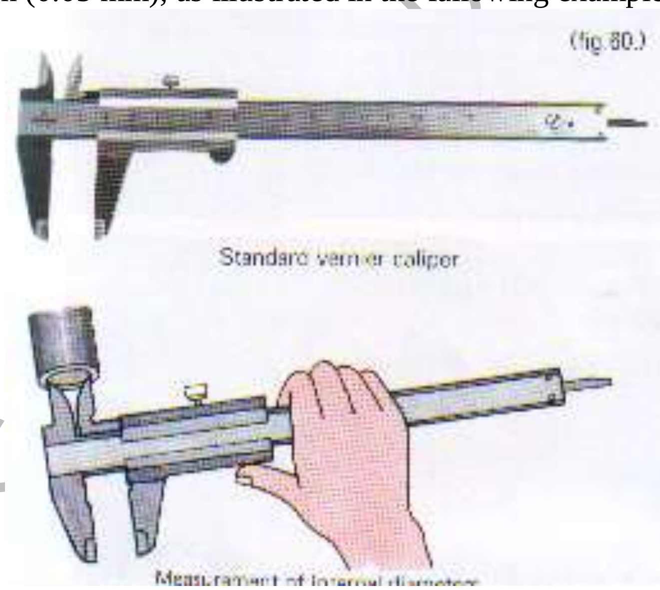
Starting procedures

After completion of all other preparations;
1) Turn the flywheel and set it to the starting position - the No. 1 cylinder is 15° after TDC on the compression stroke. In this position, the distributing valve is open and passes starting air. (Engines with more than six cy1inders can start in any position, and need not be aligned in the starting position).
2) Open the charging valve of the air reservoir and check the pressure. Charge the air if the pressure is not sufficient. (The compression pump is provided for this purpose). The pressure should be kept above 25 kg/cm2 at all times.
(3) Set the decompression lever or indicator of the engine to the starting position.

(4) Open the starting handle of the air reservoir promptly. The more the valve is opened, the easier starting becomes. If the starting handle is equipped with a start maneuvering valve. raise the handle with your fingers.
(5) Close the starting handle immediately after the engine starts running. (Tighten the handle 2 - 3 times after it is tight.)
If it is equipped with a start maneuvering valve, push it down, release the handle and close the starting valve of the air reservoir.

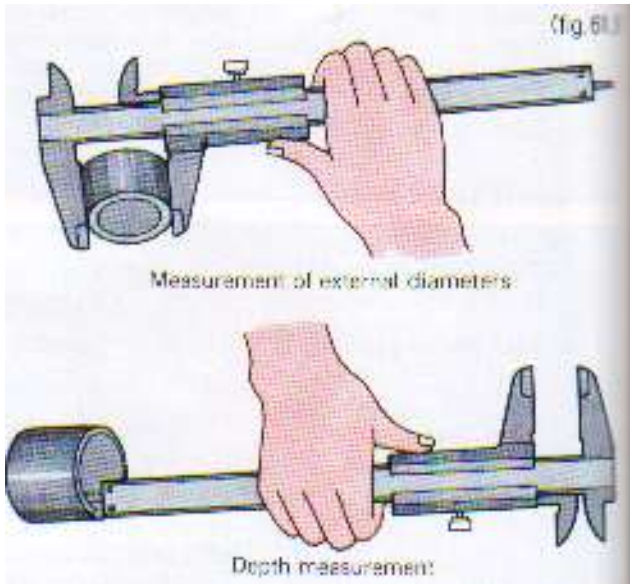
Measuring Instruments
There are numerous types of measuring instruments used for engineering applications. This chapter will deal with methods for using only some of the more frequently encountered types of instruments.

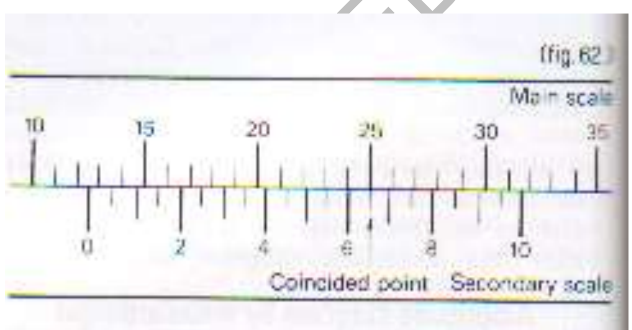
Vernier calipers
As shown in the figure, vernier calipers consist of a main or fixed scale with 1 mm graduations, and a secondary or venier scale with 20 graduations each of 19/20 mm. This instrument can measure internal diameters, external diameter-, and depth. Also dimensions can be measured with an accuracy of 1/20 mm (0.05 mm), as illustrated in the fallowing examples.



Reading vernier calipers
If, for example, we consider the two scales of the caliper which overlap each other, as shown in the diagram above, the following procedures should be followed for reading:
1. Read the main scale graduation just before the 0 of the secondary scale . . .12mm
2. Read that graduation on the secondary scale which exact1y coincides with a graduation on the main scale….. …….. 0.65mm (In this example, 25 on the main scale coincides with the secondary scale.)
3. Add items (1) and (2)
The reading is therefore 12.65mm.

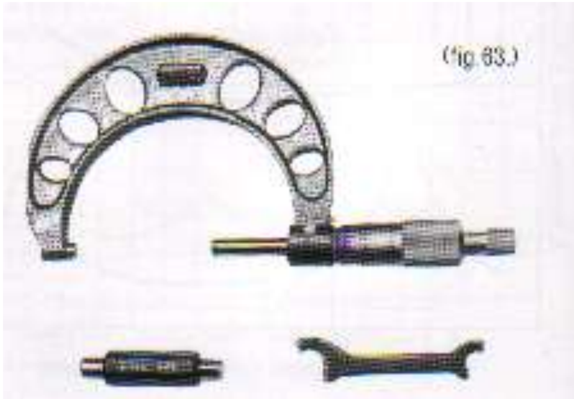
Thus, when reading standard vernier calipers, the second digit following the decimal point is always 0 or 5, which means measurements can be made to 1/20mm.





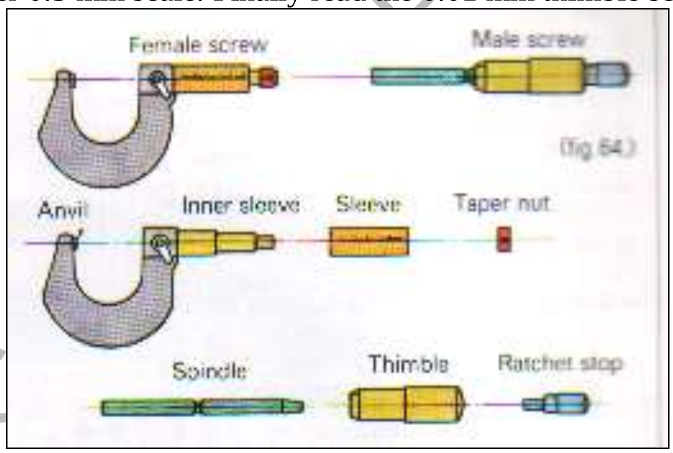
Micrometer

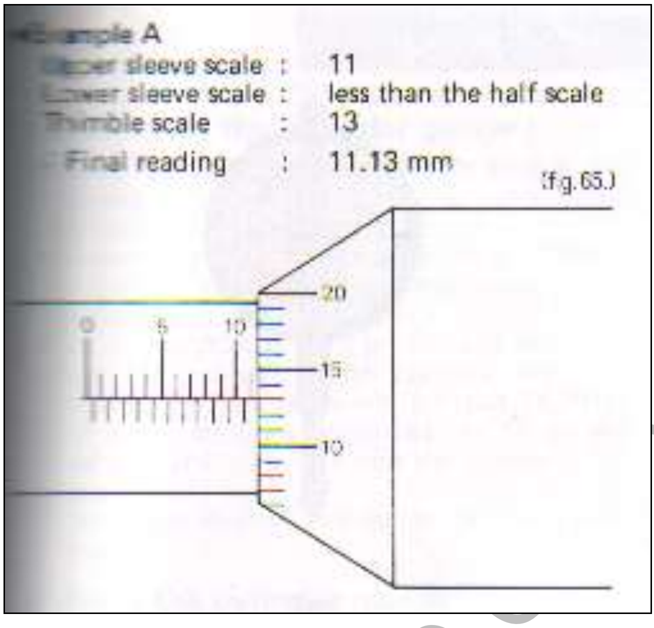
Operating principle: If the screw is turned one complete revolution, it traverses one pitch into a fixed nut. Similarly, if the screw were revolved only half a turn, it would traverse half a pitch. The micrometer based on this principle is a measuring instrument which can precisely indicate the distance a screw traverses. The nomenclature for the various parts of a micrometer is indicated on the diagram.

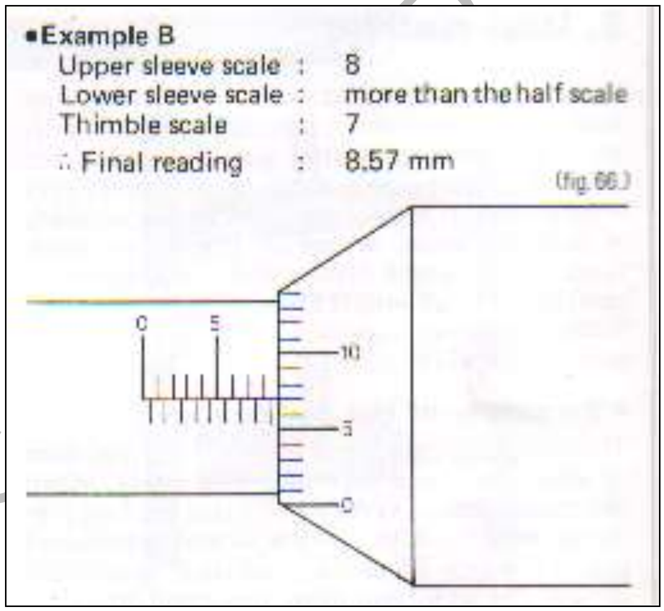


Reading micrometers

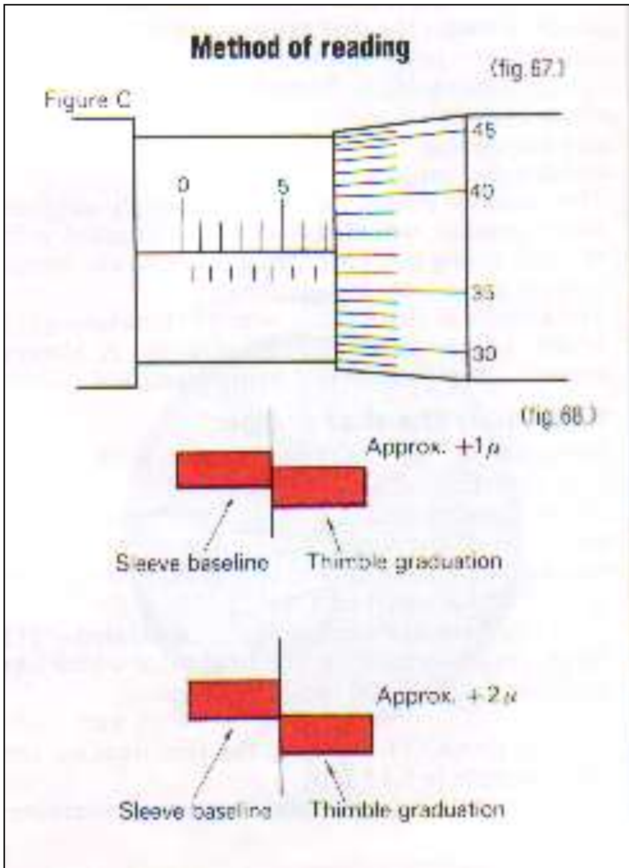
The micrometer spindle has a 0.5 mm pitch. The thimble moves simultaneously with the spindle. The circumference of the thimble is 50 equal graduations. Therefore, one complete revolution of the thimble moves the spindle by one pitch, i.e. 0.5 mm. Since the thimble has 50 equal graduations, 1 graduation would therefore be equal to 0.5xl/50 = 1/100 mm, which is 0.01 mm. The micrometer sleeve has two scales; the upper scale has 1 mm graduation and the lower one has 0.5 mm graduations. When taking micrometer readings, first read the upper 1 mm sleeve scale and then the lower 0.5 mm scale. Finally read the 0.01 mm thimble scale.







In Figs. 67 and 68 the minimum reading is 0.01 mm. However, if a small gap is still observed, a reading to 0.001 mm can be made depending on the skill of the reader. Although there are minor variations among the different types of micrometers, for a typical 0 - 25 mm micrometer one graduation on the thimble scale is approximately equal to 5 times the sleeve baseline thickness See Fig. 68).



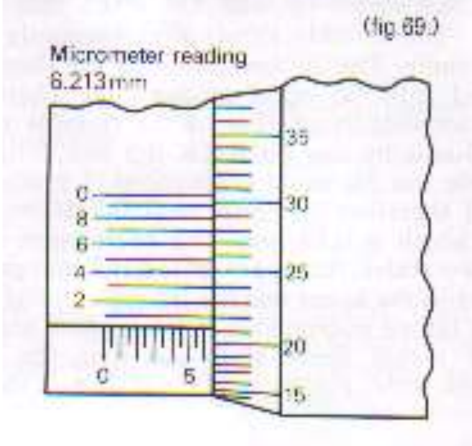
How to rear the micrometer
As you become more experienced in using the micrometer, it becomes much easier to apply your skill and judgement. In Fig. 67, for instance, the reading would be:

Sleeve scale reading	**7**
Thimble scale reading	**37**
Approximate reading from judgement	**3/10**
.'.Final micrometer reading	**7.373 mm**

Thus, by using an educated guess, measurement can be made to 1/1000 mm. However, to precisely measure to 1/1000 mm. Other types of micrometers such as vernier micrometers, or micron micrometers, which have minimum graduations of 1 / 1000 mm, should be used.

Micrometers with a secondary scale ,(Vernier Micrometer)
In order to make readings to 1/1000 mm, mark on the sleeve above the baseline, as shown in Fig. 69. To read the micrometer first read the 1 mm and 0.5 mm graduations and then 0.01 mm thimble graduations. Finally, instead of guessing, read the 1/1000 mm graduation on the vernier scale which coincides with a graduation on the thimble scale.

Method of reading



Sample reading of the Vernier Micrometer
O.5 mm sleeve scale reading 6
0.01 mm thimble scale reading ... 21
0.001 mm vernier scale reading . . .3
... Final micrometer reading 6.213mm

Dial gauge

The dial gauge is an instrument which magnifies small movements on the measuring tip. Readings are made on a graduated dial. This gauge can measure continuously and is therefore very widely used. It is used for checking the accuracy of machine tools, setting up machining operations, checking slot depths, and checking the eccentricity of cy1indrical objects. Its popularity is further enhanced because it is as easy to read as an ordinary watch.

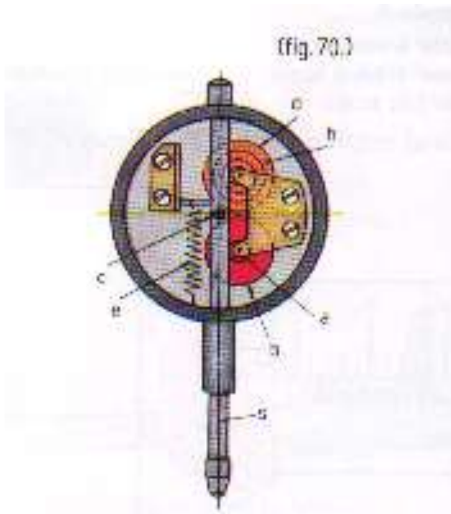
Structure of the dial gauge

The dial gauge consists of a spindle (s), a portion of which has been machined into a rack. When the spindle moves vertically it turns the first pinion (a) meshing with the rack, as well as the larger gear (b), which is on the same shaft as the first pinion. The larger gear turns the second pinion (e), which actuates the dial gauge pointer.

Usually, the large and the small gears have a diameter ratio of 10: 1. Therefore, even if the spindle movement is minute, it can be magnified to give substantial movements to the second pinion and the dial gauge pointer.

The second pinion also meshes with another larger gear(d), which is coaxially connected with the coil spring (h). This spring prevents the entire train of gears from backlashing.

The spindle is also loaded with a helical spring (e), which ensures that the spindle tip is always pressed against the object being measured.



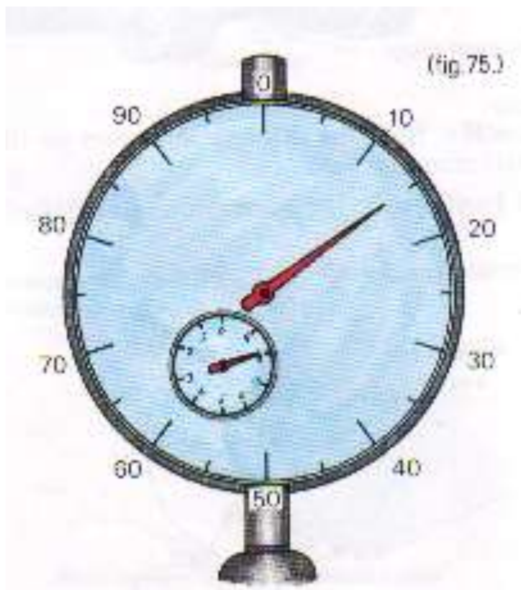
Reading the dial gauge:

Referring to the example shown in Fig. 75, first read the hand of the smaller dial. The hand of the smaller dial moves one graduation when the hand of the larger dial makes one complete revolution. This means that 1 graduation on the smaller dial is equal to 1 mm.

In this case, the reading is .... 8.00 mm - (1) Next, read the hand of the larger dial which has graduations of 1 / 100 mm; therefore,

……….. 0. 15 mm - (2). Adding items (1) and (2), the final reading for this example is 8.15 mm. Thus, with this instrument even small measurements can easily be made. It is therefore use to make measurements of valve clearances flywheel run-out, cylinder I.D., etc.

3. ELECTRICY GENERATORS



Electricity

Introduction to electricity
It is very important to have a basic knowledge of electricity and magnetism in order to deal with and repair the electrical parts and machinery associated with diesel engines. lf the basic principles are mastered, there is no need to worry even when new products are developed since new designs are merely new applications of old principles. The following is a summary of the fundamental principles of electricity and magnetism necessary for dealing with various electrical equipment.

Basic applications of electricity
The production of heat and light
Electricity can pass easily through some materials and not so easily through others. The latter type H materials are called resistances and heat is produced as electrical current flows through them. Fuses, light bulbs, glow plugs and thermo heaters ire all examples of this feature of electricity.

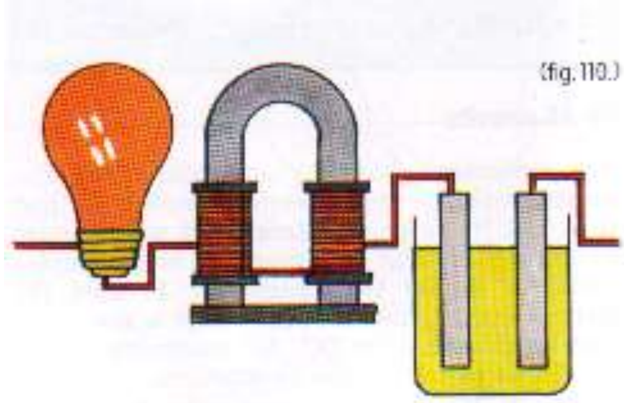
The production of magnetism

An electrical current passing through a wire will produce magnetism.
lf a magnetic material is nearby, a strong magnetic field can be produced in this material. Electrical motors, generators and switches are all applications of this feature of electricity.

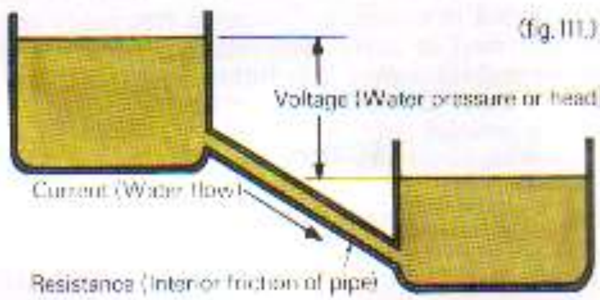
The use of electricity in chemistry
lf electrodes are inserted into an electrolytic solution, and a current is passed through, negative ions will go the positive pole and positive ions will go to the negative pole, eventually resulting in equilibrium. With such ion movement, one can visually see the results of a current flow. Electroplating, etc. is an example of the use of electricity in chemistry.

Ohm's law
Probably the most important rule concerning electrical circuits is that current is direct1y proportional to voltage and inversely proportional to resistance. This rule is called Ohm's Law and is analogous to the idea that water flow is proportional to water pressure (head) and inversely proportional to the friction inside a pipe.

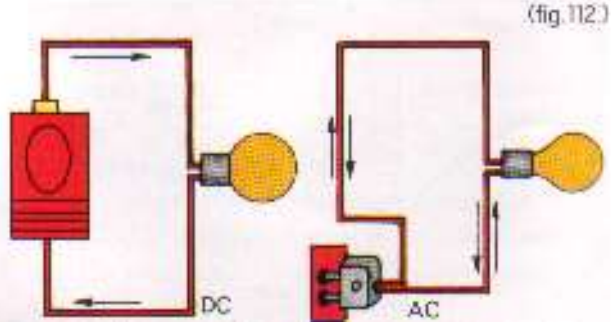
AC and DC current
When current flows in only one direction, ¡t is called a direct current (DC). Because the positive pole is fixed, DC is used in electrochemistry, but because it is more difficult to change the voltage of direct current (DC) than alternating current (AC), the latter is most commonly used. Alternating current voltage and polarity continually change with time.



Ohm's law



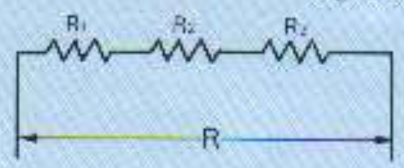
$$\text{(Current) } I = \frac{E\text{(Voltage)}}{R\text{(Resistance)}} \quad \text{.... equation 15}$$



Basic electrical circuits
DC circuits
The total value for the combination of resistances is computed as follows:

A) Resistances in series

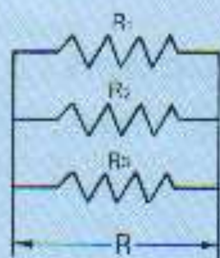
(fig. 113.)



$R = R_1 + R_2 + R_3 \ldots\ldots + R_n$ ..... equation 16

B) Resistances in parallel

(fig. 114.)



$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots + \frac{1}{R_n}}$$ ... equation 17

$$f = \frac{1}{T}$$ ..... equation 18

where,

f: frequency (Hz)

T: Cycle (Sec.)

I_m = Instantaneous value of current.

I_a = Average value of current = $0.637\ I_m$.

(The value if a sine wave is redrawn as a rectangle.)

I = Effective value of current = 0.707.

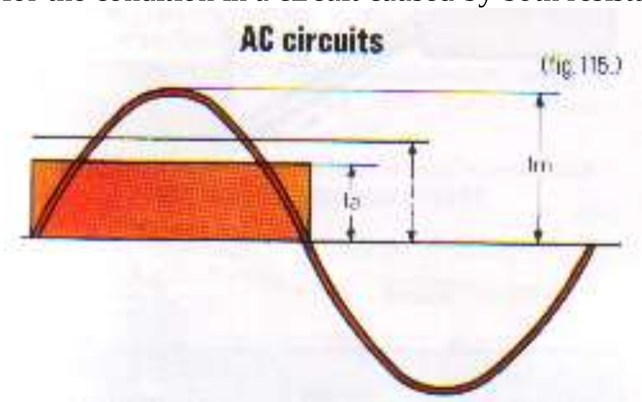
(The equivalent DC current producing the same amount of heat as the given AC current).

AC circuits

The phenomena, handling, and calculations concerned with AC are all more complicated than with DC. However, the design and manufacture of AC motors and generators are much simpler than for similar DC equipment. Because the stepping up or down of AC voltage is also much simpler than that for DC, AC electricity is used for all but certain special applications.

Although AC current is constantly changing, it returns to the same amount and direction of flow at fixed intervals. This period of time is called one cycle. The number of these cycles completed in one second is called frequency and is expressed in hertz. The relationship between cycles and frequency is as follows.

In the case of DC current, the only impedance to current flow is resistance, but in the case of AC, it is necessary to consider a phenomenon called reactance as well as resistance. Reactance is another name for inductance and capacitance.
Impedance is the name for the condition in a circuit caused by both resistance and reactance.



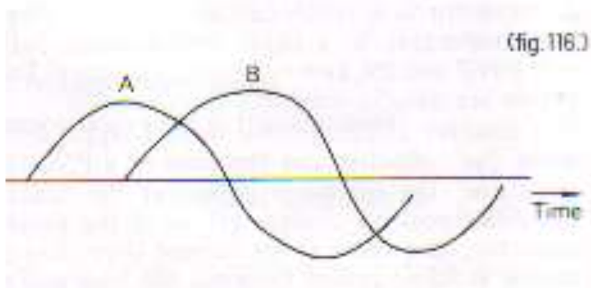
Inductance
An electrical current flowing through a circuit will generate a magnetic field. This field changes at the same rate that the current is changing. Because of electromagnetic induction, an electrical current is also produced. The amount of current produced is proportional to the rate of change of the original current. This phenomena is called self-induction.
The electromagnetic lines of force emitted from one AC circuit, can pass through another circuit and. according to the principles of electromagnetic induction, induce a current flow in the second circuit. This phenomena is called mutual induction. Inductance is expressed in "henrys" and characteristically makes the current lag behind the voltage.

Capacitance
A condenser stores static electrical charges; if a condenser is put in a circuit it will stop the passage of a DC current. The storing of an electrical charge is called capacitance and is expressed in “farads." Capacitance characteristically makes ,he current lead the voltage.

Electromagnetic induction .....
When a magnet is put into a coil, at that instant and only that instant, an electrical current is produced. The same thing happens if the magnet :s held stationary and the coil is moved over the magnet. This simply shows that if a conductor is moved perpendiculary to the magnetic lines of force emitted from a magnet, electromagnetic forces are induced in the conductor. This feature is called electromagnetic induction.

Phase .....

When two electrical currents are moving through a conductor at the same time, but do not coincide, they are said to be in different phase. The distance between these two currents is called the phase difference and is usually expressed in number of degrees. (360° = one full cyc1e.)



Summary of R, L, C, circuits

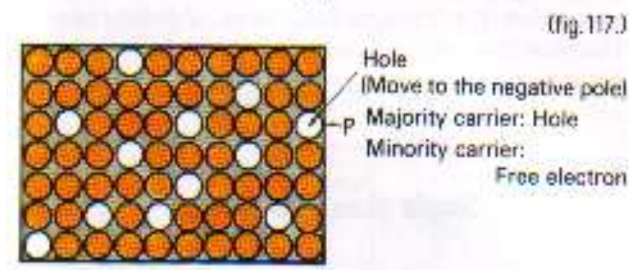
(table 9.)

Property	Symbol	Ohms	Phase	Current
Resistance	R (Ohms)	R (Ohms)	Same phase	$I = \frac{E}{R}$
Self-induction	L (Henrys)	Reactance $X = \omega L$ (Ohms)	90° lag	$I = \frac{E}{\omega L}$
Capacitance	C (Farads)	Reactance $X_c = \frac{1}{\omega C}$ (Ohms)	90° lead	$I = \omega CE$
L.C.R	L.C.R	Impedance $Z = R + (\omega L - \frac{1}{WC})$		$I = \frac{E}{Z}$

Semiconductors

The properties of semiconductors put them somewhere between conductors and nonconductors. In addition, if light, heat, or voltage is applied to a semi-conductor Eke Germanium or Silicon, the electrical characteristics, especially resistivity, can change greatly.

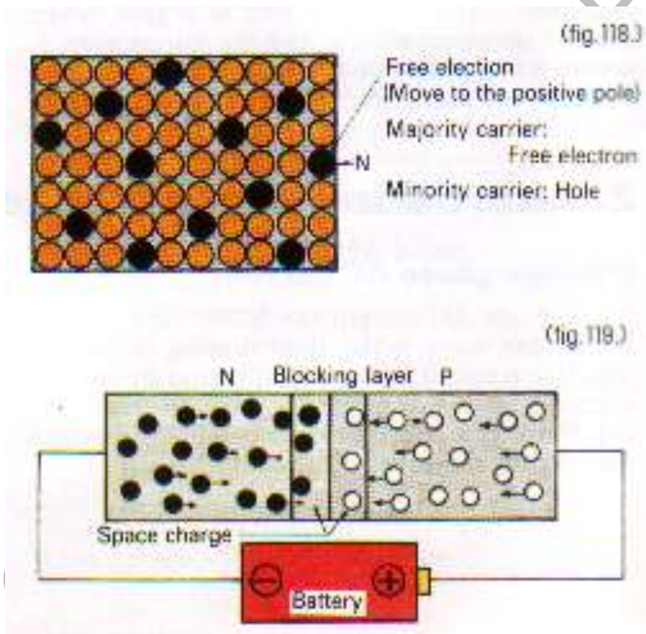
P type semiconductor ..... lf 4 valence electron Germanium or Silicon is made 99.9999999% pure and then an impurity like 3 valence electron Boron or Indium (which is called an "Acceptor") is introduced, there will be one electron short in the bonding. This situation is called a positive hole because it has a positive charge. Semiconductors possessing this positive hole are called P-type semiconductors.



Diodes

lf P and N-type semiconductors are combined, the result is called a diode or junction. The Fs hole is used by the N's free electron; this is called donation. Electric flow is from the P type to the N type; this is called the direction of easiest flow.

N-type semiconductors ..... lf a 5 valence electron impurity (which is called a "Donor") is introduced instead, there will be an extra electron in the bonding. Because of this negative charge, the semiconductor is dubbed an N-type.
Using the above types of P and N semiconductors, joint elements are produced and used in various ways.



Zener diodes
A Zener diode is a diode that has one feature different from normal diodes. This feature is once a certain voltage is reached, current will start flowing from that instant. (Zener breakdown).

UNI Transistors
A transistor is a combination of N and P-type semiconductors in a triple arrangement. N-P-N and P-N-P are the two types of transistors. Transistors are usually used for amplification. If a counter electromotive force is applied between the collector and the base of a PNP type transistor, the electrons gather at the negative base, the positive charges gather at the positive collector, and there is no current flow. lf a potential is then applied between the base and the emitter, the positive charges form the emitter flow to the base and the electrons at the base flow towards the emitter, resulting in current flow.

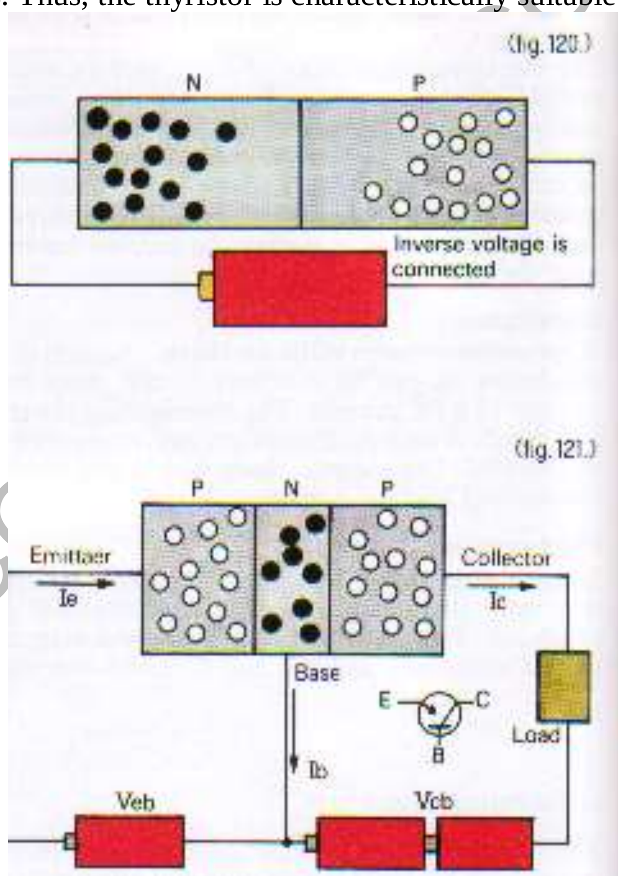
lf at this time the base is made thin, the electrons can flow from the emitter to the collector, which means that a flow of current exists between the two. The values of the current at the emitter, base, and collector are known respectively as Ie, Ib, and Ie. Their relationship is as follows. le = Ic + lb. Ib is much smaller than Ic.

Ic = x (0.95-0.99) le.

Thyristor

The thyristor is usually called a silicon controlled rectifier (SCR), but technically it is a reverse control SCR. A normal diode is of the P-N configuration, but a thyristor has a **P-N-P-N** arrangement. The middle P acts as a gate; when current flows between it and the minus pole, it allows a large amount of current to flow in the direction of easiest flow. lf the gate current Ig becomes zero, and a voltage difference is not applied, no current will flow. lf there is still some Ig. the break over voltage becomes less.

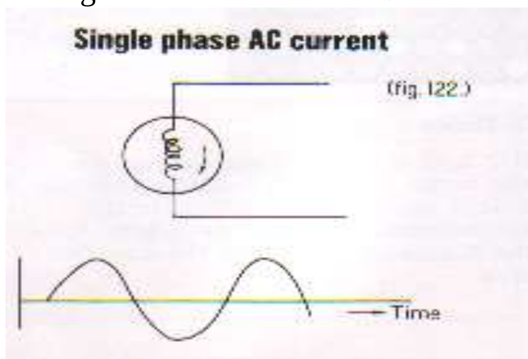
The thyristor differs from the transistor in that if Ig begins to flow and is even zero in value, a condition for flow exists. Thus, the thyristor is characteristically suitable for switching.



Alternating Current theory

Single phase AC current

Single phase AC current can be represented by a single sine wave when it is flowing through a simple circuit. lt is usually the kind of current supplied by two lines, and is used for the lighting, heating, and operation of small motors and AC welding machines, When used in amplification applications, the current flowing between the emitter and the collector can be controlled by controlling the current at the base.



4. ENGINE WATCHKEEPING

OILER RESPONSABILITY
General

The Oiler, primary responsibility is to assist the 2nd Engineer in all matters relating to machinery maintenance and watchkeeping in the engine space.
The Oiler reports to the 2nd Engineer, carrying out assigned duties on the vessel's machinery systems to ensure that the machinery and associated systems are operated and maintained in conformance with the manufacturer's instructions, company directives and the Chief Engineer's written and verbal orders.
It is expected that the Oiler will take an interest in and provide positive support to help achieve the company's objectives of obtaining and maintaining ISM certification.
It is the duty of the Oiler to understudy the 2nd Engineer and prepare himself to take over the duties of an Engineer should the necessity arise.
When joining or departing a vessel the Oiler is to meet and discuss together with the Oiler from or to whom duties are being transferred, especially for all areas for of responsibility. A report in writing, jointly signed is to be submitted to the Chief Engineer.
The Oiler is to assist and cooperate with all government and class officials who board the vessel in an official capacity.

Safety:

The Oiler is responsible
to assist in every way in the prevention of accidents.

to ensure that whenever he is operating on or with any machinery or related systems proper lockout and other safety measures are taken in order to avoid loss incidents.

Operations and Maintenance:

The Oiler is specifically responsible:
to follow instructions especially with regard to those that will develop his technical knowledge, and mechanical skills and ability to assist the 2nd Engineer in the maintenance and efficient operation of the vessel's mechanical and electrical machinery. To carry out the 2nd Engineer's instructions. Carrying out assigned duties when performing cleaning and maintenance of machinery systems.
At any time the Oiler departs the vessel he is to ensure that the 2nd Engineer is advised.
Advise the 2nd or Chief Engineer promptly in the event of any machinery failure or condition that warrants their attention.
Ensure that routine operation, lubrication, maintenance, cleaning and repair procedures carried out by him are done so in accordance with manufacturers and company directions.

Finance:

It is the Oiler responsibility:
to be alert to avoid wasteful expenditures and irregular practices in carrying out his duties.

Cargo and Bunkers:

The Oiler is responsible

to make himself knowledgeable of all cargo and bunker handling systems in order to assist and support the Chief Engineer.

At any time the Oiler is served notice from another party that he or his vessel is being held responsible for any alleged damage he is to advise the Chief or Second Engineer, and deny any responsibility.
Under no circumstances is the Oiler or anyone else on board to admit liability for any incident.

EMERGENCY ON BOARD
WHY:
In order to provide ships command staff with clear directions to assist them in potential emergency shipboard situations.
WHAT:
To provide ships command staff with rapid response guidelines.
WHO:

Senior management has prepared these guidelines and procedures to be followed on all company operated vessels.

WHAT TO DO:

In the event of the occurrence or risk of occurrence of any below listed situation, the Master will follow the guidelines laid down.

Nothing in this or any other procedure precludes the Master taking such action(s) as considered necessary for the protection of life, the ship, its cargo and the marine environment.

SHORE TERMINAL RELATED

Overloading

In the event that the vessel is overloaded, immediately stop all cargo operations and ascertain the cause and extent of the deviation. If the cause is external, the Master must contact the responsible Terminal manager NOTE PROTEST and await further instructions. Duty Operator is to be advised following GOM. Should the cause be ship sourced the Master in consultation with the Duty Operator will agree as to whom is to advice the relevant concerned parties such as the Charterer, P&I Club etc. The vessel is NOT to depart the loading berth until a resolution to the incident has been agreed and implemented.

Unloading

Cargo operations must cease immediately if any emergency situation arises related to or that might impact on unloading operations. The same instructions as noted above are to be followed.

Ballasting

Should an emergency situation arise follow the instructions noted above. No Company vessel is to proceed on any voyage in an improperly ballasted condition.

Deballasting

In the event of any emergency situation arising related to deballasting, immediately stop operations. The cause of any emergency must be ascertained and eliminated prior to resumption of operations. Ballasting/Deballasting systems are essential components of the vessel and must be maintained and operated accordingly. Again contact the shore office Duty Operator for assistance if the situation demands.

Fire or Explosion

On board the master and crew are trained to deal with such incidents. Fire at any terminal is extremely hazardous as the situation is usually beyond the scope and ability of the ship personnel to respond directly. In the event of a terminal or any other shore sourced fire presenting a possible hazard to the ship:

Stop cargo operations and secure all hazardous areas.
Sound the fire alarm.
Start the fire pumps.
Take all necessary actions, such as directing ships hoses at any nearby fire, fogging the vessel etc.
Disconnect all cargo hoses.
Prepare the ship for immediate departure.
Alert port authorities and any other regulatory body concerned as listed in the SOPEP.
Do not hesitate to remove the vessel from the danger zone.
Arrange for tug(s) and pilot assistance as necessary and as available.
Consult vessel SOPEP manual for further advise and direction.

PERSONNEL RELATED:

Abandon Ship

It is the Master's responsibility to ensure that the crew is well versed in all aspects of on board safety procedures. Equipment must be maintained and both it and the crew exercised in accordance with the above mentioned procedures and policies, to ensure that in the event abandon ship procedures have to be implemented that they are carried out in the safest and most efficient manner possible. For communications see GOM 1.0 are to be followed. Crew Muster lists and Boat Station bills are to be used to confirm the presence of all parties and delegate responsibility.

Man Overboard

Serious Injury

In the event of any personnel receiving serious injury the first duty of the Command Team is to:

Ascertain the facts and commence first aid.

Alert the nearest or most applicable State and/or port authority for medical guidance and emergency response.

Communicate with head office.

Direct the vessel's course at maximum safe speed to the nearest and best port of refuge or rescue vessel.

CONFINED SPACE RESCUE

It is the Master's responsibility to ensure that the crew is well versed in all aspects of on board safety procedures including confined space rescue. Equipment must be maintained and both it and the crew exercised in accordance with the above mentioned procedures and policies to ensure rescue is carried out in the safest possible manner.

TERRORISM

The company will not knowingly allow its ships to trade in or into any area of the world where they could be subject to terrorism. In the event such an incident occurs the Master's first responsibility is to the safety of the crew. Every effort must be made to avoid aggravating an already hazardous situation. As most acts of terrorism have political aims, governments and law enforcement agencies are usually the first to be alerted, by the terrorists.

Avoid unnecessary heroics; leave them to the professionals.

As much as possible, keep all crew members assembled in close proximity, only deliver such facts as are obvious and demanded such as contained in discharge books, do not volunteer any additional information such as ethnicity, religion or political affiliation.

Encourage the use of and assist with telecommunications especially voice, to shore based authorities. The more open the communications the better able are law enforcement agencies to monitor and manipulate the situation.

PIRACY

Through such resources as the P & I Club and the International Chamber of Commerce (ICS) the company kept aware of areas of the world where the risk of piracy exists. Vessels trading in or into such areas will be kept advised of such risks. The trading in or into such areas will be kept advised of such risks. The Master should always be aware that an act of Piracy could be committed against the vessel. Whenever trading outside the Canada/USA/NE. Europe areas, special care and attention should be directed to this subject. This subject becomes even more vital in high-risk areas of the world. Pirates many times gain entry to a vessel when in port and activate once at sea.

In Port:

Maintain an efficient deck watch.

During non-working hours and especially at night, close and lock all spaces such as the forecastle stores, paint lockers, the engine room (if unmanned) etc.

Prior to sailing, check all accommodation areas and other possible areas of concealment.

At all times maintain full deck and over-side lighting during hours of darkness.

Put rat guards on all head and stern rope lines.

Consult with Agent, terminal jetty and/or port authority as to local security arrangements. Establish security and emergency call procedures.

In high-risk areas, in consultation with the local Agent and head office it may be necessary to hire the services of professional security guards.

At Sea:

The Master must ensure that all company standing orders are being complied with, in addition he must issue written instructions in the Night Order Book and the Log Book as is deemed necessary to ensure adequate security procedures.

Have at least 2 port and 2 starboard fire hoses run out equipped with high velocity nozzles. Have fire pumps rigged ready for instant start. These can be used in the event of any person(s) attempting to gain entry to the vessel.

Ensure that ALL bridge watchkeepers (Officers and Ratings) are aware of and able to use telecommunications equipment to alert the nearest port state and/or international authorities.

Maintain an efficient deck watch at all times, in high-risk areas the Master may supplement the watches with additional lookouts, as deemed necessary.

If control of the vessel is lost to Pirates, the Master's first responsibility is the protection and Safety of the Crew. As much as possible, keep all crewmembers assembled in close proximity.

Only deliver such facts as are obvious and demanded such as contained in discharge books. Do not volunteer any additional information such as ethnicity, religion or political affiliation.

Avoid unnecessary heroics; leave them to the professionals.

STRANDING/GROUNDING

The term "STRANDING/GROUNDING" is here employed to mean that the vessel has struck bottom, remains hard aground, and cannot manoeuvre.

Upon stranding, the immediate priority is to eliminate all possible sources of ignition and to prevent flammable vapours from entering or accumulating in the engine room or in accommodation spaces. (Command) (Engine Room)

Consult charts, pilot (if onboard) and instruments to determine exact position and water depths adjacent to the point of stranding. In conjunction with this action, take draft readings form multiple onboard locations to determine ship's draft, trim and list. (Command)

Undertake thorough internal/external damage assessment to determine status and safety of vessel, and to assess spill circumstances. Consider initiating such actions as :
visual inspection of external and internal ship's structure;
visual scan around entire perimeter of vessel for any evidence of fuel leakage;
sounding of all fuel tanks, and comparison of soundings with most recent ullages (accounting for utilisation) to identify any conspicuous volume losses; and
sounding all compartments and void spaces to ensure integrity.
The essential requirement is to determine as much as possible about the physical status of the ship and her equipment, and about the quantitative characteristics of any spill, so as to appropriately judge and balance the need for attention to ship's safety and to environmental protection. (Command) (Engine Room)
Key issues which must affect decisions about responding to the stranding and/or to any associated spill include :
assessment of danger to personnel and to the vessel, if she were to become refloated and slide off her strand, or if she should work further up on to the strand;
assessment of danger to the integrity of the vessel due to being worked by seas, and due to wracking and torsion;
assessment of hazards to crew health and safety, and to the health and safety of adjacent populations due to the confirmed or possible release of hazardous substance in dangerous concentrations;
assessment of the danger of fire and explosion; and
assessment of the location of the strand relative to the exposed seaway and traffic lanes, and the consequent threat of collision associated with this location.
If the damage to the vessel is such that uncertainty in the consequence of any spill mitigation action (fuel transfer, ballast adjustment, removal from strand etc.) is unacceptably large, consider the execution of stability calculations ashore, on behalf of the stranded vessel. (Command)
Consult charts, tables, pilot (if onboard), and such other sources are required to fully determine tidal ranges and phases pertinent to the location of the strand, and to assess local ocean current conditions. These are key factors in predicting the behaviour of the stranded vessel and in determining the timing of any actions to attempt to move the vessel. (Command)
Avoid the indiscriminate opening of any plugs, ports, vents, or other means of access to compartments; so as to avoid unpredicted and unexpected loss of buoyancy. (Engine Room)
If a spill has occurred, or if a spill seems probable, estimate the volume spilled, identify the particular product, which has been spilled, and formulate a recommendation as to the need and practically of mounting a recovery operation. Factors influencing this recommendation should at least include :
volume and nature of spilled fluid;
potential for additional spill from same or other immediate sources;
weather, sea state, and ocean current conditions; and
obvious environmental impact or public awareness sensitivity to the geographical location where the spill has occurred.
This is to be viewed as a preliminary recommendation. The preparation of this recommendation must not unduly delay the commencement of notifications as instructed immediately below. (Command)

Ensure that the ship's position, water depth, draft, trim, list, estimates of volume spilled, present flow rate, and total volumes at risk, plus any recommendations regarding containment and recovery operations, are prepared for communication ashore. The stranding incident must be reported to the owner's representative. Determine the level of incident reporting which is required under the present circumstances. Initiate notification procedures to the extent required by the nature and magnitude of the incident. If any spill notification whatsoever is required, then at least shipboard personnel must make the following contacts. For reporting more serious incidents, consider use of a Detailed Report of Pollution. (Command)

Close sea suctions, when deemed possible, to avoid ingesting fuel from the water surrounding the ship. (Engine Room)

For a spill originating from an onboard tank damaged by the stranding, assess the availability of slack tanks and determine the practicality of pumping fluids from the damaged tank to slack tanks(s). If deemed feasible and safe, commence fuel transfer to slack tank (s) to empty the damaged tank. (Engine Room)

If onboard transfer of fluids from the damaged tank (s) is not possible, consider the advisability of lightening fuel to another vessel, and request necessary assistance if this action is deemed appropriate. (Command) (Engine Room)

Issues to be considered in choosing whether or not to attempt removal of the vessel from the strand include at least the following. (Command)

assessment of the likelihood of sinking, break up, or capsizing once the vessel is released from the strand;

assessment of the vessel's likely ability to maneouvre once she is free from the strand, and consideration of danger to /from traffic in the vicinity if the vessel as less than full maneouvring capability;

assessment of the need for salvage assistance;

assessment of the likelihood of further damage to hull, rudder, and machinery associated with any attempt to free the vessel from the strand;

assessment of present status and recent trends is weather and sea state conditions, as such variables might affect efforts to free the vessel from the strand;

assessment of the possible spill mitigation benefits of altering trim, or of lightening the vessel's fuel, as an alternative to immediately removing the vessel from the strand;

If the decision is made to request and await professional salvage assistance, actions, which should be considered by the stranded vessel, include at least the following. (Command)

is there benefit to be gained by setting anchors?;

is their benefit to be gained by taking on ballast?

is there benefit to be gained by further manipulating the distribution of fluids onboard, so as to minimise longitudinal stress; and

have all ignition sources been eliminated?

Authorised Individual and determine if shipboard personnel are to undertake any additional notifications. (Command)

Throughout the entire incident, ensure that accurate written logs of events, decisions, actions, and communications are maintained. (Command)

COLLISION

In responding to the consequences of a collision between own ship and any other vessel or structure, the priority considerations of the Master are:

preservation of life and safety of personnel onboard own ship and other vessel(s);

safety of own vessel and her essential equipment;

safety of other ship(s) involved in the incident, and their essential equipment;

preservation of the environment by minimising the magnitude and consequences of any spill of hazardous materials in resulting from the collision.

The Master is to maintain a clear vision for these priorities in any decisions he makes in association with the recommendations of this plan. (Master)

Sound the General Alarm to assemble emergency teams at Muster Stations. If there is any confusion about the priority of actions, confirm to emergency teams that emergency response actions such as attending to the injured or fighting fire take precedence over pollution responses.

Instruct the Engine Room and Site teams to standby. (Command)

Attend immediately to any injuries. (First Aid)

Attend immediately to any fire of threat of fire. (Site) (Secondary site)

If vessels are not interlocked, navigate own vessel to safety so as to be able to assess damage status and take emergency response actions. (Command)

If vessels are interlocked, rapid assessment must be undertaken to determine whether actions should be taken to keep vessels interlocked, or to separate the vessels. Consideration must be given to at least the following issues, from the perspective of each vessel involved in the collision:

Will fire/explosion risk increase to unacceptable levels due to sparks being generated by any attempt to separate the colliding vessels?

Is one vessel presently on fire with a risk of fire spreading to the other vessel?

Is there inflated fire risk aboard one vessel such that keeping the vessels interlocked will unnecessarily subject the other vessel to this same fire risk?

what hazard to navigation do the colliding vessels pose if they remain interlocked?

Are the vessels manoeuvrable to any degree while interlocked, and are local wind and sea conditions such that the interlocked vessels face immediate risk of stranding?

Are individual vessels likely to be manoeuvrable after separation?

Are individual vessels at risk of sinking if separated, due to damage below the water line?, and

Does the risk of increased pollution rise if the vessels are separated?

In making the decision of whether or not to attempt separation, it is the responsibility of the Master to consult with his/her counterpart aboard the other involved vessel. (Command)

Assuming that the decision is reached to attempt to separate the interlocked vessels, the following actions are recommended. (Command) (Site)

After separation, manoeuvre own vessel to a position upwind of any slick;

Close and secure all non-essential air intakes;

As early as is possible after the vessel's stability and safety have been secured, undertake thorough internal/ external damage assessment to determine the status of the vessel, and to assess spill circumstances. Consider initiating such actions as :

Internal/external visual inspection of the ship to determine if any tanks or compartments are penetrated;

Determine the bow configuration of the colliding ship: as collision with a bulbous bow vessel will possibly result in hull penetration below the water line;

A visual scan around entire perimeter of vessel for any evidence of fuel leakage;

Assessment of hazards to crew health and safety and to the health and safety of adjacent populations due to the confirmed or possible release of hazardous substances in dangerous concentrations; sounding of all fuel tanks, and comparison of soundings with most recent ullages (Accounting for utilisation) to identify any conspicuous volume losses; and

Sounding all compartments and void spaces to ensure integrity.

The essential requirement is to determine as much as possible about the physical status of the ship and her equipment, and about the quantitative characteristics of any spill, so as to appropriately judge and balance the need for attention to ship's safety and to environmental protection. (Command) (Site) (Engine Room)

If a spill has occurred, or if a spill seems probable, estimate the volume spilled, identify the particular product, which has been spilled, and formulate a recommendation as to the need and practicality of mounting a recovery operation. Factors influencing this recommendation should at least include:

1. Volume and nature of the spill;
2. Potential for additional spill from same or other immediate sources;
3. Weather, sea state, ocean current conditions, and
4. Obvious environmental impact or public awareness sensitivity to the geographical location where the spill has occurred.

This is to be viewed as a preliminary recommendation: the preparation of this recommendation must not unduly delay the commencement of notifications as instructed immediately below. (Command) (Site)

Ensure that data including the ship's position, water depth, draft, trim, list, estimates of volume spilled, present flow rate, and total volumes at risk, plus any recommendations regarding containment and recovery operations, are prepared for communication ashore. The collision must be reported to the owner's representative. If there is uncertainty concerning spill reporting, consult the SOPEP to determine the level of incident reporting which is required in the circumstances. Initiate notification procedures to the extent required by the nature and magnitude of the incident. Shipboard personnel must make if any spill notification whatsoever is required.

For reporting more serious incidents, consider use of Detailed Report of Pollution Incident.

Close sea suctions, when deemed possible, to avoid ingesting fuel from the water surrounding the ship. (Engine Room)

If the damage to the vessel is such that the uncertainty as to the consequence of any spill mitigation action (fuel transfer, ballast adjustment) is unacceptably large, consider the execution of stability calculations ashore.
For a spill originating from an onboard tank damaged by the collision, assess the availability of slack tanks and determine the practicality of pumping fluids from the damaged tank to slack tank(s). If deemed feasible and safe, commence fuel transfer to slack tank(s) to empty the damaged tank. (Engine Room)
If onboard transfer of fluids from the damaged tank(s) is not possible, consider the advisability of lightening fuel to another vessel, and request necessary assistance if this action is deemed appropriate. (Command) (Engine Room)
If tank damage is at or near the tank bottom, and if it is determined not to pump fuel from the damaged tank, and if there is sufficient confidence that the nature of the tank damage is known and understood, consider the value of pumping water into the damaged tank to establish a water bottom cushion under the remaining fuel. (Command) (Engine Room)
Throughout the entire incident, ensure that accurate written logs of events, decisions, actions, and communications are maintained. (Command)

ACTIONS : STRIKING
The term "STRIKING" is here employed to mean the vessel has touched, scraped, or struck bottom, but is not hard aground, and remains afloat.
Unusual or unexplained motion, shaking, vibration, or noise experienced while the vessel is underway may be evidence that the vessel has struck the ground. Immediate action is required to confirm the safety of the ship, to determine the nature of the incident, and to check for any pollution consequences. First priority is to stop all engines, provided that the adjacent waters safely allow this action, and that the vessel is not too near other traffic or navigational hazards that would prevent this action. (Command) (Engine Room)
Consult charts, pilot (if onboard), and instruments to determine exact position and water depths at the present location. In conjunction with this action, take draft readings from multiple onboard locations to determine ship's draft, trim and list.
Undertake thorough internal/external damage assessment to determine status and safety of vessel, and to assess spill circumstances. Consider initiating such actions as :
A visual inspection of the ship's external and internal structure;
A visual scan around entire perimeter of vessel for any evidence of fuel leakage;
The sounding of all fuel tanks, and comparison of soundings with most recent ullages (accounting for utilisation) to identify any conspicuous volume losses; and
The sounding of all compartments and void spaces to ascertain integrity.
The essential requirement is to determine as much as possible of the physical status of the ship and her equipment, and about the quantitative characteristics of any spill, so as to appropriately judge and balance the need for attention to ship's safety and environmental protection. (Command) (Engine Room)
If the damage to the vessel is such that an unacceptable uncertainty exists as a consequence of any spill mitigation action (fuel transfer, ballast adjustment, consider the execution of stability calculations ashore. (Command)

Avoid the indiscriminate opening of plugs, ports, vents, or other means of access to compartments; so as to avoid unpredicted and unexpected loss of buoyancy. (Engine Room) (Site)

If a spill has occurred, or if a spill seems probable, estimate the volume spilled, identify the particular product, which has been spilled, and formulate a recommendation as to the need and practicality of mounting a recovery operation. Factors influencing this recommendation should at least include :

The volume and nature of the spill

The potential for additional spillage from the same or other sources

The weather, sea state, and ocean current conditions; and

The environmental impact or public awareness sensitivity to the geographical location where the spill has occurred.

This is to be viewed as a preliminary recommendation: the preparation of this recommendation must not unduly delay the commencement of notification as instructed immediately below. (Command) (Site)

Ensure that data such as the ship's position, water depth, draft, trim, list, estimates of volume spilled, present flow rate, and total volumes at risk, plus any recommendations regarding containment and recovery operations, are prepared for communication shore. The striking incident must be reported to the owner's representative. If there is uncertainty concerning spill reporting, consult the SOPEP to determine the level of incident reporting, which is required. Initiate notification procedures to the extent required by the nature and magnitude of the incident.

Equipment failure

Action recommendations included in this section provide guidance for dealing with failures of essential equipment, which could result in danger to the stability and safety of the vessel, and hence could result in a pollution incident. So such instructions for responding to actual pollution incidents appear in this section, rather these recommendations are provided to assist in the avoidance of a spill.

In the event of Steering Gear failure, consider the following issues and options. (Command)

If steering capability is lost in a narrow, confined or congested seaway, reduce speed using ship's engines to the extent possible, and consider the immediate use of the vessel's anchors as well, recognising the possibility of shearing the vessel into a dangerous orientation of the decision is made to deploy anchors;

restrain the rudder to prevent rudder damage and to assist in controlling vessel drift;

if rudder can be restrained in neutral position, attempt to bring the stern into the weather by use of full astern power; or

if rudder is jammed hard over, consider the following issues and options. (Command)

In the event of Main Engine failure, consider the following issues and options. (Command)

take all possible actions to orient the vessel's head into the most favourable drift direction before speed is lost; and

recognise the influences of wind, sea current, list, and trim and rudder angle in determining the likely drift of the non-powered vessel.

In the event of Main Engine failure or Steering Gear Failure, it may be useful to deploy the ship's anchors. Considerations in so doing should include the following. (Command)

when the danger of collision, stranding, or striking appears imminent, anchors should be immediately deployed;
as a means of reducing speed in sufficiently shallow water, increasing lengths of anchor chain may be dragged across the bottom;
in deep water deployment of anchors on a partial scope of chain can have the effect of sea anchors, in assisting to keep the vessel's head into the weather.
Hull failure
This action list is to be executed in circumstance where the vessel identifies oil discharge due to hull failure in consequence of stranding, striking, collision, fire/explosion, or as the result of structural failure in consequence of heavy weather, ice impact, metal fatigue, or other such factor.
Notify the Master of any observed or suspected spill. (Personnel sighting spill)
Mobilise Command Team to the bridge. Instruct Engine Room Team to standby. (Master)
If oil on the water is confirmed or suspected, and providing that the security and safety of the vessel are not threatened by one of the above-mentioned severe events, the immediate priority is to determine the source of the spill. This investigation may include:
The assessment of all onboard sources to determine the nature and location of the leak; and
The analysis of unexplained differences by a comparison of tank ullages against ullage values at last recording, taking into account recent consumption.
The immediate intent is to isolate the source of the spill so that action to mitigate may be initiated. (Command) (Engine Room)
If onboard transfer of fluids from the damaged tank (s) is not possible, consider the advisability of lightening fuel to another vessel, and request necessary assistance if this action is deemed appropriate. (Command) (Engine Room)
If tank damage is at or near the tank bottom, and if it is determined not to pump fuel from the damaged tank, and if there is sufficient confidence that the nature of the tank damage is known and understood, consider pumping water into the damaged tank to establish a water bottom cushion under the remaining fuel. (Command) (Engine Room).
Recognise that fuel quality and segregation are secondary concerns in reaching any decision to transfer fuel for the purpose of spill mitigation. (Command) (Engine Room).
The decision to undertake any fuel transfer operation must be determined with full consideration of its potential effect on the safety of personnel onboard and on the safety of the ship and her essential equipment. (Command) (Engine Room)
If the damage to the vessel is such that uncertainty in the consequence of any spill mitigation action (fuel transfer, ballast adjustment) is unacceptably large, consider
the execution of stability calculations ashore, on behalf of the damaged vessel. (Command)
Close sea suctions, when deemed possible, to avoid ingesting fuel from the water surrounding the ship. (Engine Room)
Consider imposing an intentional trim or list to minimise the release of fluids from damaged tanks. (Command)
If damage assessment is inconclusive or incomplete, consider the use of divers to ascertain the damage situation. (Command)
Once the spill source has been identified, estimate the volume spilled, identify the particular product, which has been spilled, and formulate a recommendation as to the need and practicality

of mounting a recovery operation. Factors influencing this recommendation should at least include:
The volume and nature of spilled fluid;
The potential for additional spill from the same or other sources;
The weather, sea, state, and ocean current conditions; and
The environmental impact or public awareness sensitivity to the geographical location where the spill has occurred.
This is to be viewed as a preliminary recommendation: the preparation of this recommendation must not unduly delay the commencement of notification as instructed immediately below. (Command) (Site)
Determine the ship's position for the purpose of identifying necessary contacts for delivery of incident reports. Ensure that the estimates volume spilled, present flow rate, and total volumes still at risk (if any), plus any recommendations regarding containment and recovery operations, are prepared for communication ashore. Initiate notification procedures to the extent required by the nature and magnitude of the incident. If any notification whatsoever is required, then at least shipboard personnel must make the following contact. Supply the following contacts with a completed IMO pollution Incident Report.
For reporting more serious incidents, consider use of a Detailed Report of Pollution Incident.
Throughout the entire incident, ensure that accurate written logs of events, decisions, actions, and communications are maintained. (Command)

FIRE AND/OR EXPLOSION

- In responding to the consequences of a fire or explosion, the priority considerations of the Master are:

(1) Preservation of life and safety of personnel onboard;

(2) Safety of vessel and her essential equipment;

(3) Preservation of the environment by minimising the magnitude and consequences of any spill of hazardous materials in resulting from the fire or explosion.
The Master is to maintain a clear vision of these priorities in any decisions he/she makes associated with the recommended actions in this plan. (Master)

- Sound the General Alarm to assemble emergency teams at Muster Stations. Actions taken to control fire are to be dictated by the onboard fire plan, which is incorporated in the Muster List. If there is any confusion about the priority of actions, the Master is to confirm to emergency teams that emergency response actions such as attending to the injured or fighting fire take precedence over pollution responses. Instruct the Engine Room team to standby. (Command)
- Attend immediately to any injuries. (First Aid)
- Attend immediately to any fire of threat of fire. (Site) (Secondary Site)
- If fire is out of control to the extent that abandonment is ordered, then all attention is to be focused on personnel safety, and this pollution response plan is superseded. (Command)
- Issues that should be considered in determining if and how to fight the fire include at least the following. (Command) (Site) (Engine Room)

(1) Where is the fire located, and is it sufficiently accessible that fire fighting efforts might be successful?
(2) what are the risks of fire migrating from its present position to other locations on the vessel?
(3) is the onboard fire fighting equipment and the training of the crew adequate to deal with the severity of the current situation?
(4) is the ship manoeuvrable?
(5) is there a port of refuge available where assistance in fire fighting might be secured?
(6) are other vessels located near enough to be of assistance? and
(7) does the ship appear to have suffered severe structural damage, which might immediately affect stability and the ability to manoeuvre?

- If the decision is made to attempt to fight the fire, actions, which may be considered, include:

(1) Isolating fuel or cargo tanks from sources of ignition to the extent possible by
Applying inert gas pressure or foam to cargo tanks, by confirming the security of flame screens in vents, and by securing any other points of access to the tanks; and
(2) orienting the vessel (if manoeuvrable) so that open flame is downwind of fuel tanks; and

- As early as is possible after the fire is controlled and the vessel's safety and stability are secured, undertake a thorough internal/external damage assessment to determine status of vessel, and to any assess spill potential or circumstance. Consider initiating such actions as:

(1) The internal/external visual inspection of own ship to determine damage;
(2) A visual scan around the entire perimeter of vessel for any evidence of fuel leakage;
(3) An assessment of hazards to health and safety of the crew, and to the health and safety of adjacent populations due to the confirmed or possible release of hazardous substances in dangerous concentrations;
(4) The ascertaining of the contents of all fuel tanks, and comparing them with most recent (allowing for consumption) to identify any losses; and
(5) The sounding of all compartments and void spaces to verify their continued integrity. Care must be taken to avoid indiscriminate opening of compartments, which might allow progressive flooding and hence promote structural failure or endanger the stability of the vessel.

The essential requirement is to determine as much as possible about the physical status of the ship and her equipment, and the quantity and characteristics of any spill, so as to appropriately judge and balance the need for attention to ship's safety and to environmental protection. (Command) (Site) (Engine Room)

- Ensure that a fire watch is maintained to avoid recurrence of fire. (Command)
- If a spill has occurred, or if a spill seems probable, estimate the volume spilled, identify the particular product, which has been spilled, and formulate a recommendation as to the need and practicality of mounting a recovery operation. Factors influencing this recommendation should be at least include:

(1) The volume and nature of the spill;
(2) The potential for additional spill from the same or other sources;
(3) The weather, sea state, and ocean current conditions; and
(4) The environmental impact or public awareness sensitivity to the geographical location where the spill has occurred.
(5) The status of fire fighting.

This is to be viewed as a preliminary recommendation: the preparation of this recommendation must not unduly delay the commencement of notifications as instructed immediately below. (Command) (Site)

- Ensure that data such as ship's position, water depth, draft, trim, list, estimates of volume spilled, present flow rate, and total volumes at risk, plus any recommendations regarding containment and recovery operations, are prepared for communication ashore. The fire must be reported to the owner's representative. If there is uncertainly concerning spill reporting, consult P&I to determine the level of incident reporting which is required under the present circumstances. Initiate notification procedures to the extent required by the nature and magnitude of the incident. Shipboard personnel must make if any spill notification whatsoever is required, then at least the following two contacts.
- For reporting more serious incidents, consider use of Detailed Report of Pollution Incident. (Command)
- If the damage to the vessel is such that uncertainty in the consequence of any spill mitigation action (fuel transfer, ballast adjustment) is unacceptably large, consider the execution of stability calculations ashore. (Command)
- Close sea suctions, when deemed possible, to avoid ingesting fuel from the water surrounding the ship. (Engine Room)
- For a spill originating from an onboard tank damaged by the fire or explosion, assess the availability of slack tanks and determine the practicality of pumping fluids from the damaged tank to slack tank(s). If deemed feasible and safe, commence fuel transfer to slack tank(s) to empty the damaged tank. (Engine Room)
- If onboard transfer of fluids from fluids from the damaged tank(s) is not possible, consider the advisability of lightening fuel to another vessel, and request necessary assistance if this action is deemed appropriate. (Command) (Engine Room)
- Throughout the entire incident, ensure that accurate written logs of events, decisions, actions, and communications are maintained. (Command)

WHY:

MARPOL 73/78 Annex V requires that all ships on international voyages have in place a waste management program. As company vessels are at all times to be read and able to conduct such voyages, company vessels will comply with Annex V.

WHAT: Under the general direction of the Master the First Seaman will be the responsible Environmental Control Officer. Although each department head will continue for the control and management of waste control within the vessel, for the purpose of control and disposal of waste from the vessel the First Seaman will be the responsible person.

WHO: The First Seaman will ensure that all waste disposal in port and at sea is carried out in strict compliance with the regulations of Annex V.

WHAT TO DO: Using FORM – P.7.1a the First Seaman will record the disposal of all ship generated waste material. Prior to discharging waste of any type from the vessel the Master's signed authorisation must be obtained. In liaison with Department heads the First Seaman will ensure that an adequate supply of waste containers are available. Ship generated waste will be collected at suitable containment areas until disposal. Disposal will be carefully controlled and recorded.

Any person disposing waste in an uncontrolled or illegal manner is to be reported to head office by the vessel Master. Disciplinary action up to and including dismissal will be applied at the company's discretion.

Summary of at sea garbage disposal regulations

Garbage Type	[1]All ships except platforms		[1]Offshore platforms
	Outside special area	[2]In special areas	
Plastics – including synthetic ropes and fishing nets and plastic garbage bags	Disposal prohibited	Disposal prohibited	Disposal prohibited
Floating dunnage, lining and packing materials	> 25 miles offshore	Disposal prohibited	Disposal prohibited

Paper, rags, glass, metal, bottles, crockery and similar refuse	> 12 miles	Disposal prohibited	Disposal prohibited
All other garbage including paper, rags, glass, etc. comminuted or ground	> 3miles	Disposal prohibited	Disposal prohibited
Food waste not comminuted or ground	> 12 miles	> 12 miles	Disposal prohibited
[3]Food waste comminuted or ground	> 3 miles	> 12 miles	
Mixed refuse types	4	4	4

Offshore Platforms and associated ships include a;; fixed or floating platforms engaged in exploration or exploitation of sea bed mineral resources and all ships alongside or within 500 m of such platforms

Garbage disposal regulations for special areas shall take effect in accordance with regulation.

Comminuted or ground garbage must be able to pass through a screen with a mesh size no larger than 25 mm.

When garbage is mixed with other harmful substances having different disposal or discharge requirements the more stringent disposal requirements shall apply.