A Lab Manual On:

Fishing Craft Technology

The School of Agricultural and Allied Sciences.

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Index

SERIAL NO.	TOPIC	PAGE NO.
01.	Studies on Traditional Fishing Crafts. (Gujarat)	1 - 3
02.	Studies on Traditional Fishing Crafts. (Maharashtra)	4-5
03.	Studies on Traditional Fishing Crafts. (Goa, Kanataka & Kerela)	6-9
04.	Studies on Traditional Fishing Crafts. (Andhra Pradesh)	10
05.	Studies on Traditional Fishing Crafts. (Odisha)	11
06.	Studies on Traditional Fishing Crafts. (WestBengal)	12
07.	Studies on Traditional Fishing Crafts. (Andaman & Nicobar Islands)	13-14

08.	Studies on Traditional Fishing Crafts. (Lakshwadweep Islands)	15
09.	Introduction to Drawing Instruments.	16- 44
10.	Lines Plan Drawing	45
11.	Sheer Plan Drawing	46
12.	Half Breadth Plan Drawing	47-49
13.	Types Of Hull of Boats	50- 52
14.	General View of Boat	53 – 86
15.	Types Of Marine Engines	87 – 88
16.	Engine Installation	88 - 89

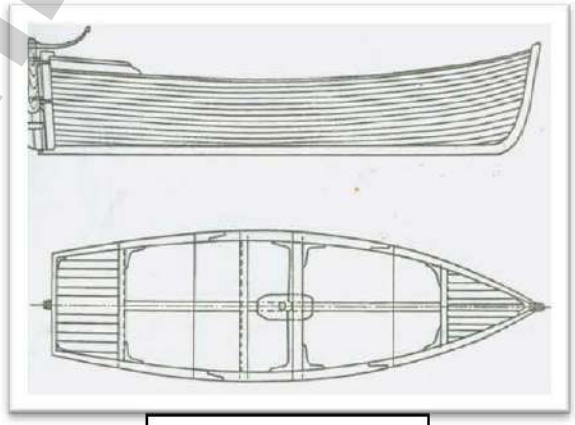
1. Studies on traditional fishing crafts (Gujarat)

Fishing boats of Gujarat

There is marked difference in the geographical and physical features of northern and southern regions of Gujarat. Whereas the northern region is arid and stony, the southern region is distinguished by sandy bottom. The following types of boat with their broad features gives along side are found in Gujarat.

1) Haler machwa:

- Length varies from 8-10 m
- Broad beam and square stern
- Open boat except for short decking in the fore and aft.
- Carvel planking with unusually large and heavy frames
- Tall mast carries on large lateen sail of Arab pattern
- It is used for gillnet fishing.



Machwa Type Boat

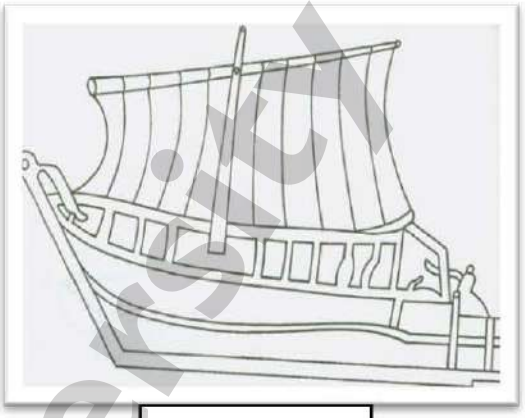
2) Porbandar machwa

- Length varies from 6-8 m
- Square stern and raked stem
- Used for gill net fishing

3) Cambay machwa

- Raked stem
- Undecked except for short length at stern
- Truncated stern with a slight rake

4) Navalaki hodi



Navalkodi Hodi

- Length 5-6 m, breadth 1-1.5 m and draft of 90-105 cm
- Square stern and overhang bow
- Decked only fore and aft
- Single mast carries lateen soil

5) Malia boat

- Flat bottom boat which measure about 6-7 m in length, breadth 1.5 m with 65cm draft.
- Ends are pointed and there is small rudder
- Carvel planking
- Mast carries a lateen sail
- Small decking fore and aft
- Used in tidal waters for prawn fishery.

6) Dugout canoe

- Double – ended round bottom boat
- Length varies from 5-9 m, breadth 60-90 cm and depth 60-68 cm
- Small sail raised on a wooden mast
- Used for gill netting.

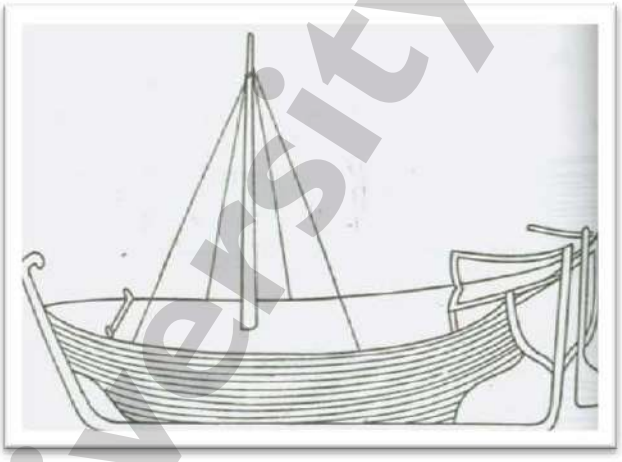
7) Ludhia

- The boat measures 9-10 m in length and 1.5 to 2 m breadth
- Short decking at the fore and aft
- Slightly racked stem and stern
- Two masts with small lateen sails

- Carved planking and has strong keel and heavy frames

8) Madhwad type wahan

- Length 10-13 m and breadth 2-3 m
- Raked stem and square stern
- Decked at the fore and aft
- Large heavy rudder
- Mast with lateen soil
- Used for operation of gill nets and dol nets.



Madhwad Type Wahan

Video Link:

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2. Studies on traditional fishing crafts (Maharashtra)

Fishing boats of Maharashtra:

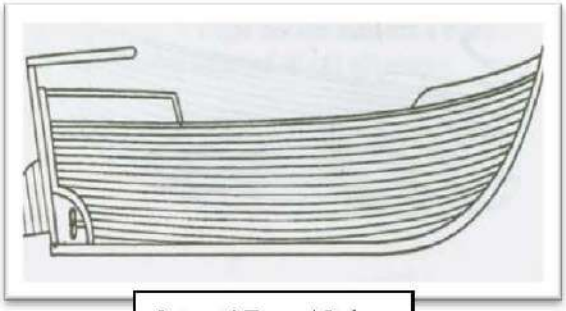
The physical and geographical features of northern Maharashtra up to Mumbai are similar to those of southern Gujarat. Southern Maharashtra has a rocky coast with sheltered bays, creeks and harbours. The following types of fishing boats are found in Maharashtra.

1) Bombay machwa (Karanja boat)

- Length 15 m, breadth 3-5 m and depth 1 m
- Long raking bow with great over hang and sheer. The actual keel is short in relation to the overall length.
- There are two masts, sails are of lateen type.

2) Satpati type (Gal boat)

- Length ranges from 10-15 m 4
- Carvel planking
- Medium pointed bow, broad stem, straight keel, high gunwale, and transom stern
- Used for gill netting.



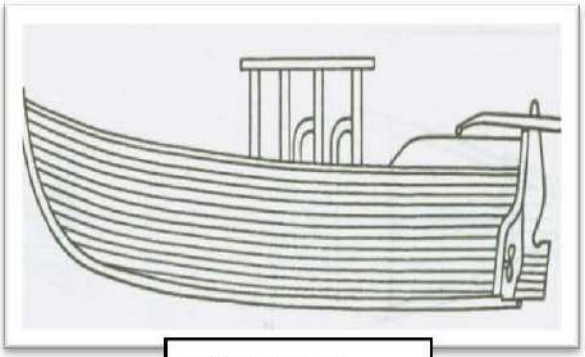
Satpati Type (Gal

3) Bassein boat

- Long, straight, pointed fine entry bow with abrupt round stern
- Carvel planking
- Broad hull straight keel and average gunwale

4) Versova boat (Hoda)

- Arched keel, round stern and deep fore foot
- Stem less raked than Bassein boat, it resembles Bassein boat in other respects
- Aft deck is present but no fore deck
- Used for operation of dol nets.



Versova Boat

5) Hodi (Toni)

- It is widened replicate of ordinary dugout, but built by planks
- Length varies from 7-10 m and breadth 0.75-3 m
- Single mast with lateen sail
- Stem and stern are curved like dugout
- A weather board about 30 cm high is fitted along the gunwale from the stem to just abaft the 5
- mast to keep out sea and spray.

6) Rathnagiri machwa

- Length 10 m, breadth 3 m and depth 1.15 m
- Broad beam, long over hanging bow, round stern and raked stem post
- Open boat with low free board, single mast lateen sail
- Used for deep sea gill net fishing

7) Rampani boat

- Length about 16 m
- Narrow keel, stem and stern
- No mast is carried as the boat is rowed
- Fitted without riggers to give stability
- Used for operation of Rampini nets.

The Indian teak is commonly used for the construction of fishing boats in Maharashtra. The vessels are very sturdy. One of the distinguishing features of these boats is their long overhanging bow which gives these undecked boats a reserve buoyancy and spray deflection in rough water. The planks are joined by tongues and groove fitting.

Bombay machwas are operated from north of Mumbai as far as Jaigarh in the south. Satpati type is used up to Ratnagiri. Hodi is operated from Mumbai to Jaigarh, Ratnagiri machwas from Jaigarh to Karnataka border and Rampini boats in Southern Maharashtra and Northern Karnataka.

Video Link:

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3. Studies on traditional fishing crafts (Goa, Karnataka & Kerela)

Fishing boats of Goa, Karnataka and Kerala

Fishing boats of Goa The traditional fishing craft of Goa are dugout canoes and planked boats with large out riggers. There is a rudimentary keel in the dugouts. The size of the boat varies from 7-8 m.

Fishing boats of Karnataka

Rampani boats are popular in Northern Karnataka and dugout in Southern Karnataka.

Fishing boats of Kerala

- Dugout
- Plank built canoe
- Raft Catamaran

1) Dugout:

- Single logs of trees like mango and aini are scooped for its construction.
- Three types of dugouts are found to be in operation. They are
- Large ones known as Odam – 11.6 m length.
- Medium ones known as Thonies – 8 m length
- Smaller ones known as Bepu thoni – 7.5 m length
- They are propelled by paddles and sails. Sails are either square or sprit type. No rudder is used. Steering is by means of big paddle one quarter side.
- Larger ones operate boat seines and smaller ones gill nets and lines.

2) Plank built canoes (Tonga Vallam / Chemboke)

- Built with planks which are sewn with coir ropes
- Propelled by means of paddles and occasionally sails.

- Two types are distinguished i.e. A larger one– 12 x 1.5 x 0.8 m, B – Smaller one 7 x 1 x 0.6 m
- Used for operation of shore seines and gill nets

3) Raft catamaran (Chalatadi)

- It is constructed by tying 3-5 logs of soft wood with coir ropes
- Propelled by split bamboo oars and sails
- Used in pairs to operate boat seines and individually to operate gill nets and long lines.

Fishing boats of Tamil Nadu

Four regions can be distinguished along the coast of Tamil Nadu, each region having fishing craft with specific features Colachel to Cape Comorin

1) Boat catamaran

- It is made of three logs, the centre one fitted at a lower level than the other two giving it a boat
- shape.
- The logs are held by means of two blocks of wood on either end and secured by coir ropes • passing through the grooves on the side of the logs.
- Size varies from 6.5 – 7.5 m
- Small triangular sail is used 7
- Normally operated in pairs for boat seiners

2) Boat canoe (Vallam)

- Similar to Malabar dugout but spread by wedges and heightened by flared 22-25 cm wash • strakes.
- Length varies from 9-13 m
- Single mast at amidships with lug sail. In larger ones, mizzen mast is also carried.
- Large rudder is fitted which descends much below the round bottom.
- Used for operation of gill nets and long lines.

3) Tuticorin boat

- It measures 9.6 x 2.0 x 0.9 m
- Long, relatively narrow with nearly vertical stem and stern
- Sheer line is almost straight.
- Single mast with lug sail
- Frames are not carried up to the gunwale but cut away at the sheer plank. The upper most • planks are framed with a separate short piece not fastened to the main frame.

4) Kilakaral boat

- It is similar to Malabar dugout with additional vertical stakes.
- Provided with either one or two out riggers for stability.
- Single mast with lug sail
- Use temporary rudder fixed at the sharp curved stern by orthodox pintle and gudgeon

5) Fishing Canoe

- Hull is either a dugout or plank built canoe
- Single mast with square headed log

6) Adirampatnam fishing canoe

- Hull is a dugout canoe with wash strakes
- There is a pair of quarter steering boards instead of fixed rudder.
- Single mast, occasionally three masts are used
- For steering the boat, quarter boards are manipulated with feet by steer man sitting at the aft
- The balance board is exceptionally long.

7) Three masted plank built canoe

- Three masts are present

8) Kalla Dhoni

- Heavy transom stern
- Carries the largest and heaviest balance board
- Rigged with three masts and lug sails

9) Coromandal coast

- Catamaran
- Masula boat.

10) Catamaran

- Made up of 1-1.6 m logs tied together raft wise. The logs are cut square at the stern and
- tapered at the bow with a little raise.

- The logs do not end in one line at the aft
- Bamboo mast is used with triangular sail. Five types are identified mostly depending upon the • number of logs used.

11) Periyamaram
- 8 m long and 1 m wide consisting of 4 logs
- Middle pair project 1.2 m beyond outer logs

12) Irukumaram
- Made up of five logs, middle being the longest
- Used for gill net fishing

13) Kolamaram
- Made up of seven logs
- Two masts are used.

14) Thundilmaram
- Made of five logs without beaked prow

15) Chinnanaram
- Made of three logs

16) Masula boat
- Size measures 9 x 2.4 x 1.2 m
- Open boats without ribs
- Planks are sewn with coir rope and inter space is filled with dry straw
- Stem and stern are raked, keel narrow
- High free board
- No mast or sail, long paddles are used
- Used for operation of shore seiners.

Colachel to cape Comorin is a surf beaten coast where boat catamarans are popular. Gulf of mannar is also surf-beaten coasts with sheltered areas and coral beds. Fishing grounds are far away. In this region, boat canoe, boat catamaran, Tuticorin and Kilakarai boats are in operation. Though the physical conditions are similar in palkbay fishing craft operating are different. Popular craft in palk bay are fishing canoe, Adiram patnam canoe three masted plank-built canoe and kalla dhoni. Coromandel coast is surf beaten without shelter. Here surf landing catamarans and flexible, masula boats are predominant.

https://www.youtube.com/watch?v=Av8wvcq73qI&ab_channel=BiharAnimalSciencesUniversity%2CPatna (Video Link:)

4. Studies on traditional fishing crafts (Andhra Pradesh)

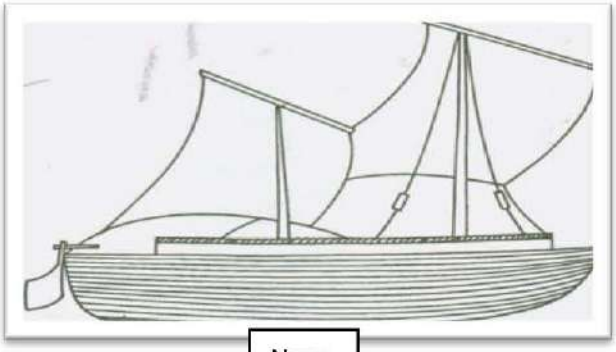
Fishing boats of Andhra Pradesh

Being surf beaten coasts without shelters, the following surf – landing crafts are predominant

1) Catamaran (Teppalu)
   - Made of 4 logs, it is 6.6 m long and 1.35 m broad.
   - All logs end in a line unlike coromandel catamarans. Wash boards are attached at the sides.
   - Triangular sails are used from bamboo mast. Paddles of 1.5 m long are used.
   - Used for operating gill nets, lines and boat seines

2) Masula boat
   - Similar to the one described under coromandel coast excepting some minor details its planks are made of mango wood and stitched with palmirah leaf fibre keeping a continuous rope in between the seams.

3) Nava
   - It measures 10 x 2 x 0.7 m
   - Narrow round bottom boat without keel, heavy framed and carvel planked with a short fore deck and longer aft deck
   - Carries one mast and a lateen sail
   - Mainly used for operation of gill nets



Nava

Video Link:

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5. Studies on traditional fishing crafts (Odisha)

Fishing boats of Odisha:

Two regions can be differentiated along the Orissa coast. The southern part is surf beaten, whereas the northern part has sandy bottom extending far out into the sea. The boats used are

1) Botali
   - It measures 7 x 1.5 x 1.5 m
   - Vertical and pointed stem and stern with full amidships section
   - Both carvel and clinker planking are seen
   - Used for operation of gill nets.

2) Catamaran
   - Five logs are tied in a boat shape, front portion being narrowed to a point and aft part abruptly truncated.
   - Used for the operation of gill nets, boat seines are also operated occasionally.

3) Nava
   - An ideal surf landing craft similar to the one described under fishing boats of Andhra Pradesh.

4) Bar boat
   - It measured 8 m long and 2.5 m broad
   - Similar to masula type
   - No ribs or frames and planks are stitched with coir ropes

Video Link:

https://www.youtube.com/watch?v=Av8wvcq73qI&ab_channel=BiharAnimalSciencesUniversity%2CPatna

6. Studies on traditional fishing crafts (West Bengal)

Fishing boats of West Bengal:

The physical conditions of the coast line are similar to those of northern Orissa. The following two boats are used.

1) Batchari boat
   - It measures 13.5 m x 1.3 m x 0.5 m
   - The stern is as high as bow and they are sharp and raked.
   - They are partly decked without keel
   - Propelled by sails and oars
   - Used for operation of variety of gears like drift net, bag net, dip net etc.,

2) Chot boat
   - It measures 10.2 x 2.5 x 1.1 m 12
   - It has short overhangs and high freeboard
   - Mostly propelled by oars though it carries a sprit sail
   - There is only a loose decking of split bamboo rods
   - Used for operation of heavier fishing gears like seine nets and bag nets.

Video Link:

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7. Studies on traditional fishing crafts (Andaman and Nicobar Islands)

Fishing boats of Andaman and Nicobar Islands

Influence of Australian design is seen in the fishing craft of these Islands. Dugout and out rigger canoes are common. However, the shape of dugouts is different and the outrigger canoes have more than two out riggers attached in a different manner. These are described below.

1) Dugout
   - Length varies from 2.75 m – 10.5 m
   - The bow and stern are prolonged horizontally to form an overhang shelf platform which gives
   - footing for the harpooners on look out for fish.
   - Propulsion is by means of oars, steering with paddle
   - Holes are made in the gunwale on each side and a piece of wood is thrust through them as a sort of thwart. This is to provide a means of fastening the end of harpoon line.

2) Out rigger canoe
   - It is provided with multiple booms varying from 3-12 m. These booms are slender poles secured at their inner ends by being passed through the holes on the sides of dugout close to the edge. This is similar to the design found in Australia.
   - Floats are connected to the booms by means of three short stanchions.

3) Flat bottom
   - It measures 6.5 m Over All Length
   - There is no keel and the bottom is shaped into curve
   - Carvel planking painted with coal tar
   - Small fore and aft deck
   - Not suitable for operation during monsoon.

4) Round bottom
   - Length ranges from 4.5 – 7.5 m
   - Keel is present and the bottom is shaped round
   - Carvel planking
   - Found suitable for operation even during monsoon.

The out rigger canoe used in Nicobar Islands is different from that of Andaman's described above. These are better built and more elegant with not more than two booms. They are fitted with 3-4 vertical bamboo masts each carrying a lateen sail.

Video Link:

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8. Studies on traditional fishing crafts (Lakshwadeep Islands)

Fishing boats of Lakshwadeep Islands

1) Raft (Kathufathi)
   - 5-6 logs are tied into raft by means of two coconut poles and fastened by coir ropes
   - Propulsion is by paddles
   - Used for hook and line operation.

2) Plank built boat (Kalundhoni)
   - Both stem and stern are slightly curved. Stern is broader than the bow.
   - Keel is a single piece of coconut palm or wood
   - Oars and sails are used for propulsion. Rudder is fixed over the skeg.
   - The boat is divided into seven compartments by transverse planks.
   - Used for pole and line fishing.

3) Masodi
   - It measures 12.5 m in length and 3 m broad
   - The stern is broader than the bow and is provided with a fishing platform
   - The boat carries two lateen sails and 18 oars for rowing
   - The hull is divided into 12 compartments and two bait tanks are provided
   - Used for pole and line fishing.

Video Link:

https://www.youtube.com/watch?v=Av8wvcq73qI&ab_channel=BiharAnimalSciencesUniversity%2CPatna

9. Introduction to drawing and drawing instruments

Instruments And Materials Of Drawing

INTRODUCTION

Various drawing instruments are used for making all drawings. The quality of a drawing depends on the quality of drawing instruments and drawing materials used. The drawing instruments need proper care and right adjustment. An engineering student must have complete knowledge of drawing instrument and materials. This topic mainly deals with the basic knowledge of drawing insteuments and materials, along with their uses.

Instruments Or Drawing

The following drawing instruments are required for preparing a neat and correct drawing.

Basic Instruments

1. Drawing board
2. Drawing sheet
3. Drawing pencil
4. Drawing clips or pins
5. Eraser
6. Eraser shield

Instruments for Drawing Straight Lines

1. Set- squares

Instruments For Drawing Curved Lines

1. Large size compass
2. Small bow compass
3. French curve

Instruments For Measuring Distance

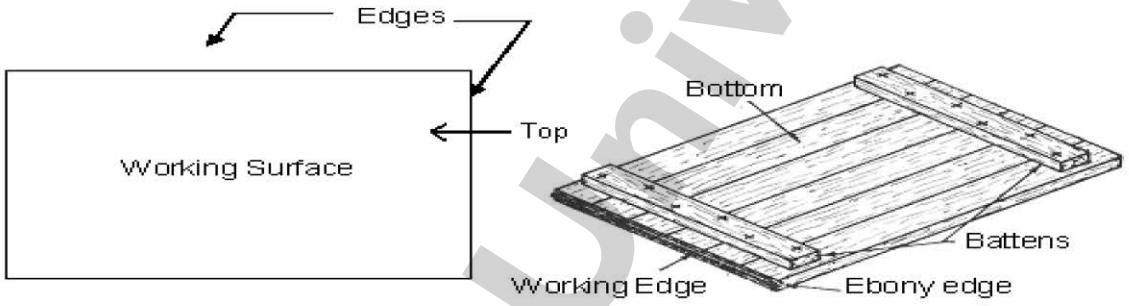
1. Large size divider
2. Small bow divider
3. Scales

Instruments For Measuring Angles

1. Protractors
2. Set-squares

Drawing Board :-

A drawing board with its working surface upward. The top surface of the board is perfectly smooth and level. The bottom of the drawing board. A drawing board is rectangular in shape and is made of well seasoned soft wood such as oak or pine. A straight ebony edge is fitted on the left side on the board against which the head of the T- square moves.



Drawing Board (Top) **Drawing Board (Bottom)**

Drawing Sheet :-

The drawing is frequently made in pencil on the drawing sheet. The best drawing sheet has the following qualities:

1. Light cream buff in colour to have good appearance
2. Fine grains to pick up the graphite and produce clean, dense black lines
3. Strong fibers
4. Superior erasing qualities
5. Folding strength
6. Toughness
7. Smooth surface
8. Hard surface

Drawing Pencil :-

Neatness, quality and accuracy of the drawing greatly depends upon the type and conditions of the pencil used for drawing. Pencil leads are made of graphite with clay added

in varying amounts to make 18 grades from 9H to 7B. These grades can be divided in three groups:

1. Hard : 9H to 4H
2. Medium : 3H to B (3H, 2H, H, F, HB and B)
3. Soft : 2B to 7B

Pencil of 9H is the hardest and that of 7B is the softest. Harder pencils have leads of small diameters and softer pencils of larger diameters to give adequate strength. The choice of grade of pencil depends upon the type of work, texture of paper, atmosphere, humidity, etc. Following pencils should be used for drawing work in class:

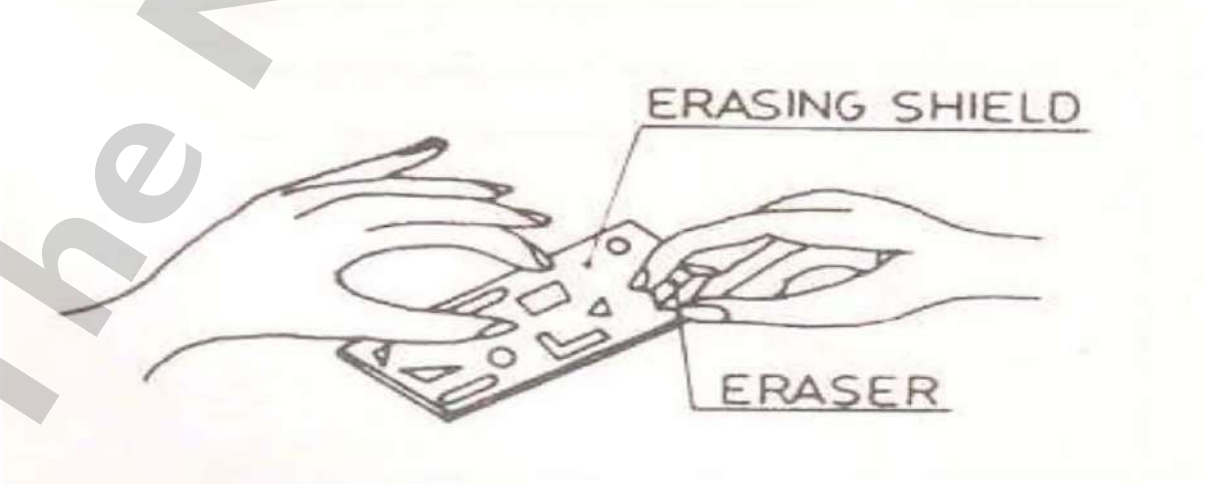
1. 2H Pencil - For drawing outlines, Centre lines, Break lines, etc.
2. H Pencil - For dimensioning, arrowheads, hatching lines, lettering, sketching, circles, arcs, etc.
3. Micro tip pencil - 0.5 mm for drawing outlines and 0.8 mm for shading and sketching

Drawing Clips Or Pins :-

Drawing clips or pins are used to fix the drawing sheet on the drawing board at the required place. Frequent use of pins cause formation of impressions of pin pricks on the board, thus spoiling the surface of the board. The present trend is to go in for steel clips, if the size of the drawing paper is the same as that of the drawing board. Clips are used at all the four corners of the drawing board to clamp the paper. Adhesive tapes are also used for fixing the drawing sheet.

Eraser :-

Eraser is used to remove the extra lines, lines/marks drawn by mistake and to clear soiled spots on the drawing. Only pencil eraser is used. Soft India-rubber is the most suitable kind of eraser for pencil drawings. The eraser used should be such that the surface of the drawing paper is not spoiled in anyway. It is desirable to use erasing shield to protect the near by lines from being erased. The rubber crumbs formed after erasing should be swept away with a clean duster and should never be brushed off with hands. Use of eraser should be minimized by proper planning.

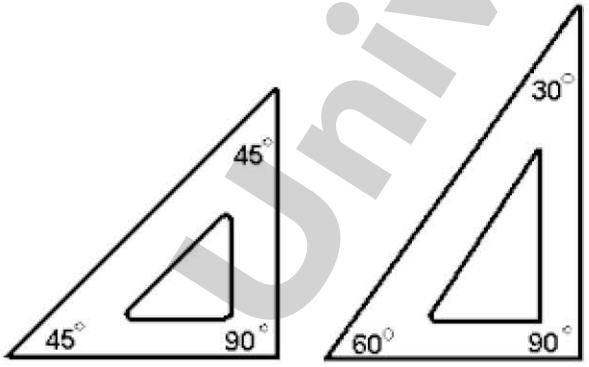


Erasing Shield :-

It is a thin metal or plastic plate cut with slots, circles and curves of different dimensions. It helps to erase unwanted pencil lines without erasing the surrounding lines.

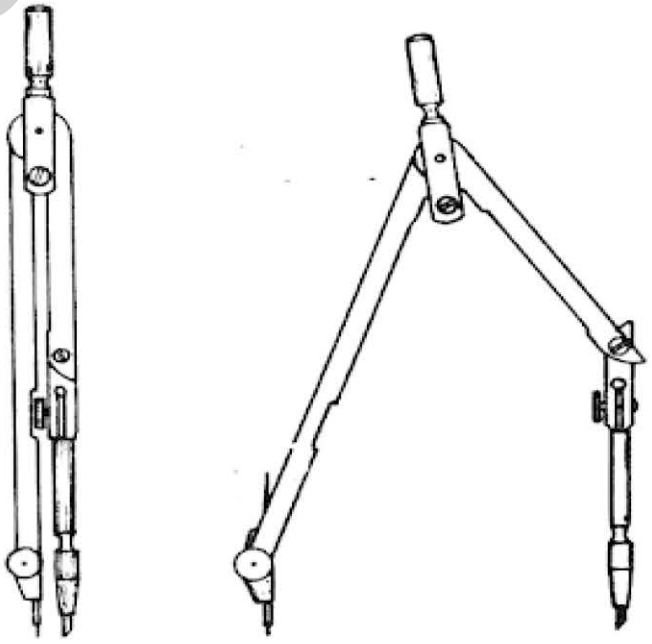
Set-Squares :-

Set-squares are made of transparent plastic and are available in the shape of triangles, having a French curve or simply a gap cut in the body. These are used for drawing short straight lines, measuring and drawing certain angles. A good combination of set-squares is 30^{O} x 60^{O} set square with a long edge of 250 mm and a 45^{O} set squares with each edge of 200 mm.



Large Size Compass :-

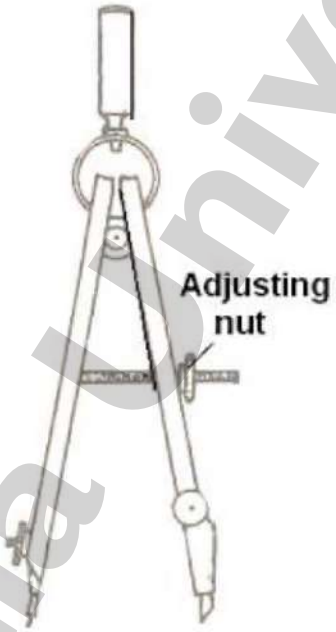
The compass is used for drawing circles and arcs. It consists of two legs hinged together at its upper end. A pointed needle is fitted at the lower end of one leg, while a pencil lead is inserted at the end of the other leg. The lower part of the pencil leg is detachable and it can be interchanged with a similar piece containing an inking pen. Both the legs are provided with knee joints. Circles up to about 120 mm diameter can be drawn with the legs of the compass kept straight. For drawing smaller circles, both the legs should be bent at the knee



joints so that these are perpendicular to the surface of the paper.

Small Bow Compass :-

Small bow compass is conveniently used for drawing circles and arcs of small diameters. It is very handy when a number of small circles of the same diameter are to be drawn. The adjusting nut of the small compass may be on the side or at the centre. This adjusting nut is provided to make fine adjustment for accurate small circles.



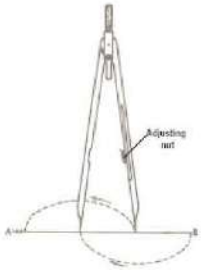
Large Size Divider :-

The dividers has two legs hinged at the upper end and is provided with steel pins at both the lower ends, but it does not have the knee joints. The dividers are used to

- Divide straight or curved lines into desired number of equal parts.
- Set off distances from the scale to the drawings.
- Transfer measurements from one part of the drawing to another.

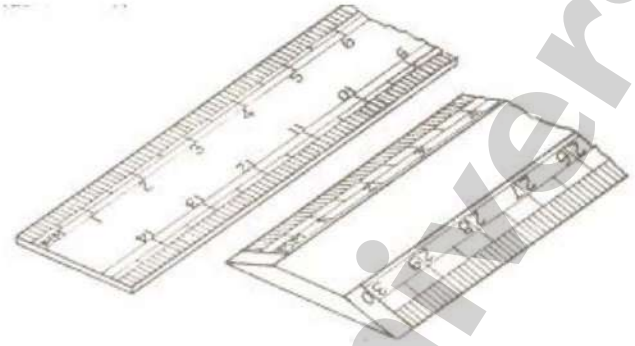
Small Bow Divider :-

The small bow divider is adjusted by a nut and is very convenient for marking minute divisions and large number of short equal distances.



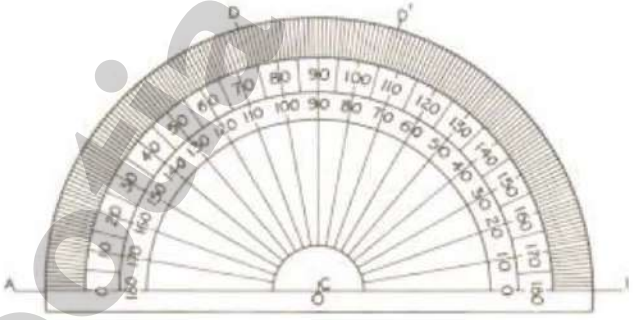
Scales :-

Scales are made of wood, steel, celluloid or plastic. Stainless steel scales are more durable. Scale may be flat or of triangular cross- section. 15 cm long and 2 cm wide or 30 cm long or 3 cm wide flat scales are commonly used. These are usually about 1 mm thick. The longer edges of the scale are marked with inch and its sub-divisions on one side and centimeter and its sub-divisions on the other side.



Protractors :-

Protractors or Pro-circles are used for drawing any desired angle. These are made of hard transparent plastic. The edges are either squared or beveled. Semi-circular type protractor.



Precautions for Neatness in Drawing Work :-

Cleanliness and neatness in drawing work are very important requirements. Following precautions are required to be taken to keep a drawing neat and clean:

1. The hands should be kept clean at all times during work.
2. All the drawing instruments should be kept clean by wiping with a cloth/towel.
3. Special emphasis is to be given to sliding instruments on the drawing sheet, such as T- square and set squares. These instruments must be cleaned properly every time.
4. Pencil should always be kept sharp and used properly. It should be sharpened away from the drawing sheet and other instruments.

5. Dirt and graphite particles from the pencil will make the drawing dirty. Hence, every care should be taken to remove them from the drawing sheet.
6. Direct contact of hand with the drawing sheet should be avoided.
7. Rubbing or erasing should be done properly with soft eraser.

Technical Lettering

INTRODUCTION

Technical Lettering is a barren piece of engineering drawing. It gives data concerning measures, and guidelines, as notes and measurements. On a drawing, the entire of the composed data is consistently through lettering. It isn't manually written. Likewise, it very well might be added here, that Lettering is fitting and right words however not (Printing implies the creation of literature on a print machine)

Lettering

The writing of alphabets and numerals such as A, B, C, D……Z and 1, 2, 3……9, 0 respectively is called **Lettering**.
Mainly, there are two types of lettering most commonly used in engineering drawing viz. Gothic Lettering and Roman Lettering.

Classification Of Lettering

The lettering, in general, is classified in two categories :-
1. Gothic Lettering
2. Roman Lettering.

Gothic Lettering

Lettering having all the alphabets or numerals of uniform thickness is called **Gothic Lettering**.
1. Vertical Gothic Lettering
2. Italic or Inclined Gothic Lettering.

Single Stroke Vertical Gothic Lettering

These are vertical letter having thickness of each line of alphabet or numerals etc. Same as the single stroke of a pencil.Since Stroke means that the letter is written with one or more stems or curves and each made with single stroke.

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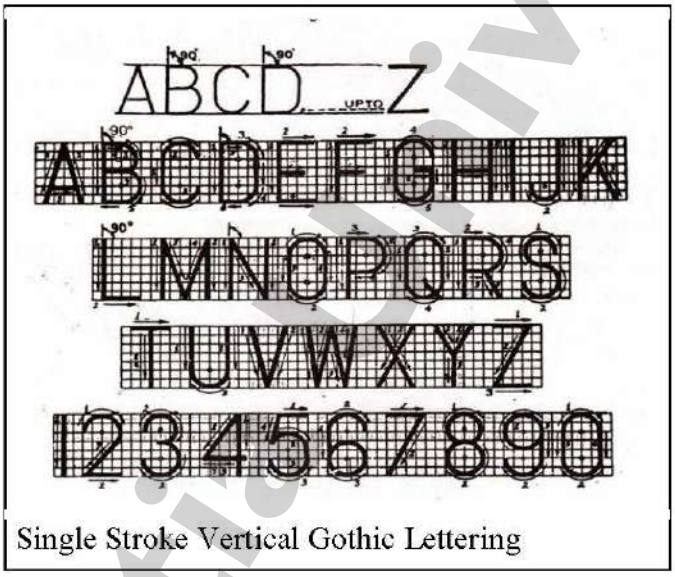
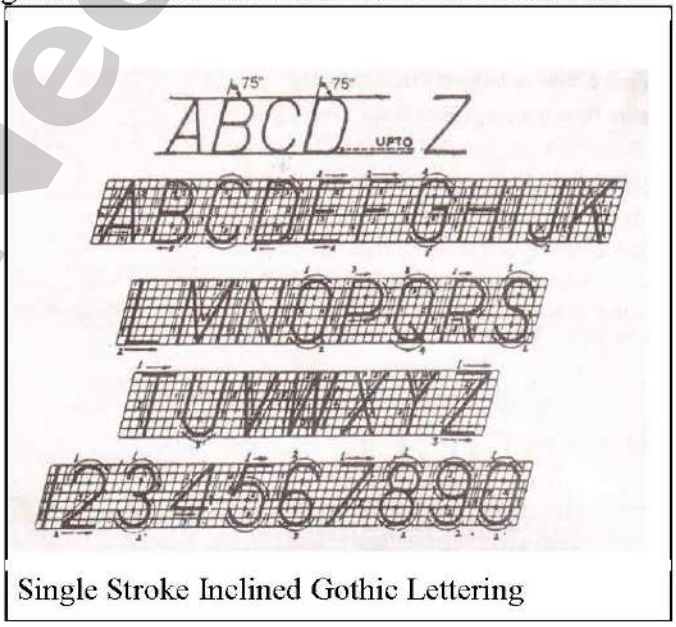


Single Stroke Vertical Gothic Lettering

Single Stroke Inclined Gothic Lettering

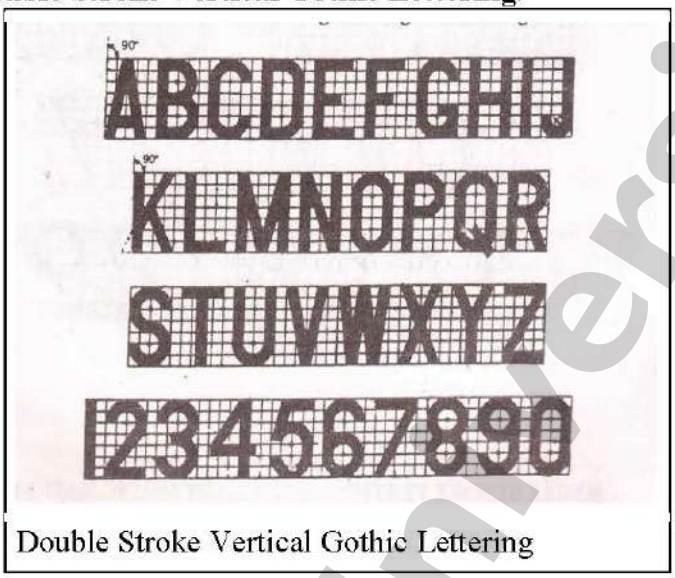
These are single stroke letter inclined at **75'** to the **Horizontal.**



Single Stroke Inclined Gothic Lettering

Double Stroke Vertical Gothic Lettering

Vertical letter drawn by double Stroke of pencil with uniform thickness between these strokes are called **Double Stroke Vertical Gothic Lettering.**



Double Stroke Vertical Gothic Lettering

Double Stroke Vertical Gothic Lettering

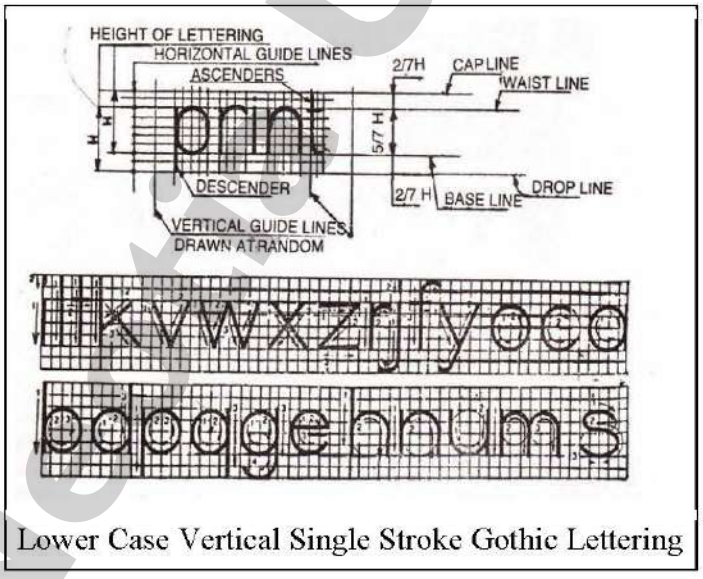
Double Stroke Inclined Gothic Lettering

Double stroke gothic when inclined at an angle of **75'** is called **Double Stroke Inclined Gothic Lettering**.

Double Stroke Inclined Gothic Lettering

- **Lower Case Vertical Single Stroke Gothic Lettering**

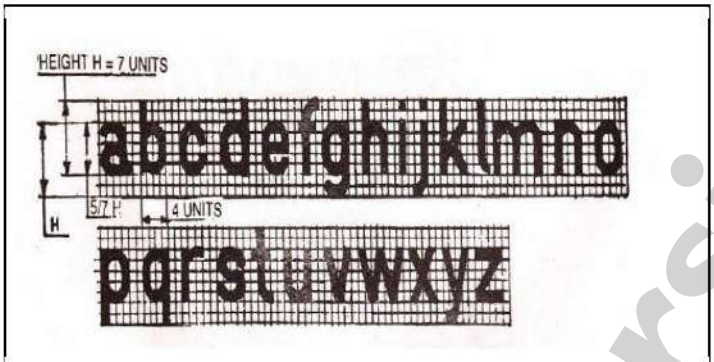
Lower case vertical gothic lettering is shown along with its sizes. Which is quite self explanatory.



Lower Case Vertical Single Stroke Gothic Lettering

- **Lower Case Vertical Double Stroke Gothic Lettering**

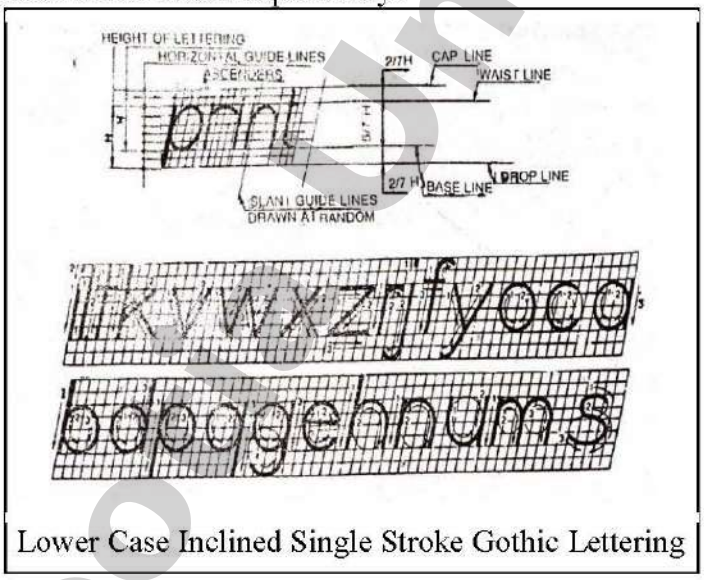
It is shown along with its size which is quite self explanatory.



Lower Case Vertical Double Stroke Gothic Lettering

- **Lower Case Inclined Single Stroke Gothic Lettering**

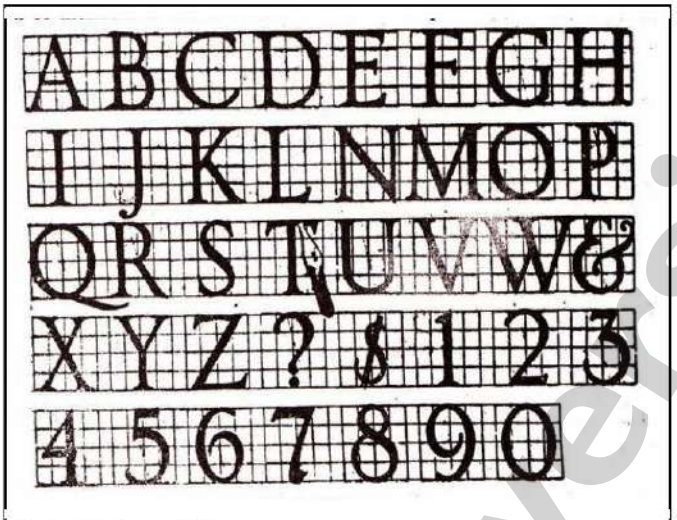
It is shown with its sizes which is self explanatory.



Lower Case Inclined Single Stroke Gothic Lettering

- **Roman Lettering**

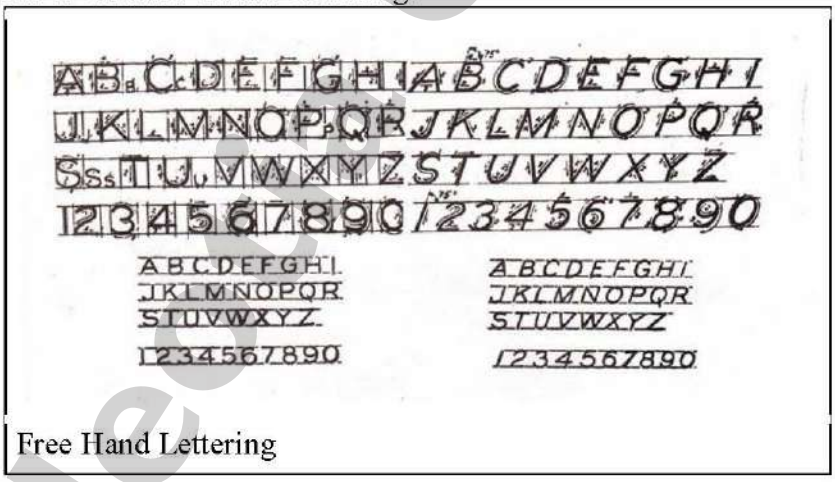
The lettering in which all the letters are formed by thick and thin elements is called **Roman Lettering**.
It may be vertical or inclined or inclined. It can be written with a chisel pointed Pencil or D-3 type Speed Ball Pen.



Roman Lettering

- **Free Hand Lettering**

The writing of alphabets without the use of drawing instruments and in free hand is called **Free Hand Lettering**.
It may be vertical or Inclined Gothic Lettering.



Free Hand Lettering

Free Hand Lettering

- **Mechanical Lettering**

In Mechanical Lettering, standard uniform characters that are executed with a special pen held in a scriber and guided by a template. Mechanical lettering does not normally require the use of lettering guidelines. You will use mechanical lettering principally for title blocks and notes on drawings, marginal data for special maps, briefing charts, display charts, graphs, titles on photographs, signs, and any other time that clear, legible, standardized lettering is required. One of the most popular types of mechanical lettering sets is the LEROY lettering set.

The Mechanical Lettering is some times done using special type of device called a Pantograph.

A *PANTOGRAPH* is basically a device consisting of four links which are pinned to each other in a parallelogram fashion. The links can move about the hinge. The lowermost link of the parallelogram is fixed to two rigid supports. One vertical link at one end is connected to a profile tracer which traces the profile of the letter to be drawn and the second vertical link and the other horizontal link are jointly connected to a pencil that draws the exact shape of the profile traced.

Height Of Lettering

The height "h" of the capital letter is taken as the base of dimensioning. The main requirement of lettering on engineering drawing are legibility, uniformity, ease and rapidity in execution.

Both upright and inclined letter are suitable for general use. All letters should be capital, except where lower case letters are accepted internationally for abbreviations.

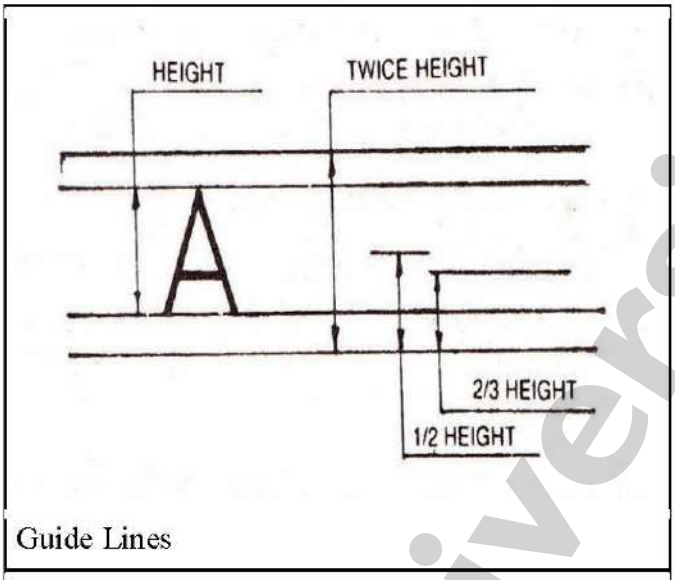
The recommended size of lettering is as under :-

ITEM	SIZE h, mm
Drawing number in Title Block and letters denoting Cutting Plane Section	10, 12
Title of Drawing	6, 8
Sub-titles and Headings	3, 4, 5, 6,
Notes, such as Legends, Schedules, Material list, Dimensioning	3, 4, 5
Alteration, Enteries and Tolerances	2, 3

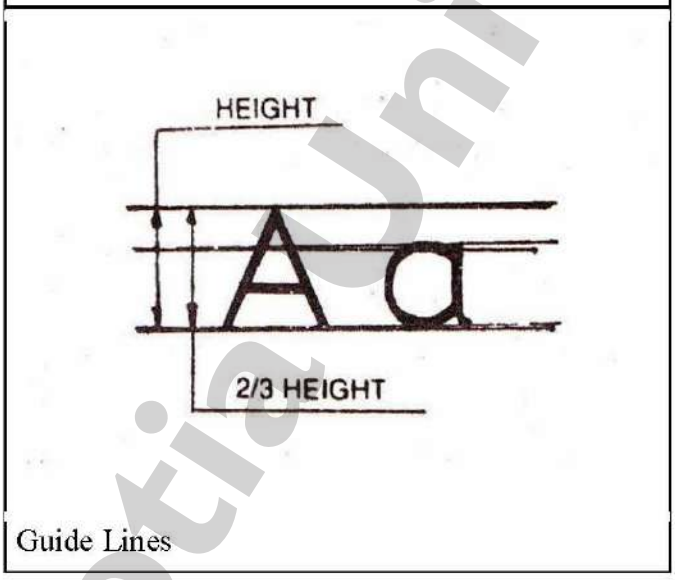
Guide Lines

The light thin lines drawn to obtain uniform and correct height of letters are called **Guide Lines**.

Guide line should be drawn very light and thin, so that, they need not be erased after the lettering is finished. To erase guide lines after finishing the lettering is not easily possible. Guide line for capital and lower case lettering.



Guide Lines

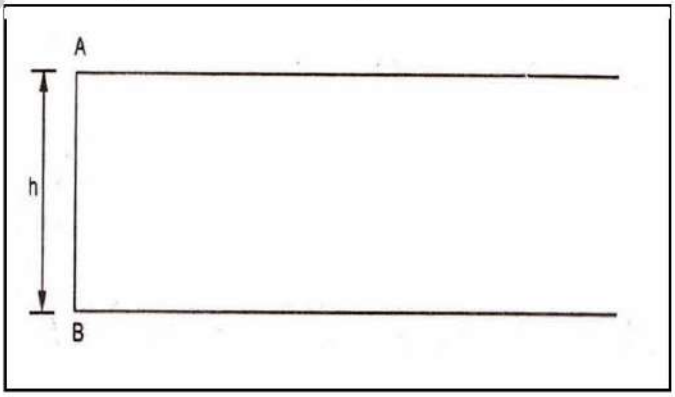


Guide Lines

- **How To Draw Graph For Lettering**

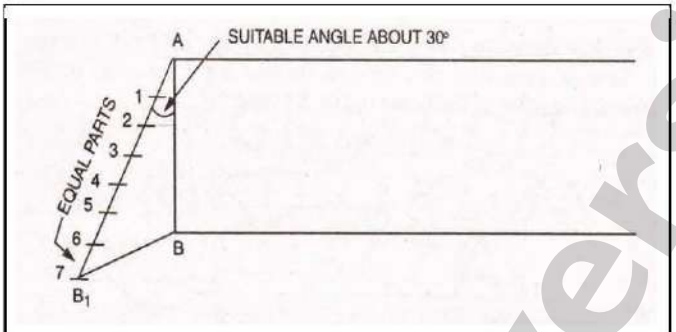
The letters are drawn in a graph. Before drawing the alphabets or numerals of 7:4, 5:4 or any other ratio, a graph is needed.

- First of all take the height of the lettering and draw two parallel horizontal lines.



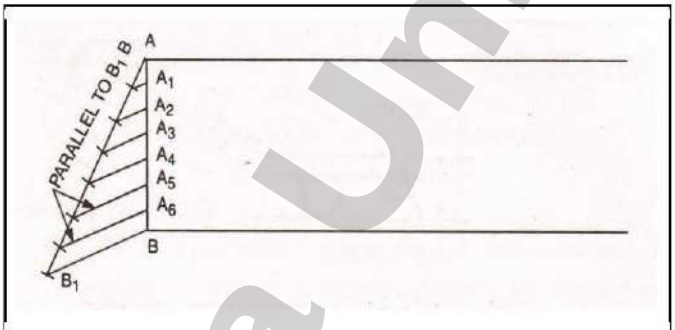
Draw Graph For Lettering

- Draw an inclined line at A and mark, 7 or 5 or as required number of vertical squares or rhombii, parts of any suitable size. Join B1 with B.



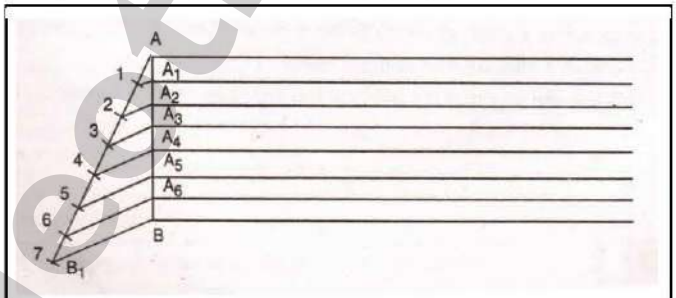
Draw Graph For Lettering

- Draw parallel line to B1B from 1, 2, 3, 4, 5, 6 meeting the line AB at A1, A2, A3, A4, A5 and A6.



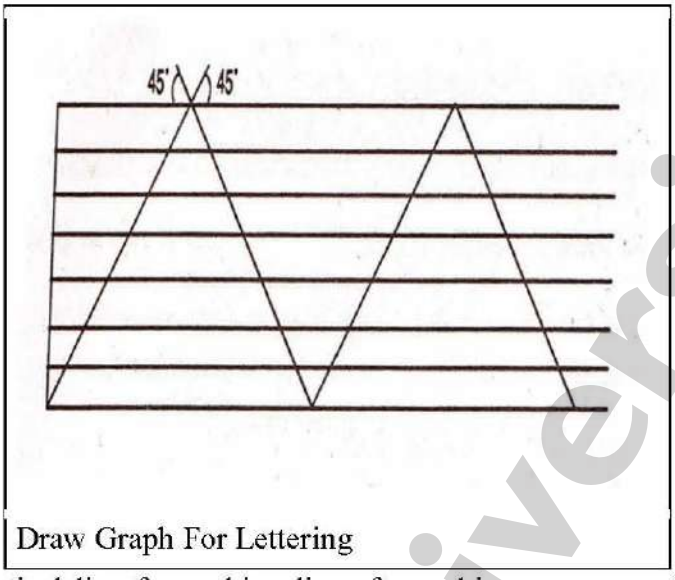
Draw Graph For Lettering

- From A1, A2, A3, A4, A5 and A6 draw horizontal line.



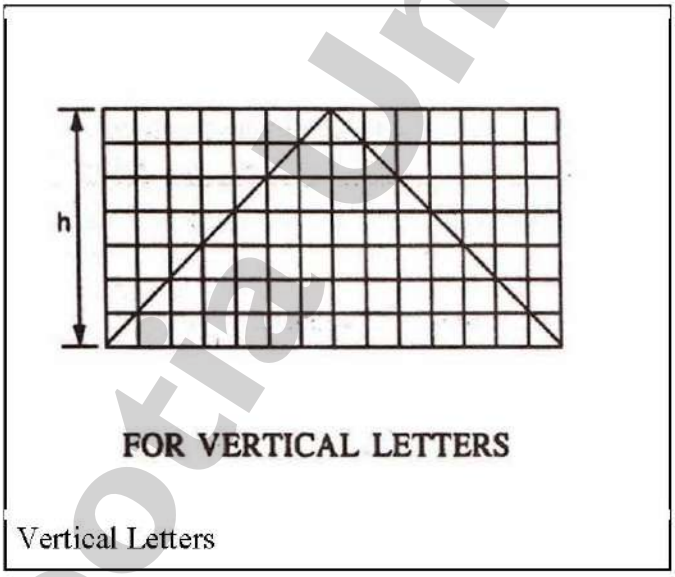
Draw Graph For Lettering

- From point B draw line at **45'** to the horizontal.

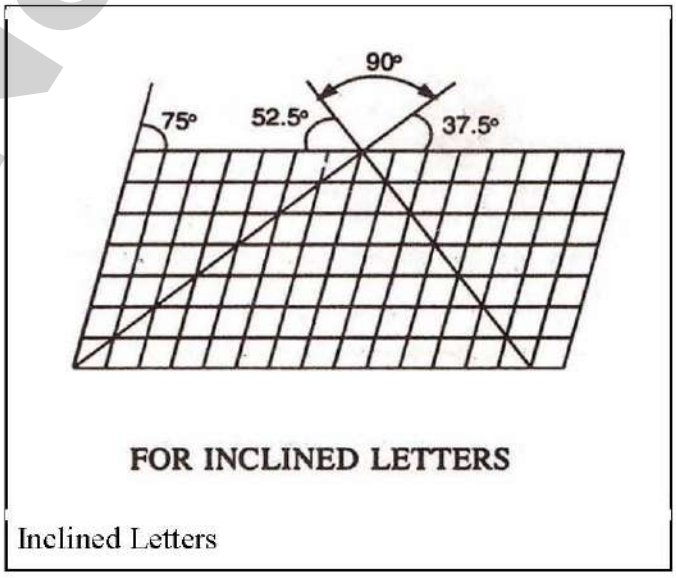


Draw Graph For Lettering

- Draw the vertical line for making lines for making squares and inclined line at an angle of 75' for making graph for inclined letters.



Vertical Letters



Inclined Letters

Geometric Construction

Introduction

Strict interpretation of geometric construction allows use of only the compass and an instrument for drawing straight lines, and with these, the geometer, following mathematical theory, accomplishes his solutions. In technical drawing, the principles of geometry are employed constantly, but instruments are not limited to the basic two as T-squares, triangles, scales, curves etc. are used to make constructions with speed and accuracy. Since there is continual application of geometric principles, the methods given in this topic should be mastered thoroughly. It is assumed that students using this book understand the elements of plane geometry and will be able to apply their knowledge.

The constructions given here afford excellent practice in the use of instruments. Remember that the results you obtain will be only as accurate as your skill makes them. Take care in measuring and drawing so that your drawings will be accurate and professional in appearance.

Geometric Nomeniclature

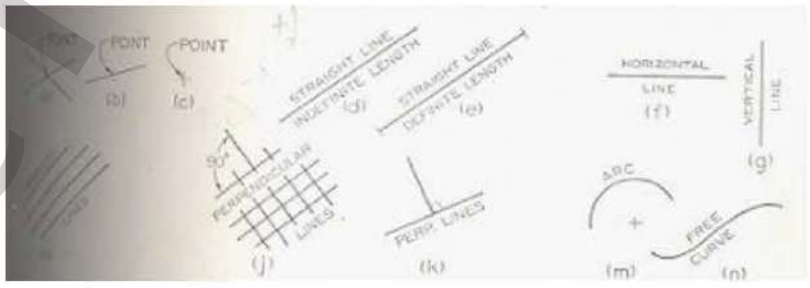
A. Points In Space

A point is an exact location in space or on a drawing surface.

A point is actually represented on the drawing by a crisscross at its exact location. The exact point in space is where the two lines of the crisscross intersect. When a point is located on an existing line, a light, short dashed line or cross bar is placed on the line at the location of the exact point. Never represent a point on a drawing by a dot; except for sketching locations.

B. Line

Lines are straight elements that have no width, but are infinite in length (magnitude), and they can be located by two points which are not on the same spot but fall along the line. Lines may be straight lines or curved lines. A straight line is the shortest distance between two points. It can be drawn in any direction. If a line is indefinite, and the ends are not fixed in length, the actual length is a matter of convenience. If the



end points of a line are important, they must be marked by means of small, mechanically drawn crossbars, as described by a pint in space.
Straight lines and curved lines are considered parallel if the shortest distance between them remains constant. The symbol used for parallel line is //. Lines, which are tangent and at 90º are considered perpendicular. The symbol for perpendicular line is ⊥.

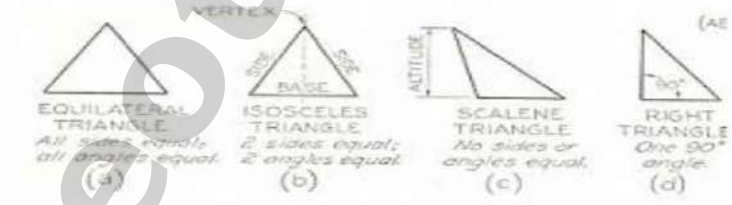
C. Angle

An angle is formed by the intersection of two lines. There are three major kinds of angles: right angels, acute angles and
obtuse angles. The right angle is an angle of 90º, an acute
Angle is an angle less than 900, and an obtuse angle is an

Angle more than 90º, A straight line is 180º. The symbol for an angle is < (singular) and <'s (Plural). To draw an angle, use the drafting machine, a triangle, or a protractor.

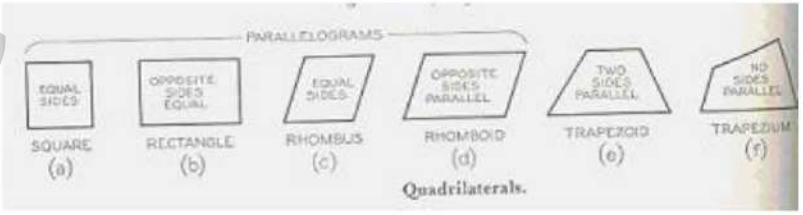
D. Triangles

A triangle is a closed plane figure with three straight sides and their interior angles sum up exactly 1800. The various kinds of triangles: a right triangle, an equilateral triangle, an isosceles triangle, and an obtuse angled triangle.



E. Quadrialteral

It is a plane figure bounded by four straight sides. When opposite sides are parallel, the quadrilateral is also considered to be a parallelogram.



Quadrilaterals.

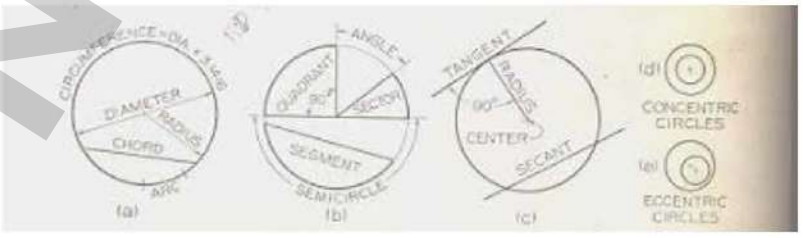
F. Polygon

A polygon is a closed plane figure with three or more straight sides. The most important of these polygons as they relate to drafting are probably the triangle with three sides, square with four sides, the hexagon with six sides, and the octagon with eight sides.

G. Circle

A circle is a closed curve with all points on the circle at the same distance from the center point. The major components of a circle are the diameter, the radius and circumference.

- *The diameter of the circle* is the straight distance from one outside curved surface through the center point to the opposite outside curved surface.
- *The radius of a circle* is the distance from the center point to the outside curved surface. The radius is half the diameter, and is used to set the compass when drawing a diameter.
- *A central angle*: is an angle formed by two radial lines from the center of the circle.
- *A sector*: is the area of a circle lying between two radial lines and the circumference.
- *A quadrant*: is a sector with a central angle of 900 and usually with one of the radial lines oriented horizontally.
- *A chord*: is any straight line whose opposite ends terminate on the circumference of the circle.
- *A segment*: is the smaller portion of a circle separated by a chord.
- *Concentric circles* are two or more circles with a common center point.
- *Eccentric circles* are two or more circles without a common center point.
- *A semi circle* is half of the circle.



H. Solids

They are geometric figures bounded by plane surfaces. The surfaces are called faces, and if these are equal regular polygons, the solids are regular polyhedral.

Geometric Constructions

To construct the above mentioned geometric figures, we have to know some principles and procedures of geometric construction. Thus, the remaining of this chapter is devoted to illustrate step-by-step geometric construction procedures used by drafters and technicians to develop various geometric forms.

A. How To Bisect A Line Or An Arc

To bisect a line means to divide it in half or to find its center point. In the given process, a line will also be constructed at the exact center point at exactly 90º.

Given: Line A-B.

Step 1: Set the compass approximately two-thirds of the length of line A-B and swing an arc from point A.

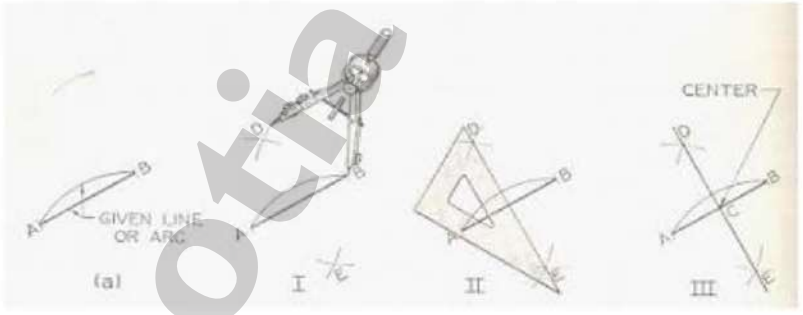
Step 2: Using the exact same compass setting, swing an arc from point B.

Step 3: At the two intersections of these arcs, locate points D and E.

Step 4: Draw a straight-line connecting point D with point E.

Where this line intersects line A-B, it bisects line A-B.

Line D-E is also perpendicular to line A-B at the exact center point.



B. How To Divide A Line In To Number Of Equal Parts

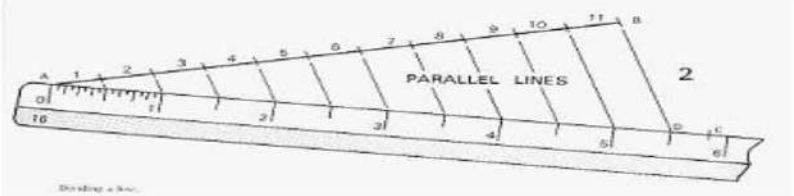
Given: Line A-B.

Step 1: Draw a construction line AC that starts at end A of given line AB. This new line is longer than the given line and makes an angle of not more than 300 with it.

Step 2: Find a scale that will approximately divide the line AB in to the number of parts needed (11 in the example below), and mark these divisions on the line AC.

There are now 'n' equal divisions from A to D that lie on the line AC (11 in this example).

Step 3: Set the adjustable triangle to draw a construction line from point D to point B. Then draw construction lines through each of the remaining 'n-1' divisions parallel to the first line BD by sliding the triangle along the straight edge. The original line AB will now be accurately divided.



C. How To Bisect An Angle

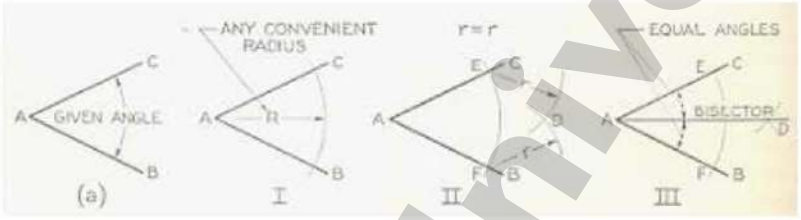
To bisect an angle means to divide it in half or to cut it in to two equal angles.

Given: Angle BAC.

Step 1: Set the compass at any convenient radius and swing an arc from point A.

Step 2: Locate points E and F on the legs of the angle, and swing two arcs of the same identical length from points E and F, respectively.

Step 3: Where these arcs intersect, locate point D. Draw a straight line from A to D. This line will bisect angle BAC and establish two equal angles: CAD and BAD.



D. How To Draw An Arc Or Circle (Radius) Through Three Given Points

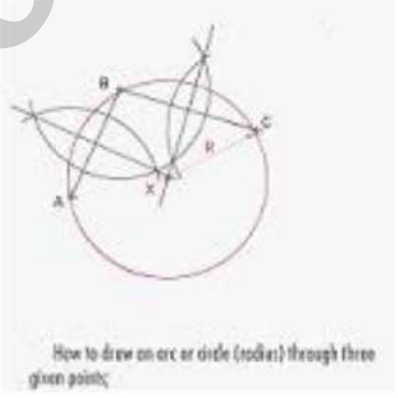
Given: Three points in space at random: A, Band C.

Step 1: With straight line, lightly connect points A to B, and B to C.

Step 2: Using the method outlined for bisecting a line, bisect lines A-B and B-C.

Step 3: Locate point X where the two extended bisectors meet. Point X is the exact center of the arc or circle.

Step 4: Place the point of the compass on point X and adjust the lead to any of the points A, B, or C (they are the same distance), and swing the circle. If all work is done correctly, the arc or circle should pass through each point.

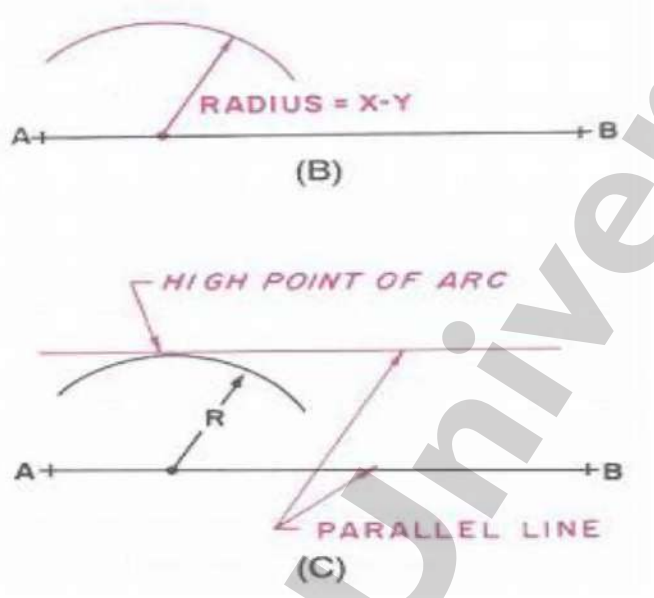


E. How To Draw A Line Parallel To A Straight Line At A Given Distance

Given: Line A-B, and a required distance to the parallel line.

Step 1: Set the compass at the required distance to the parallel line. Place the point of the compass at any location on the given line, and swing a light arc whose radius is the required distance.

Step 2: Adjust the straight edge of either a drafting machine or an adjusted triangle so that it line sup with line A-B, slide the straight edge up or down to the extreme high point, which is the tangent point, of the arc, then draw the parallel line.

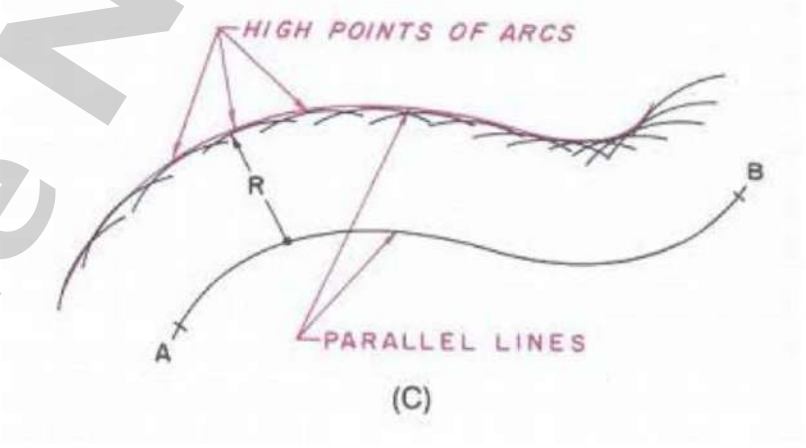


F. How To Draw A Line Parallel To A Line Curved Line At A Given Distance

Given: Curved line A-B, and a required distance to the parallel line,

Step 1: Set the compass at the required distance to the parallel line. Starting from either end of the curved line, place the point of the compass on the given line, and swing a series of light arcs along the given line.

Step 2: using an irregular curve, draw a line along the extreme high points of the arcs.



G. How To Draw A Perpendicular Lines To A Line At A Point

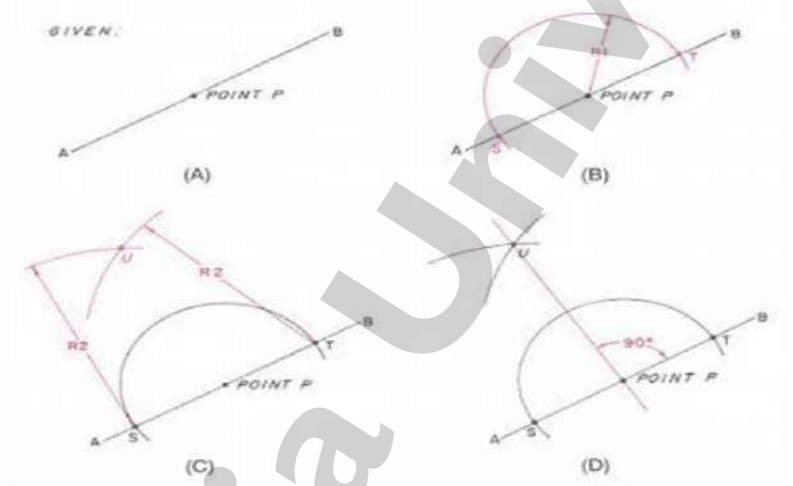
Method 1

Given: Line A-B with point P on the same line.

Step 1: Using P as a center, make two arcs of equal radius or more continuous arc (R1) to intercept line A-B on either side of point P, at points S and T.

Step 2: Swing larger but equal arcs (R2) from each of points S and T to cross each other at point U.

Step 3: A line from P to U is perpendicular to line A-B at point P.



H. How To Draw A Perpendicular To A Line At A Point

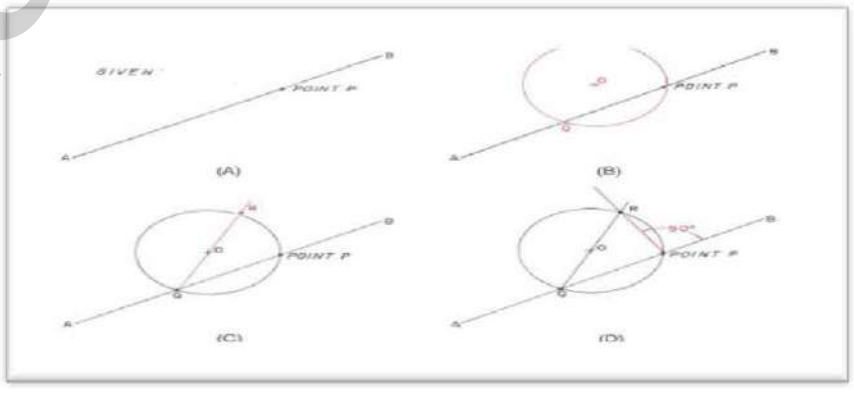
Method 2

Given: Line A-B with point P on the line.

Step 1: Swing an arc of any convenient radius whose center O is at any convenient location NOT on line A-B, but positioned to make the arc cross line A-B at points P and Q.

Step 2: A line from point Q through center O intercepts the opposite side of the arc at point R.

Step 3: Line R-P is perpendicular to line A-B (A right angle has been inscribed in a semi circle).



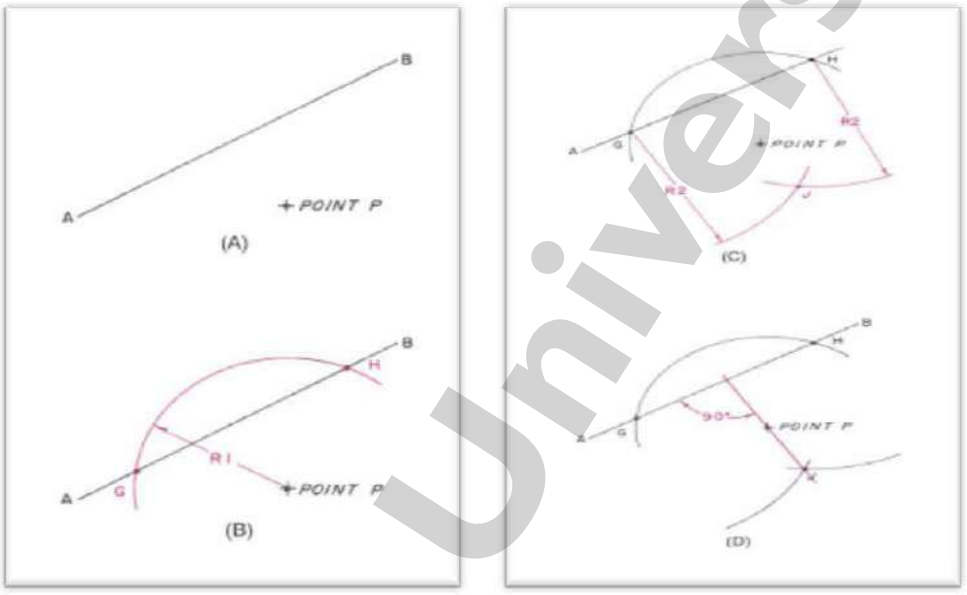
I. How To Draw A Perpendicular To A Line From A Point Not On The Line

Given*:* Line A-B and point P.

Step 1: Using P as a center, swing an arc (R1) to intercept line A-B at points G and H.

Step 2: Swing larger, but equal length arcs (R2) from each of the points G and H to intercept each other at point J.

Step 3: Line P-J is perpendicular to line A-B.



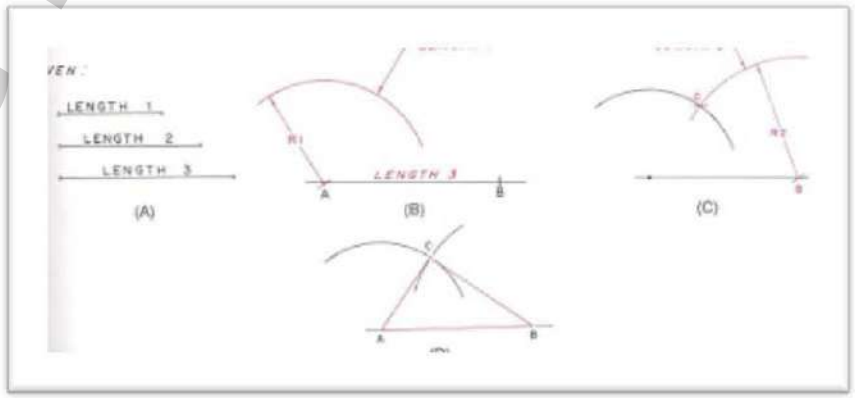
J. How To Draw A Triangle With Known Lengths Of Sides

Given*:* lengths 1, 2, and 3.

Step 1: Draw the longest length line, in this example length 3, with ends A and B. Swing an arc (R1) from point A whose radius is either length 1 or length 2; in this example length 1.

Step 2; using the radius length not used in step 1, swing an arc (R2) from point B to intercept the arc swung from point A at point.

Step 3: Connect A to C and B to C to complete the triangle.



K. How To Draw A Square

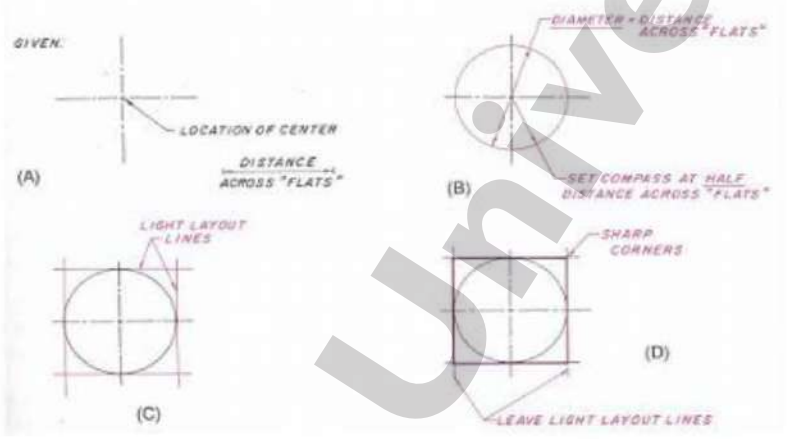
Method-1

Given: The locations of the center and the required distance across the sides of a square.

Step 1: Lightly draw a circle with a diameter equal to the distance around the sides of the square. Set the compass at half the required diameter.

Step 2: Using triangles, lightly complete the square by constructing tangent lines to the circle. Allow the light construction lines to project from the square, with out erasing them.

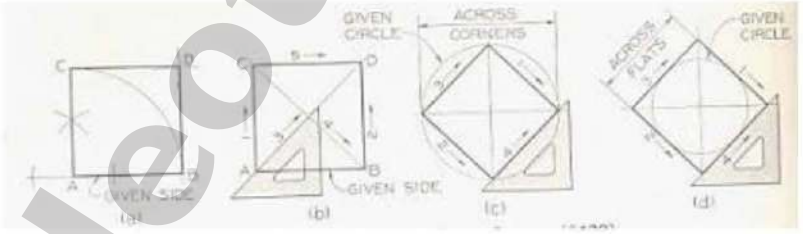
Step 3: Check to see that there are four equal sides and, if so, darken in the actual square using the correct line thickness.



Method-2

Given one side AB. Through point A, draw a perpendicular.

With A as a center, and AB as radius; draw the arc to intersect the perpendicular at C. With B and C as centers, and AB as radius, strike arcs to intersect at D. Draw line CD and BD.



L. How To Draw A Pentagon (5 Sides)

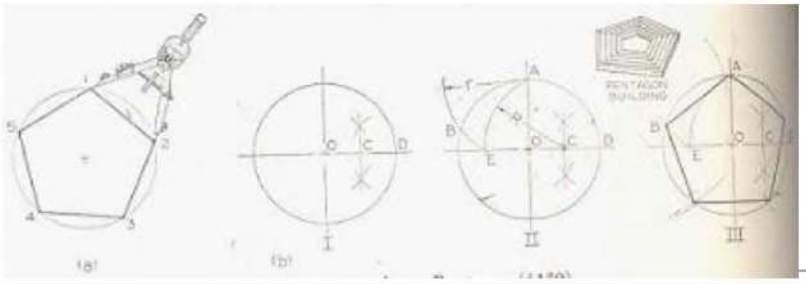
Given: The locations of the pentagon center and the diameter that will circumscribe the pentagon.

Step 1: Bisect radius OD at C.

Step 2: With C as center, and CA as radius, strike arc AE.

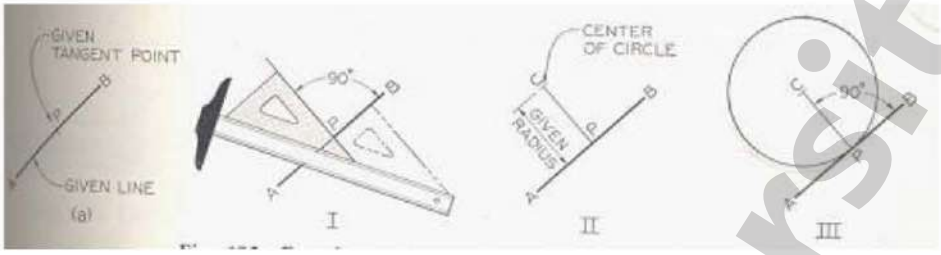
With A as center, and AE as radius, strike arc EB.

Step 3: Draw line AB, then set off distances AB around the circumference of the circle, and draw the sides through these points.



O. To Draw A Circle Tangent To A Line At A Given Point

Given*:* Given line AB and a point on the line.



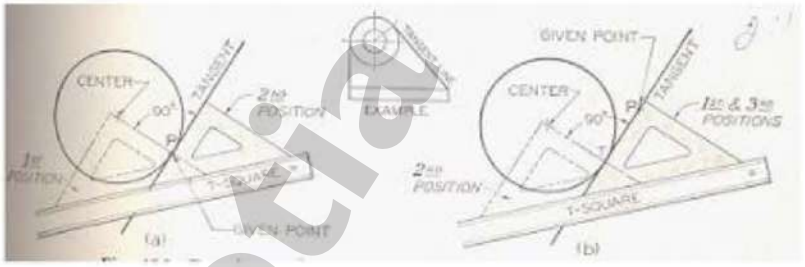
Step 1: At P erect a perpendicular to the line.
Step 2: Set off the radius of the required circle on the perpendicular.
Step 3: Draw circle with radius CP.

P. To Draw A Tangent To A Circle Through A Point

Method-1

Given: Point P on the circle.

Move the T-square and triangle as a unit until one side of the triangle passes through the point P and the center of the circle; then slide the triangle until the other side passes through point P, and draw the required tangent.



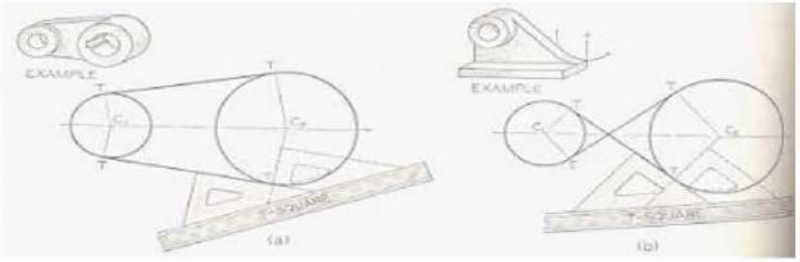
Method-2

Given: Point P outside the circle.

Move the T-square and triangles as a unit until one side of the triangle passes through point P and, by inspection, is the tangent to the circle; and then slide the triangle until the other side passes through the center of the circle, and lightly mark the point of tangency T. finally move the triangle back to its starting position and draw the required tangent.

Q. To Draw Tangents To Two Circles

Move the T-square and triangles as a unit until one side of the triangle is tangent, by inspection, to the two circles; then slide the triangle until the other side passes through the center of one circle, and lightly mark the point of tangency. Then slide the triangle until the side passes through the center of the other circle, and mark the point of tangency. Finally slide the triangle back to the tangent position, and draw the tangent lines between the two points of tangency. Draw the second tangent line in similar manner.



R. How To Construct An Arc Tangent To An Angle

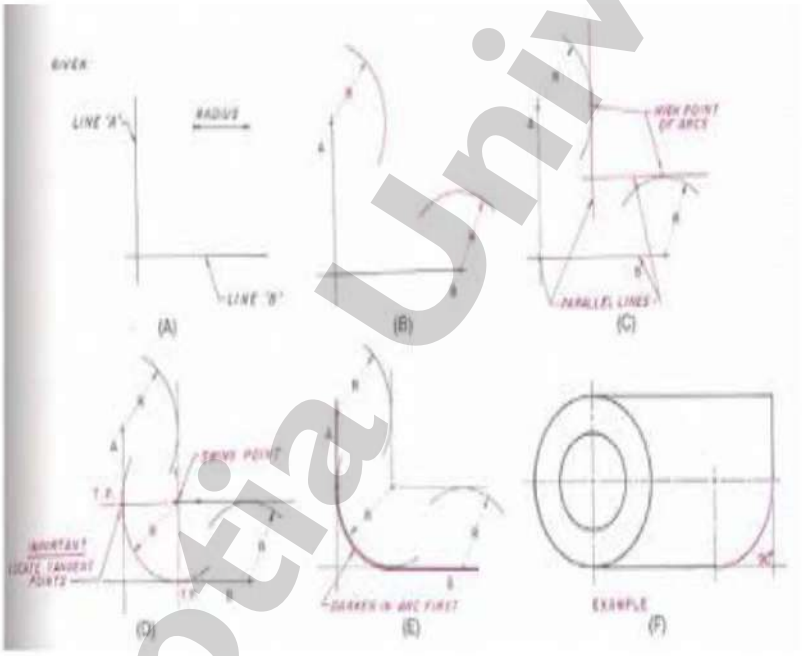
Given: A right angle, lines A and B and a required radius.

Step 1: Set the compass at the required radius and, out of the way, swing a radius from line A and one from line B.

Step 2: From the extreme high points of each radius, construct a light line parallel to line A and another line parallel to line B.

Step 3: Where these lines intersect is the exact location of the required swing point. Set the compass point on the swing point and lightly construct the required radius.
Allow the radius swing to extend past the required area. It is important to locate all tangent points (T.P) before darkening in.

Step 4: Check all work and darken in the radius using the correct line thickness. Darken in connecting straight lines as required. Always construct compass work first, followed by straight lines. Leave all light construction lines.



S. How To Construct An Arc Tangent To Two Radii Or Diameters

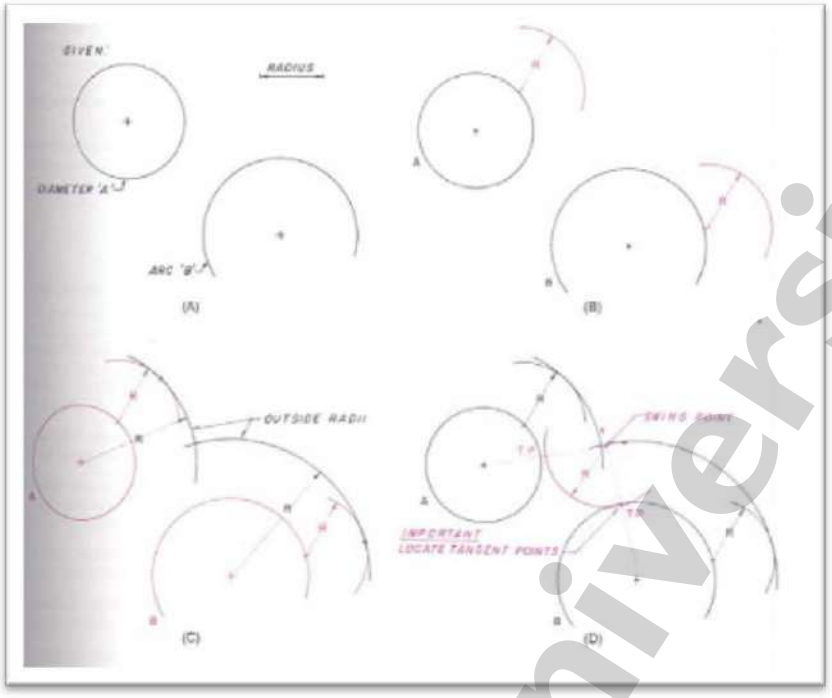
Given: Diameter A and arc B with center points located, and the required radius.

Step 1: Set the compass at the required radius and, out of the way, swing a radius of the required length from a point on the circumference of given diameter A. Out of the way, swing a required radius from a point on the circumference of a given arc B.

Step 2: From the extreme high points of each radius, construct a light radius outside of the given radii A and B.

Step 3: Where these arcs intersect is the exact location of the required swing point. Set the compass point on the swing point and lightly construct the required radius.
Allow the radius swing to extend past the required area.

Step 4: Check all work; darken in the radii using the correct line thickness. Darken in the arcs or radii in consecutive order from left to right or from right to left, thus constructing a smooth connecting line having no apparent change in direction.

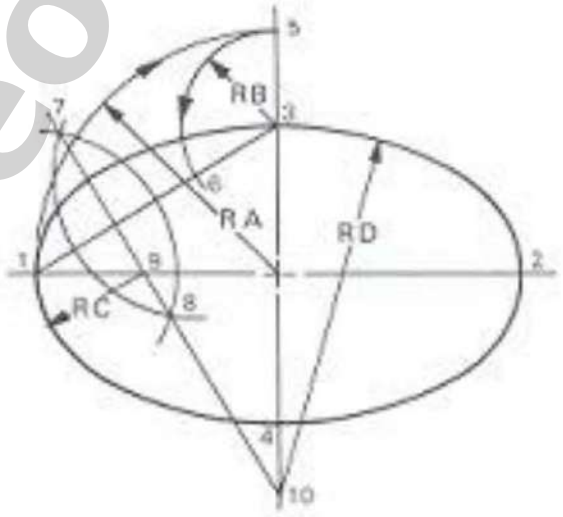


T. To Draw An Ellipse (By Four-Centered Method)

Join 1 and 3, layoff 3-5 equal to 01-03. This is done graphically as indicated in the fig. Below by swinging 1 around to 5 with O as center where now 03 from 05 is 3-5; the required distance. With 3 as center, an arc from 5 to the diagonal 1-3 locates 6. Bisect 1-6 by a perpendicular crossing

0-1 at 9 and intersecting 0-4 produced (if necessary) at 10.

Make 0-9' equal to 0-9, and 0-10' equal to 0-10. Then 9, 9', 10, and 10' will be centers for four tangent circle arcs forming a curve approximating the shape of an ellipse.



U. How To Draw An Ogee Curve

An ogee curve is used to join two parallel lines. It forms a gentle curve that reverses itself in a neat symmetrical geometric form.

Given: Parallel lines A-B and C-D.

Step 1: Draw a straight line connecting the space between the parallel lines. In this example, from point B to point C.

Step 2: Make a perpendicular bisector to line B-C to establish point X.

Step 3: Draw a perpendicular from line A-B at point B to intersect the perpendicular bisector of B-X, which locates the first required swing center. Draw a perpendicular from line C-D at point C to intersect the perpendicular bisector of CX, which locates the second required swing center.

Step 4: Place the compass point and adjust the compass lead to point B, and swing an arc from B to X. Place the compass point on the second swing point and swing an arc from X to C. This completes the ogee curve.

Video Link:

https://www.youtube.com/watch?v=jzshv9sALD8&t=459s&ab_channel=SkillBook

9. Lines plan drawing

Lines of plan of boat

The sheer plan, half breadth plan and body plan are collectively called as "LINES PLAN" or "SHEER DRAWING'. This is the most important drawing of all, because it imparts the three planes of reference to show the exact form of a hull.

Buttock Lines:

Buttock lines are the straight lines drawn parallel to the centre line and perpendicular to the reference line. These lines appear as straight lines in the plan as well as in the section view and as curved lines in the profile view.

Diagonal Lines:

Diagonal lines are the lines drawn diagonally to the centre line in the section view.

Mould Lofting:

This is the process of transferring the plans or blue prints into full-size interpretation on a floor or series of boards.

Off set table:

Off set table is drawn by the designer and it should be attached to the plans. The off set table is particularly relative to the body plan. The measurements on the table normally expressed in feet, inches.

Video Link:

https://www.youtube.com/watch?v=RHGW-BxTMwE&ab_channel=classAsurfacing

https://www.youtube.com/watch?v=NuNKSzo7Eso&ab_channel=SteeringMariners

10. Sheer Plan drawing

Drawing of sheer plan

Aim: To draw the Sheer plan using off set table.
OFF-SET TABLE
Sheer plan

Height above the baseline

Station	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	-1
Keel	0	0	0	0	1	3	4	6	7	8	10 ½	11 ½	13	15	16	17	18 ½	21 ½	30	63	15 8
Rabbet	-	-	-	-	7	8	10 ½	12 ½	13 ½	15	16 ½	18	19 ½	21 ½	22 ½	23 ½	25	28	38	86	-
Deck	-	92	90	88	87	86	86	86	87	88	88 ½	90 ½	93	96	99 ½	10 3	10 7	11 2	11 7	12 1 ½	-
Sheer	11 3	11 2	11 0	10 9	10 8	10 7	10 6	10 6	10 7	10 8	11 1	113	11 5	11 9	122	12 7	13 1	13 6	14 0	14 7	-

Video Link:

https://www.youtube.com/watch?v=RHGW-BxTMwE&ab_channel=classAsurfacing

https://www.youtube.com/watch?v=NuNKSzo7Eso&ab_channel=SteeringMariners

11. Half Breadth plan drawing

Half breadth plan
Height from the centre line

Sheer	61	64	66 ½	68	70	71	72 ½	73 ½	74	74	74	74	73 ½	72 ½	72	68	64	55 ½	42	24	-
DECK	57	61	64	66 ½	69	71	72 ½	73 ½	74	74	74	73 ½	73	72	70	65	59	50	35	16	
LWL	-	8 ½	43	55	60 ½	65 ½	69	70 ½	71 ½	72 ½	72	70 ½	66 ½	62 ½	57 ½	48 ½	38 ½	25 ½	12 ½	-	-
WL – III	-	-	-	22 ½	40 ½	50 ½	57	61 ½	64 ½	66 ½	65	62	59	53	46	36 ½	26	18 ½	8 ½	-	-
WL-II	-	-	-	-	13	22 ½	22 ½	32 ½	41	47 ½	51 ½	52 ½	49 ½	44 ½	36 ½	30	23 ½	16 ½	11	6 ½	
WL – I	-	-	-	-	5 ½	9 ½	13 ½	17 ½	22	24 ½	24 ½	23 ½	21 ½	18	13 ½	10	6 ½	5	-	-	-
KEEL	-	2 ½	3	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½	3 ½

All Measurements are given in inches
Vessel parameters
Length over all --- 43' 6" Depth moulded --- 6' 0"
Load Water line --- 38' 8" Draught --- 3' 10"

Breadth --- 12' 4" Distance between water plane= 2'
Distance between each station is 25¾"

Procedure:

- With help of a T-square draw a reference line.
- Draw a centre line at right angle to the reference line.
- With reference to the given data mark the stations to a given distance on the reference line.
- From the centre line mark nine stations towards aft side and nine stations towards forward side (i.e. distance between each station is 25 ¾ ").
- Locate the stations "19" and station – "1" towards aft and forward side respectively for a distance of 29".
- Draw the vertical lines from each station.
- With reference to the offset table readings mark the points on the above vertical lines for the respective stations (say keel line).
- Draw a smooth curve joining all these points to obtain the keel line.
- Similarly draw rabbet, sheer and deck lines.
- Locate the point on the centre line for a given draught height (i.e. 3' 10") from the top of the keel line.
- Draw a horizontal line from that point to obtain the load water line (LWL).
- Locate the points on the centre line for the given water lines
- (say WL-I, WL-II etc.) and draw the horizontal lines from the respective points.

PROFILE / SHEER PLAN

Sheer Plan which is usually placed at the top left hand side of the lines plan drawing represent the shape of the ship hull looking from the side of ship at several buttock lines. Buttock line is the vertical plane that cuts the ship along its length, creating the buttock line curves as indicated in Figure 2.10. The middle buttock line (normally labeled as BL 0) is the plane that cuts the ship along its centre line which creates the profile curve of the ship. Other buttock lines are drawn outward (offsets) of ship's centre line and normally at equally spaced distance. The stations and waterlines grids are shown in this sheer plan drawing.

To draw the half breadth plan.

Procedure:

- Draw a horizontal line parallel to the reference line and below the sheer plan (i.e. centre line).
- Draw the vertical lines from the different stations which are marked on the sheer plan to meet the centre line.

- With reference to the off set table readings locate the points on these vertical lines (say keel line).
- Draw a smooth curve by joining the above points.
- Similarly locate the points for WL – I, WL – II, WL – III, LWL, deck and sheer lines and draw the smooth curves.

To draw the Body Plan.

Procedure:

- Measure the distance between the centre line and keel line in half breadth plan (say station 9). Transfer the same distance from the centre line to the keel line in the sheer plan with the help of a divider.
- Similarly measure the distance between centre line to WL-I, WL-II etc. in the half breadth plan and transfer the same distances from centre line to WL-I, WL-II etc. in the sheer plan respectively.
- Draw the smooth curve by joining all these points.
- Draw the similar curve for different stations (Say 8,7,6, etc.).
- Mark forward side stations on right hand side of the centre line.
- Mark the aft side stations on left hand side of the centre line

Video Link:

https://www.youtube.com/watch?v=RHGW-BxTMwE&ab_channel=classAsurfacing

https://www.youtube.com/watch?v=NuNKSzo7Eso&ab_channel=SteeringMariners

13. Types of Hull Of Boats

Boats are built to do a variety of things and much of the differentiation lies in the shape of their hull. Displacement hulls ride through the water while planing hulls ride on top of it. Within each category, there are numerous configurations that further define the boat and its most popular uses.

Common Types of Boat Hulls

1. Displacement Hulls
2. Planing Hulls
3. Flat Bottom
4. V-Bottom
5. Tri-Hull (Tunnel Hull)
6. Pontoon
7. Semi-Displacement Hulls
8. Multi-Hulls
9. Catamarans
10. Trimarans

Displacement Hulls

Large ships, some **trawlers** and traditional recreational **sailboats** have displacement hulls. They are slower moving but quite steady under way and are capable of carrying large loads with relatively small propulsion units. Displacement hulls are usually round on the bottom with ballast placed low in the center. At rest, round hulls tend to roll with the waves and swells.

Planing Hulls

Most powerboats and **personal watercraft** have planing hulls that ride on the water at higher speeds. They behave like displacement hulls at low speed but pop up onto a plane usually around 15-16 MPH depending on the design and load. Planing hulls come in a variety of shapes, each of which has it benefits and disadvantages.

Flat Bottom: Flat-bottomed boats are very stable and can carry a heavier load. They require only a small engine to get on plane but can ride rough and wet in chop or heavy weather. **Small aluminum** or fiberglass **bay and fishing boats** often benefit from flat hulls, which have a shallow draft and provide a good amount of deck space both of which are ideal for fishing on calm bodies of water such as small lakes and ponds or slow rivers.

V-Bottom: Deep V hulls cut through waves and ride smoothly in chop. They take a bit more power to push up onto a plane, tend to roll or bank in sharp turns and due to the angle of the hull, have less interior volume for stowage or accommodations. Fast, distance fishing boats like **center consoles** tend to have a V bottom so they can run fast on open water to get to the fishing grounds quickly.

Tri-Hull or Tunnel Hull: Popular with fisherman as well as with sport boat enthusiasts, tri-hulls, also called cathedral hulls, have a combination M-shaped bottom. They're quite buoyant and stable and they get on plane quickly. They offer good volume below and significant deck space above. At speed, they tend to pound when they encounter choppy water so they're ideal for lakes of calm bays.

Pontoon: Pontoon boats ride on (typically) aluminum tubes. Traditional pontoons have two tubes but newer designs have three and are called **tritoons**. Pontoon boats are all about deck space and make excellent boats for families and entertaining on the water. The newer tritoons can carry large outboards and so they've become planing boats capable of towing for water sports or reaching distant fishing spots.

Semi-Displacement Hulls

Semi-displacement hulls combine rounded sections for increased storage and tankage, and flatter hull sections to partially lift the forward part of the hull out of the water, thereby

decreasing drag at high cruising speeds. They generate large bow and stern waves and may need high horsepower engines to get on plane. Larger, **cruising motor yachts** lean toward the semi-displacement design.

Multi-Hulls

Boats with separate and distinct hulls are called **multi-hulls** and can be catamarans or trimarans. Multi-Hulls can be either power or sailboats and have displacement or planing hulls depending their shape and the size of their engines.

Catamarans: Catamarans have two hulls with a deck or trampoline in between. Their benefits include excellent stability and depending on size and type, significant living space aboard. Large cats (35 feet and over) have become popular in charter use because they offer more interior and deck space and an easier motion to induce less seasickness. With two engines, catamarans are very maneuverable but they do require more room to turn and berth. Small catamarans usually have just a trampoline in between the hulls and make fun daysailers.

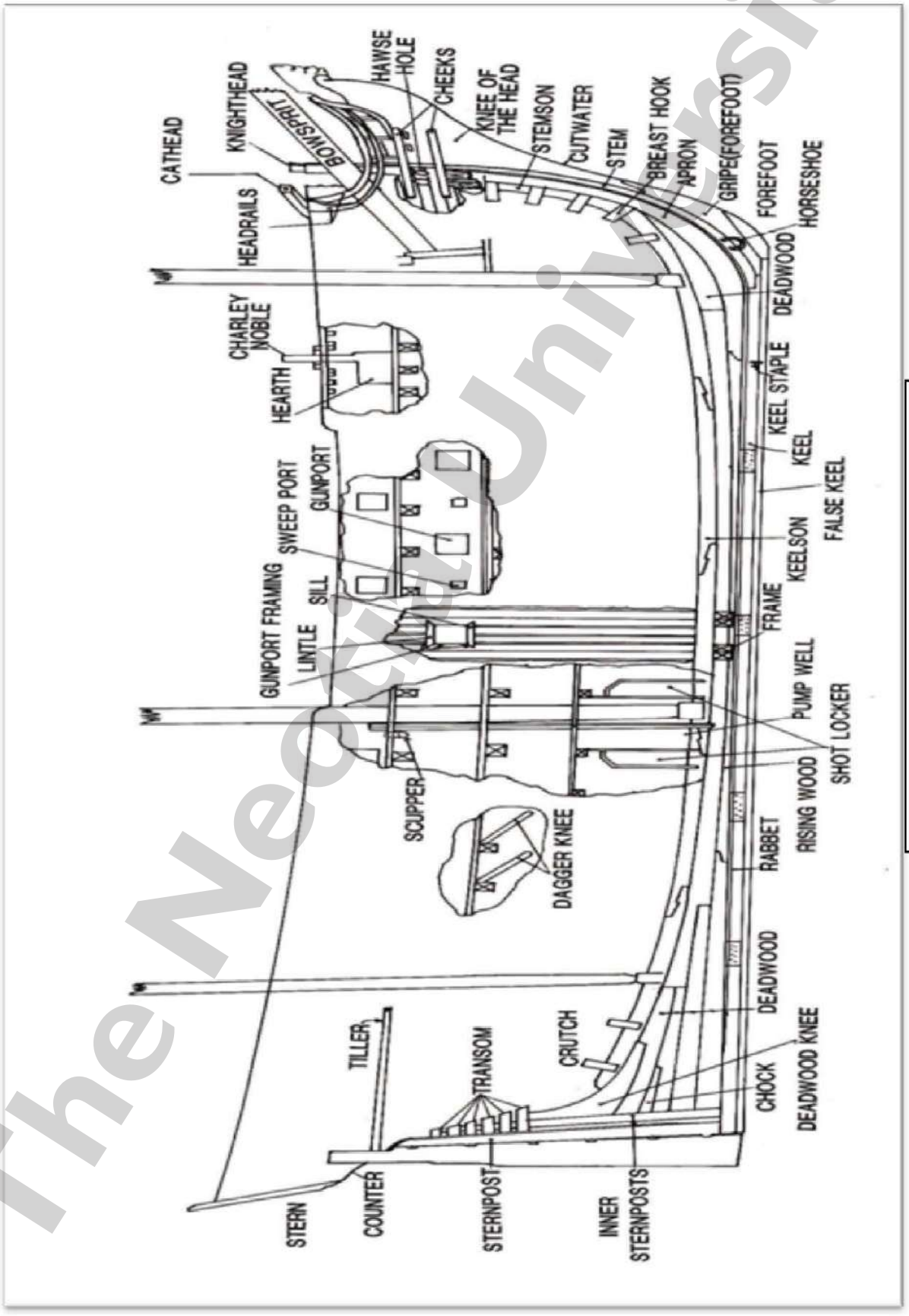
Trimarans: Trimarans are often (but not always) sailboats. They have three hulls: a main hull and two amas (side hulls used for stability). On some smaller trimarans, the arms that hold the amas can fold inward, making the trimaran narrower and in some cases trailerable. Trimarans require smaller engines and they sail faster primarily due to the reduced wetted surface (the area in contact with the water), which cuts down on drag.

Video Links

https://www.youtube.com/watch?v=utNBAsSMIok&ab_channel=ImproveSailing

https://www.youtube.com/watch?v=VaZC0aMLOkQ&ab_channel=ImproveSailing

14. General View of Boat



General View of a Boat

- **Adze** [Adz] An axe-like tool with its blade at right angles to the handle, used for shaping and dressing wood.
- **Amidships**. The middle of a vessel, either longitudinally or transversely.
- **Anchor** A wooden, stone, or metal device that, when connected to a vessel with a cable or chain, was used to secure the vessel to the bed of a waterway to prevent it from drifting.

  Anchor bed. A reinforcement or platform, fitted on the side or deck of a vessel, on which an anchor or stack of anchors was stowed.

    - (p. 1108) *Best bower*. One of the principal anchors of a ship, normally the one used first; in the last several centuries, it was usually the second largest anchor and was carried on the starboard bow.
    - *Bill*. The tip of the anchor's palm; also called a pea, **peak**, or pick.
    - *Bower*. One of the principal anchors of a vessel, permanently attached to a cable or chain and stowed ready for immediate use.
    - *Crown*. That portion of an anchor where its arms joined the shank.
    - *Fluke*. The pointed or chisel-shaped end of an anchor arm, which was designed to dig into the bottom.
    - *Grapnel* A relatively small anchor, usually fitted with four or five arms, used variously for making fast to other vessels, snagging cables, or anchoring small boats.
    - *Kedge*. A light anchor used for moving a vessel or temporarily holding it in a waterway.
    - *Palm*. The triangular flat face of an anchor's fluke.
    - *Shank*. The shaft of an anchor.
    - *Sheet anchor*. The heaviest anchor of a large vessel, shipped in a ready position to be used for any emergency. In the later years of large sailing ships, this was the third bower and was usually carried in the starboard bow next to the best bower. It was also called the sacred anchor.
    - *Shoe*. A convex block of wood into which an anchor bill could be fitted to prevent damage to the ship's side when the anchor was hoisted.
    - *Stock*. A wooden, stone, or metal crosspiece near the top of and perpendicular to the shank; it was designed to cant one of the arms so that its fluke dug into the bottom.

- *Stream anchor*. A smaller anchor, often about one-third the weight of the best bower, which was carried in the stern and used to prevent a vessel from swinging in narrow waterways.

- **Anchor stock planking** A form of planking in which the longitudinal shapes of the planks resembled anchor stocks. It was similar to the top and butt method of planking and was intended to prevent shifting and increase the longitudinal strength of wales and other stress-bearing planks.
- **Apron** A curved piece of timber fixed to the after surface of the stem or to the top of the forward end of the keel and the after surface of the stem; an inner stempost.
- **Athwartships**. Across the ship from side to side; perpendicular to the keel.
- **Auger** A tool used for boring holes.
- **Average frame spacing**.
- **Back piece** The aftermost piece of a rudder.
- **Back rabbet** The upper surface of a keel rabbet or the nesting surface of a post rabbet.
-
- **Back rabbet line**. The line formed by the junction of the inner plank surface and the upper, or inner, rabbet surface. (p. 1109)

Balanced rudder A rudder whose stock is placed aft of its leading edge so that the water pressure is approximately equal on its forward and after surfaces; balanced rudders require less turning power than conventional rudders.

- **Ballast**. Heavy material, such as iron, lead, or stone, placed low in the hold to lower the center of gravity and improve stability.
- **Batten**. A thin plank or strip of wood used to determine hull curvatures or to temporarily connect timbers during construction.
- **Batten clamp**. *See* **Sintel**.
- **Baulk** [Balk]. *See* **Beam**.
- **Beakhead**. A platform or projecting structure forward of the forecastle.
- **Beam** A timber mounted athwartships to support decks and provide lateral strength; large beams were sometimes called baulks. *See also* **Breadth**.
- **Beam arm** [Curved half-beam] A curved partial beam whose inboard end was scarfed or tenoned into the side of a deck beam and (p. 1111) outboard end terminated at the shelf clamp. Beam arms were used to reinforce potentially weak areas adjacent to hatches, bitts, masts, etc. They were essentially long knees laid as half beams.

- **Bearding line** The line formed by the junction of the outer garboard surface with the keel, or the outer surfaces of planking ends with the posts.
- **Beetle** A heavy wooden mallet used to drive treenails, wedges, etc. *See also* **Mallet**.
- **Belfry**. The structure in which the ship's bell was hung. Belfries were usually mounted in the forecastle, although they sometimes appeared near the helm or mainmast; in some instances they were elaborate and ornate.
- **Berth deck** [Birth deck] The deck immediately below the **gundeck**.
- **Bevel** The fore-and-aft angle or curvature of an inner or outer frame surface.
- **Beveled edge**. *See* **Chamfer**.
- **Bevel gauge** A tool used to determine frame face bevels.
- **Beveling**. The technique of shaping a frame timber to its correct fore-and-aft curvature.
- **Bilge**. The area of the hull's bottom on which it would rest if grounded; generally, the outer end of the floor. When used in the plural, especially in contemporary documents, **bilges** refers to the various cavities between the frames in the floor of the hold where bilge water tends to collect.
- **Bilge boards**. Loose boards placed over the bilges to protect cargo from bilgewater damage.
- **Bilge clamp**. On ancient ships, a thick strake of ceiling fastened to the inner frame faces at or just above the turn of the bilge; thick ceiling opposite a bilge wale. *See also* **Ceiling**.
- **Bilge keel**. A secondary keel placed beneath the bilge or at the outer end of the floor. Sometimes called a **sister keel**.
- **Bilge ledge**. A rabbeted longitudinal timber fastened over the frames above the bilge to support transverse ceiling planking.
- **Bilge strake** [Bilge plank] A thick strake of planking placed at or below the turn of the bilge; its purpose was to reinforce the area of the bilge or floor heads. Infrequently it is called a bilge wale.
- **Binding strakes** The closest full-length strakes, or belts of strakes, to the middle of the deck. They reinforced the many openings (hatches, mast steps, pumps, etc.) between them. Binding strakes were so named only when they were thicker than the rest of the deck planks, being fitted into notches in the tops of deck beams.
- **Bite** [Bitar (pl.)]. An athwartship beam in a Viking vessel.

- **Bitt** [Bit] A strong upright post used for securing lines and cables. **Boat**. An open vessel, usually small and without decks, intended for use in sheltered water. This term is discussed in the introduction.
- **Bobstay piece** Part of the knee of the head.
- **Body lines**. *See* **Station lines**.
- **Bollard timbers**. *See* **Knightheads**.
- **Bolt**. A cylindrical metal pin used to fasten ships' timbers together.
- **Boss**. *See* **Wart**.
- **Bottom**. The underwater portion of a fully loaded hull; also used as a general designation for a seagoing vessel.
- **Bow**. The forward part of a hull, specifically, from the point where the sides curve inward to the stem.
- **Bow drill** [Fiddle drill] A device with a hollowed handle in which a spindle rotates; the spindle is connected to a drum, around which a cord is wrapped and run back and forth by means of a bow to rotate the drill bit.
- **Bowsprit** A spar projecting forward from the bow.
- **Boxing** [Boxing joint] A type of scarf used primarily to join the keel to the stem or keel timbers to each other.
- **Brace** A metal housing and straps used to secure the stock of a quarter rudder to its blade. Also, the straps of a **pintle** or **gudgeon**.
- **Bracket**. A small brace or knee used to support the gratings in the head of a ship.
- **Breadth**. The width of a hull; sometimes called **beam**, which is technically the length of the main beam.
- **Breaming**. *See* **Graving**.
- **Breast hook** A large, horizontal knee fixed to the sides and stem to reinforce and hold them together.
- **Breastwork**. Ballustrades along the upper decks.
- **Bulkhead**. A vertical partition, either fore-and-aft or athwartships.
- **Bulwark** The side of a vessel above its upper deck.
- **Burden** [Burthen]. The cargo capacity of a vessel.
- **Butt** The lateral end of a hull plank or timber.
- **Butt joint** The union of two planks or timbers whose ends were cut perpendicularly to their lengths; sometimes called **carvel joint**.
- **Buttock**. The convex part of the hull beneath the stern deck.

- **Buttock lines**. Projections on a lines drawing that reveal vertically oriented longitudinal hull shapes.
- **Cable locker** [Cable tier]. The compartment where the anchor cable was coiled and stored. Large vessels often had elaborate drainage systems for disposing of the seawater that seeped from recently hauled cables, including tier decks with raised beams that allowed the water to pass beneath the coils.
- **Caboose** [Camboose]. A vessel's galley, or kitchen.
- **Camber** [Crown] The arch, or convexity, of a timber; decks were usually cambered so that water would run to the sides and out the scuppers.
- (p. 1114) **Cant frame** [Cant timber] A framing member mounted obliquely to the keel centerline in the ends of a vessel; canting provided better frame distribution and permitted more nearly rectangular cross sections of the timbers along the vessel's incurving ends.
- **Cap** [Capping piece]. A block used to cover the exposed ends of timbers and spars.
- **Caprail** [Main rail, Cap] A timber attached to the top of a vessel's frames.
- **Capstan** [Capstern]. A spool-shaped vertical cylinder, mounted on a spindle and bearing, turned by means of levers or bars; used for moving heavy loads, such as hoisting anchors, lifting yards, or careening vessels.
- **Careen**. To deliberately list a vessel so that part of its bottom was exposed for caulking, cleaning, repairing, etc.
- **Carling** [Carline] Fore-and-aft deck timbers set between the deck beams to stiffen them and support the ledges.
- **Carrick bitt** An upright timber supporting the shaft of a windlass; also called a **carrick head** or **windlass bitt**.
- **Carvel-built** Planked so that the seams were smooth, or aligned, as opposed to **clinker-built**. Northern European scholars reserve "carvel-built" for frame-first forms of construction; thus, the flush-laid bottom planks of a cog are not described as "carvel" laid planks.
- **Carvel joint**. *See* **Butt joint**.
- **Cathead** A beam, or crane, projecting from the bow and used for hoisting the anchor clear of the bow after it had surfaced.

Cattail. The inboard end of a cathead.

- **Caulk** [Calk]. To drive oakum, moss, animal hair, or other fibrous material into the seams of planking and cover it with pitch to make the seams watertight. *See also* **luting**.
- **Caulking batten** [Caulking lath]. A thin wooden strip used to close caulked seams and hold the caulking material in place. *See also* **Ribband carvel**.
- **Caulking iron** . A chisel-shaped tool used to drive caulking into seams.
- **Caulking mallet** A short-handled mallet used to strike caulking irons.
- **Ceiling** . The internal planking of a vessel.
- (p. 1116) **Centerboard** [Drop keel, Sliding keel]. A wooden or iron plate that could be raised and lowered within a watertight housing called the **trunk**; the trunk was built over a slot in the keel or in the hull bottom next to the keel. Centerboards increased lateral resistance and therefore reduced **leeway** when tacking or sailing off the wind.
- **Chamfer** [Beveled edge] The flat, sloping surface created by slicing the edge off a timber.
- **Channel** [Chain wale]. A thick, horizontal plank projecting from the side of a vessel and used to support the shrouds and keep them clear of the bulwarks.
- **Channel wale**. A wale, or belt of wales, located at the line of the channels, to which the chains of the shrouds were fastened.
- **Charley Nobel** The chimney, or flue, of the galley hearth or stove.
- **Chase port**. A gunport placed in the bow or stern to accommodate fore-and-aft mounted guns.
- **Check**. *See* **Shake**.
- **Cheek** [Cheek knee] On later vessels, a knee or brace between the side of the bow and the knee of the head; on ancient warships, a protuberance at the side of the stem against which the side planking was stopped.
- **Chine**. The angular junction of the bottom and side of a vessel; usually found on flat-bottomed hulls, or those with little deadrise. Can also refer to a longitudinal timber located just inside the junction, to which athwartships bottom planks are fastened.
- **Chock** . An angular block or wedge used to fill out areas between timbers or to separate them; chocks were used to fill out deadwoods and head knees, separate frames and futtocks, etc.

- **Cistern**. A term applied variously to pump wells or to collecting basins at the discharge ends of pumps.
- **Clamp** A thick ceiling strake used to provide longitudinal strength or support deck beams; clamps were often located directly opposite the wales and acted as internal wales; a clamp that supported a deck beam was called a *shelf clamp*.
- **Clench** [Clinch] To secure a nail or bolt by bending or flattening its projecting end over the surface it last penetrated; a nail whose tip and shaft were both clenched is said to be double-clenched, as in the fastening of ancient ship frames and planks.
- **Clenched lap** [Lapstrake]. *See* **Clinker-built**.
- **Clinker-built** [Clincher-built, Clencher-built]. A vessel constructed so that its outer planking overlaps, and is fastened to, the plank immediately below it. Where planks overlap the ones above them (there have been no European vessel finds to support this alleged method), the procedure is known as *reverse clinker*. The surface of a plank overlapped by a neighbor is called a **land**, and this double thickness is normally held together with closely spaced rivets or nails clenched over metal washers called **roves**. Northern European specialists limit the term "clinker-built" to vessels whose planks are rivetted together; hulls. whose overlapping planks are fastened with clenched nails, as in most cog construction, are called *clenched lap* or *lapstrake hulls*.
- **Coak** A rectangular or cylindrical pin let into the ends or seams of timbers about to be joined in order to align or strengthen the union.
- **Coaming** [Combing] A raised border at the edge of a hatch whose function was to prevent water from entering the space below.
- **Cockpit**. The surgeon's compartment; the sick bay. On yachts, the well from which the vessel is directed.
- **Common ceiling** The ordinary ceiling used to prevent cargo and ballast from falling between the frames; common ceiling was usually made from relatively thin planking and seldom contributed longitudinal strength to the hull structure.
- **Companion**. A covering over a cabin hatchway.
- **Companion way**. A stairway or ladder leading from one deck to another.
- **Compass timber** [Compassing]. Naturally curved timbers used for frames and construction in the ends of a hull.
- **Copper-bottomed** [Coppered]. A vessel whose bottom was sheathed in copper to prevent fouling and worm infestation.
- **Copper fastened**. A vessel whose fastenings were made of copper.

- **Cordage**. A general term for ropes and cables.
- **Counter** Technically, the transverse section between the bottom of the stern and the wing transom. However, many documents and drawings refer to the counter as the entire transverse area between the top of the sternpost and the rail or taffrail.
- **Counter timbers** Vertical timbers framing the counter.
- **Crab**. A small capstan, usually portable and lacking a drumhead at the top of its barrel.
- **Cradle**. A structure for supporting a vessel out of water.
- **Crone**. An English translation of an old Norse term denoting the elongated mast steps on Viking vessels.
- **Crossbeam** A substantial timber placed across a pair of bitts.
- **Cross pillar**. *See* **Pillar**.
- **Crotch** [Crotch timber]. A V-shaped or Y-shaped frame or floor timber made from the crotch of a tree; usually mounted on the keel or deadwood in the ends of a vessel.
- **Crow** [Crow bar] A strong iron bar, pointed or chisel-shaped at one end, used for prying or moving heavy timbers.
- **Crown**. *See* **Camber**.
- **Crutch** A bracing timber used to prevent a mast step from shifting laterally; also, a curved or angular timber, similar to a breast hook and used for a similar purpose in the lower part of the stern. On modern vessels, a support for booms at rest.
- **Cuddy**. A cabin or shelter in the forward part of a small vessel.
- (p. 1118) **Curved scarf** [Curved butt, S-scarf] The union of two planks or timbers whose ends were canted in the shapes of reverse curves.
- **Cutting-down line**. The elevations of the tops of the floor timbers and deadwoods; in most cases, the curved line formed by the bottom of the keelson, stemson, and sternson.
- **Cutwater** The forwardmost part of the stem; the stem piece or nosing that parts the water.
- **Dagger knee** A knee set angularly on the inside of the hull; a knee that is neither vertical or horizontal.
- **Dagger piece**. Any piece of timber, but usually a frame timber, mounted at an angle to the vertical or horizontal planes.
- **Dead flat**. The flat part of the hull in the area of the midship frame; generally, the widest part of the hull, which separated the forward part from the after part.

- **Deadrise** The amount of elevation, or rising, of the floor above the horizontal plane; the difference between the height of the bilge and the height of the keel rabbet.
- **Deadwood** Blocks of timber assembled on top of the keel, usually in the ends of the hull, to fill out the narrow parts of a vessel's body. *See also* **Rising wood**.
- **Deadwood knee**A knee placed within the deadwood to support the sternpost.
- **Deadwork**. The part of the hull above the full-load waterline.
- **Deal**. A thin plank of fir or pine, most commonly used to sheath hulls.
- **Deck beam**. *See* **Beam**.
- **Deck hook**. A breast hook placed beneath a deck to support it at or near the stem.
- **Deck transom** A transom that supported the after ends of deck planks.
- **Depth of hold**. The distance between either the bottom of the main deck or the bottom of its beams and the limber boards, measured at the midship frame.
- **Diagonal braces**. Pillars or posts set angularly in the hull to stiffen it; although used in pairs, they differed from cross pillars in that each brace occupied only one side of the hull.
- **Diagonal framing**. Frames or riders placed diagonally over the regular frames or ceiling to provide additional stiffening to a hull.
- **Diagonals**. Lines on a hull drawing representing specific oblique sections of the hull.
- **Diagonal scarf** [Diagonal butt] An angular junction of two planks or timbers.
- **Diminishing strakes** Belts of outer planking above and below the wales that were successively reduced in thickness, providing a more gradual transition from the protrusion of the wales to the thickness of the side planking.
- **Double-ender**. A vessel whose bow and stern have approximately the same horizontal shape, such as rounded, pointed, or square ends.
- **Double framing** A general term signifying frames composed of two rows of overlapping futtocks.
- **Dowel** [Dowel pin] A cylindrical piece of wood (of constant diameter) used to align two members by being sunk into each. A cylindrical coak. Unlike treenails and pegs, dowels served an alignment function only, additional fastenings being necessary to prevent separation of the joint.
- **Draft** [Draught]. The depth to which a hull is immersed; also, a drawing or plan.
- **Draft marks** [Draught marks, Load lines]. Figures or lines cut into, or attached to, the stem and sternpost to indicate the depth at which each end of the hull is immersed.
- **Drag**. The difference between the draft of a vessel's stern and its bow.

- **Drawknife** A knife with two handles mounted at right angles to the blade; drawknives are used for shaping and beveling.
- **Drift**. The difference between the diameters of a bored hole and the bolt that is driven into it.
- **Drift bolt**. A cylindrical bolt, headed on one end, that is slightly larger in diameter than the hole into which it is driven.
- **Drop keel** [Sliding keel]. *See* **Centerboard**.
- **Drop strake** A strake of planking that is discontinued near the bow or stern because of decreasing hull surface area. A central stealer.
- **Dunnage**. Brushwood, scrapwood, or other loose material laid in the hold to protect the cargo from water damage or prevent it from shifting, or to protect the ceiling from abrasion.
- **Ekeing** [Lengthening piece] A timber used to lengthen another timber, such as the extension of a deck hook or knee.
- **Entrance** [Entry]. The foremost underwater part of a vessel.
- **Eye bolt** A bolt with a circular opening at one end.
- **Eyes**. A name sometimes given to the hawse holes or the areas around them; on ancient ships, ocular decorations at the same locations.
- **Fair**. To shape or adjust a timber or timbers to the correct curvature or location; also, to correct discrepancies in a ship's drawings.
- **Fair curve** [Fair line]. A shape or line whose curvature agrees with the mold loft or that is mechanically acceptable and seaworthy.
- **Fall home**. *See* **Tumblehome**.
- **False keel** [Shoe] A plank, timber, or timbers attached to the bottom of the keel to protect it in the event of grounding or hauling; on large ships, false keels were sometimes made quite thick in order to increase the size and strength of the keel. In North America from the eighteenth century onward, and perhaps in other areas, false keels were called shoes.
- **False keelson**. *See* **Rider keelson**.
- (p. 1120) **False stem**. An outer timber fixed to the forward surface of the stem to strengthen or protect it, or to provide better symmetry to the cutwater. Also, a name sometimes given to the apron in English documents.
- **False sternpost**. A member attached to the after surface of the sternpost to reinforce or protect it.

- **Fashion piece** [Fashion timber] A timber that framed the shape of the stern.
- **Fay**. To fit or join timbers closely together.
- **Figure piece** A name sometimes given to the upper piece of the knee of the head, upon which the figurehead rested.
- **Filling frame** A frame composed of a single row of timbers, usually scarfed together, that filled the space between the main, or double-rowed, frames of a large ship.
- **Filling piece** [Filler] A single timber or block used to fill out an area, such as the side of a gunport where it did not coincide with a frame, or in the spaces between frames to maintain rigidity.
- **Fine lines**. A descriptive term applied to a vessel with a sharp entrance and a narrow hull.
- **Fish**. An English term for the modern Norwegian word describing the fishtail-shaped mast partners on Viking vessels.
- **Fish plate** A metal plate used to join two timbers externally.
- **Flare**. The upward and outward curvature of a vessel's bows; a curved outfall.
- **Flat scarf** The union of two planks or timbers whose diagonal ends were nibbed (cut off) perpendicular to their lengths. When planking is scarfed vertically, the ends are not nibbed.
- **Floor**. The bottom of a vessel between the upward turns of its bilges.
- **Floor head**. The outer extremity of a floor timber.
- **Floor head line**. *See* **Rising line**.
- **Floor ribband** [Floor ribbon]. The floor rising line; specifically, a ribband or batten fastened to the outside of the frames at the heads of the floor timbers; used for fairing and to determine the shapes and lengths of intermediate frames.
- **Floor timber** A frame timber that crossed the keel and spanned the bottom; the central piece of a compound frame.
- **Flush deck**. A deck running continuously from bow to stern, without breaks or raised elements.
- **Foot wale** [Footwaleing] Thick longitudinal strakes of ceiling located at or near the floor head line or turn of the bilge. Some eighteenth-century English documents called the thick strakes next to the limber strake, or sometimes all of the ceiling, **footwaleing**, in which case the heavy strakes near the turn of the bilge were known as **thick stuff**.

- **Forecastle**. Variously, a short, raised foredeck, the forward part of the upper deck between the foremast and the stem, or the quarters below the foredeck.
- **Forefoot** A curved piece between the forward end of the keel and the knee of the head; the **gripe**. In some documents describing large ships, it is the name given to the rounded forward portion of the gripe, inserted as a separate piece.
- **Fore hood**. The end of a plank at the stem rabbet.
- **Forelock bolt**. An iron bolt with a head on one end and a narrow slot at the other; secured by placing a washer over its protruding end and driving a flat wedge, called a **forelock**, into the slot. Forelock bolts were one of the most popular of shipbuilding fastenings, being commonly used to secure major timbers from Roman times until the nineteenth century.
- **Forepeak**. The forward extremity of the hold.
- **Frame** A transverse timber, or line or assembly of timbers, that described the body shape of a vessel and to which the planking and ceiling were fastened. Frames were sometimes called **timbers** or, erroneously, ribs (*see* **Rib**). Ancient ships often had frames composed of lines of unconnected timbers; later ships usually had compound frames composed of **floor timbers**, **futtocks**, and **top timbers**. **Square frames** were those set perpendicular to the keel; in the bow and stern there were **cant frames**, running obliquely to the keel. Forward of the cant frames and fayed to them, in large round-bowed vessels, were the frames running parallel to the keel and stem, sometimes called **knuckle timbers**; more accurately, these were the **hawse pieces** and **knight heads**, the latter being the frames adjacent to the apron or stem-son that extended above the deck to form bitts and support the bowsprit. The aftermost frames were the **fashion pieces**, which shaped the stern.
- **Frame head**. *See* **Timber head**.
- **Frame heel**. *See* **Timber heel**.
- **Freeboard**. The distance between the waterline and upper deck.
- **Furring**. *See* **Sheathing**.
- **Futtock** A frame timber other than a floor timber, half-frame, or top timber; one of the middle pieces of a frame.
- **Futtock plank**. In English shipbuilding, the first ceiling plank next to the limber strake.
- **Gallery**. A balcony projecting from the stern or quarter of a large ship.

- **Galley**. A seagoing vessel propelled primarily by oars, but usually one that also could be sailed when necessary. Also, a name given to a vessel's kitchen.
- **Gammoning hole** [Gammoning slot] An opening in the knee of the head through which the bowsprit gammoning (lashing) passed.
- **Gammoning knee**. A curved timber attached to the top of a vessel's stem, to which the bowsprit was lashed; sometimes used in lieu of a more elaborate knee of the head.
- **Gammon piece** The part of the knee of the head containing the gammoning hole.
- (p. 1122) **Garboard strake** [Garboard] The strake of planking next to the keel; the lowest plank. Also, the lowest side strake of a flat-bottomed hull.
- **Girdling** [Girding]. The practice of adding timber to the sides of ships to increase their breadth and thereby improve stability. The practice was most common on sixteenth- and seventeenth-century British vessels and was employed to overcome design flaws due to inability to calculate metacentric height.
- **Grating**. A latticework hatch cover used for light and ventilation. Also, a term applied to the latticework deck in the heads of large ships.
- **Graving** [Breaming]. The practice of cleaning a hull's bottom by burning barnacles, grass, and other foul material preparatory to recoating it with tar, sulphur, etc. The vessel was careened or drydocked to perform this task.
- **Graving iron** . A hook-like tool used for removing old caulking.
- **Graving piece** A wooden patch, or insert, let into a damaged or rotted plank.
- **Gripe** A curved piece joining the forward end of the keel to the lower end of the knee of the head. Generally, the same as **forefoot**.
- **Gudgeon** A metal bracket attached to the sternpost into which a rudder **pintle** was hung; the female part of a rudder hinge.
- **Gundeck** The deck where the guns were located; large ships had as many as three gundecks (a three-decker), called the lower, middle, and upper gundecks.
- **Gunport framing**.. The **sills**, **lintles**, and **filling pieces** that shape and reinforce the gunports.
- **Gunwale** [Gunnel] The upper edge of a vessel's side. In sixteenth-century vessels, the wale against which the guns rest.
- **Half beam** A beam extending from the side to a hatch or other obstruction. *See also* **Beam arm**.

- **Half-frame**. A frame whose heel began at or near one side of the keel or deadwood and spanned part or all of that side of the hull; half-frames normally were used in pairs.
- **Hanging knee** A vertical angular timber used to reinforce the junction of a beam and the side.
- **Harpins** [Harpings]. The forward planks of wales that were strengthened by increased thickness near the stem; usually found on large, round-bowed vessels. Also, a term applied to specially shaped battens fitted to the cant frames or other areas of extreme curvature during construction; used to check and adjust frame bevels.
- **Hatch** [Hatchway] A rectangular opening in a vessel's deck.
- **Hatch beam** A removable beam that supported the hatch cover and provided lateral strength when the hatch was not in use.
- **Hatch coaming**. *See* **Coaming**.
- **Hawse block**. A wooden plug used to close a hawse hole in heavy weather.
- **Hawse bolster**. One of the heavy planks fixed around or below the hawse holes to protect the hull planking.

Hawse hole A cylindrical hole in the bow through which the anchor cable passed.

- **Hawse hook**. A breast hook above the upper foredeck; usually, the highest breast hook.
- **Hawse piece** [Hawse timber] A fore-and-aft framing timber whose heel was fayed to the forward most cant frame and which reinforced the bow of a large, round-bowed vessel; hawse pieces were so named because the hawse holes were partially cut through them.
- **Hawse pipe**. The tube through which the anchor cable passed between the hawse hole and windlass or capstan deck.
- **Hawser**. A strong rope used to tow or tie up a vessel.
- **Head**. In a general sense, the forward part of a vessel; the extreme bow area; also, a name sometimes given to the **figurehead** or, on later vessels, to the latrine. *See also* **Timber head**.
- **Head knee**. Sometimes a designation for **cheek knee** (cheek), but more frequently an alternate term for **knee of the head**.
- **Head ledge** An athwartships hatch coaming.
- **Headrails** Curved rails extending from the bow to the knee of the head.
- **Head timber**. Any small timber in the head, but usually those supporting the gratings.

- **Heel**. The junction of the keel and sternpost; also, an angular timber connecting the keel to the sternpost. Separate heel timbers on cogs and cog-like vessels are most frequently called hooks.
- **Heel knee** [Stern knee]. An angular timber reinforcing the junction between the keel and the sternpost.
- **Helm**. The tiller or steering wheel; in a general context, the wheel, tiller, and rudder.
- **Helm port** [Rudder hole]. The opening in the stern where the rudder stock entered the hull.
- **Helm port transom** The timber reinforcing the helm port.
- **Hog** [Hogging]. The strain on a hull that causes its ends to droop.
- **Hog** [Hog timber]. *See* **Rising wood**.
- **Hogging truss** [Hogging frame]. A strong fore-and-aft framework built into a vessel to prevent hogging; hogging trusses were most commonly seen in canal boats and other long inland vessels. In ancient vessels, it was a strong cable supported by forked posts and attached to the ends of the hull to serve the same purpose.
- **Hold** In a general sense, the interior of a hull. The term is more commonly used to describe the part of a merchant ship's interior where the cargo and ballast were stowed or, on a warship, the room below the deck where stores and ballast were kept.
- **Hooding ends** [Hoods, Hood ends]. The ends of planks that fit into the stem and sternpost rabbets; hooding ends were sometimes reduced in thickness to permit a better join with the posts.
- **Hook**. A knee-like timber that connected the keel or central plank to the stem or sternpost. A northern European designation, it is used almost exclusively in reference to cogs and cog-like vessels. In later English documents, bow hooks were called **gripes**; stern hooks were called **heels**.

Hook and butt A method of planking whereby one edge of the plank was straight while its opposite side had sloping edges locked by a hook. Infrequently, the term was also used to denote a hook scarf.

- **Hook bolt** A bolt with a hook-shaped head used for securing detachable lines, tackle, and other gear.
- **Hook scarf** The union of two planks or timbers whose angular ends are offset to lock the joint. Hook scarfs are sometimes locked with wedges, or keys.

- **Horning** [To horn]. A process by which frames were aligned to assure that they were level and exactly perpendicular to the keel. *See* **Horning pole** for a description of the process.
- **Horning pole** [Horning board, Horning line]. A batten, pole, or line used to align frames; one end was mounted over the keel centerline, or atop the stem or sternpost, while the other end was marked and swung across each frame head to ensure that each side of the frame was equidistant from, and perpendicular to, the keel centerline.

Scarfs and seams.

Horseshoe [Horseshoe clamp, Plate] A U-shaped iron plate fastened across the seam of the stem and forefoot to strengthen it.

- **Horsing**. A term used to describe the process of driving caulking into planking seams.
- **Hypozomata**. A cable or assembly of cables installed in ancient galleys to overcome hogging.
- **Inner stempost**. The inner timber or timbers of a double-layered stem; unlike an apron, an inner stempost ends at the keel-stem scarf.
- **Inner sternpost** A vertical timber attached to the forward surface of the sternpost to increase its strength, and in some cases, to support the transoms.
- **Intermediate timbers**. Those individual timbers installed between the sequential frames for additional localized strength. They could span part of the bottom, turn of the bilge, or side. The term applies primarily to ancient ships and inshore craft, where they reinforced the areas around beams, mast steps, bilge sumps, etc., or extended upward as frames for bulkheads and weather screens.
- **Inverted knee**. *See* **Standing knee**.
- **Iron knee**. *See* **Plate knee**.
- **Jeer bitts** Upright posts used for staying the various courses or halyards.
- **Jib-boom**. A spar extending the length of the bowsprit.
- **Joggles**. Notches cut into the surface or edge of a timber, as in the exterior frame surfaces of clinker-built hulls or in the edges of some ancient Egyptian hull planks.
- **Keel** The main longitudinal timber of most hulls, upon which the frames, deadwoods, and ends of the hull were mounted; the backbone of the hull.
- **Keel plank** [Central plank, Kingplank]. A central hull plank that was substantially thicker than the rest of the bottom planking and whose breadth was at least twice as great as its thickness; a thick bottom plank used in lieu of a **keel**.

- **Keelson** [Kelson] An internal longitudinal timber or line of timbers, mounted atop the frames along the centerline of the keel, that provided additional longitudinal strength to the bottom of the hull; an internal keel. Most commonly, a single keelson was installed that was no larger than the keel. On very large vessels, however, various combinations of as many as a dozen keelsons were assembled. Where extra molding was required, one or more additional keelsons, called **rider keelsons** or **false keelsons**, were bolted to the top of the main keelson. They could be of identical size to, or smaller than, the main keelson. Auxiliary keelsons bolted alongside the main keelson were known as *sister* (U.S.), *side, auxiliary*, or *assistant keelsons*. However, care should be exercised in interpreting the various keelsons from contracts. For instance, some nineteenth-century American contracts for large schooners refer to the keelson above the main keelson as the sister, and the one above that as the assistant sister keelson. On occasion, large square timbers were placed at the floor head line or near the bilge, usually above the bilge keels. These were called **bilge keelsons** or, in some British document, **sister keelsons**. Secondary keelsons did not necessarily run the full length of the hull, terminating at the ends of the hold, the last square frames, or some other appropriate location.
- **Keel staple** [Keel clamp]. A large metal staple used to attach the false keel to the keel.
- **Kevel head**. The extension of a frame or top timber above the bulwarks to form a bitt, to which ropes were secured.
- **Kingplank** [Central strake, Kingstrake]. Variously, the central strake of a flush deck or the central strake of a hull without a keel.
- **Knee** [Knee timber] An angular piece of timber used to reinforce the junction of two surfaces of different planes; usually made from the crotch of a tree where two large branches intersected, or where a branch or root joined the trunk. *See also* **Dagger knee**, **Hanging knee**, **Lodging knee**, and **Standing knee**.
- **Knee of the head** [Head knee] A knee or knee-shaped structure, fixed to the forward surface of the stem, that formed the cutwater at its lower end and supported the headrails and figurehead at its upper end.
- **Knightheads** The forwardmost frame timbers, which ran parallel to the stem, their heels being fayed to the forwardmost cant frames and their heads extending above deck level to form bitts that supported the bowsprit between them. Also, a name given to a pair of bitts, located just aft of the foremast on merchant ships, that supported the

ends of the windlass, or to any bitt whose upper end was carved in the shape of a human head.

- **Knuckle**. A sharp angle in a frame.
- **Knuckle timbers** A name sometimes applied to the fore and aft frames in the bow of a roundbowed ship. The **hawse pieces** and **knightheads**.
- **Land**. The portion of a plank that is overlapped by another on a clinker-built vessel.
- **Lapstrake** [Clenched lap]. *See* **Clinker-built**.
- **Larboard**. *See* **Port**.
- **Ledge** A short beam set between and parallel to the deck beams to provide intermediate support of the deck; the ends of ledges were supported by **carlings**, **clamps**, or **lodging knees**.
- **Leeboard**. A large plate, or assembly of timbers, mounted on the side of a hull and lowered when sailing off the wind to increase lateral resistance and reduce **leeway**.
- **Leeway**. The sideways drift of a vessel when sailing with the wind abeam.
- **Lengthening piece**. *See* **Ekeing**.
- **Level lines**. Another name for the **waterlines** on hull plans; they described the horizontal sections of the hull.
- **Light** [Light port]. An opening in a vessel's side or deck, usually glazed, to let light into a compartment.
- **Limber boards** Ceiling planks next to the keelson which could be removed to clean the limbers; on some ancient vessels, limber boards were laid transversely above the centerline of the keel. Holes or slots were sometimes cut into limber boards so that they could be lifted more easily.
- **Limber holes** [Watercourses] Apertures cut in the bottom surfaces of frames over, or on either side of, the keel to allow water to drain into the pump well.
- **Limber ledges.** Rabbeted timbers running parallel to the keel and atop the floor timbers for the purpose of supporting transverse ceiling planks.
- **Limbers**. Watercourses or channels alongside or central to the keel or keelson, through which water could drain into the pump well.
- **Limber strake** The lowest permanent ceiling strake, fastened to the tops of the frames next to the limber boards and keelson.
- **Lines** [Hull lines]. The various shapes of a hull; expressed graphically, a set of geometric projections, usually arranged in three views, that illustrates the shape of a vessel's hull.

Lining The common ceiling of the orlop, berthing, and gun decks of ships, set between the spirketting and the clamps. The lining was frequently called **quickwork**, a term more commonly used in British documents.

- **Lintle** The upper horizontal timber framing a gunport, large square light, or gallery door.
- **Load line**. In some cases the term **load line** denoted full-load draft. *See* **Draft marks**.
- **Locked pintle**. A **pintle** that was flanged or keyed in order to prevent the rudder from accidentally unshipping.
- **Lodging knee** [Lodge knee] A horizontal, angular timber used to reinforce two perpendicular beams or the junction of a beam and the side of the hull.
- **Longitudinal**. *See* **Stringer**.
- **Loof**. The after part of the bow, where the side began curving inward toward the stem.
- **Loom**. Another term for the stock of a quarter rudder. Also, the stock, or pole piece, of an oar or sweep.
- **Luting**. A term used frequently to describe the caulking of lapstrake (clinker-built) hulls. In most cases, animal hair, wool, or moss was soaked in pitch or resin and laid in a **luting cove**, which was cut in the lower inside surface of the overlapping plank. Luting generally refers to caulking inserted between two hull members before they were assembled, as opposed to driven caulking (*see* **Caulk**). The term is also applied to any plastic material used between two adjacent members.
- **Main**. In shipbuilding, the adjective applied to the most important timbers, or those having the greatest cross-sectional area; thus, on ancient vessels the main wale was usually the lowest and largest, while on later warships it was the one below the gunports; also, main breadth, main hatch, main hold, main keelson, etc.
- **Main frame**. A term sometimes applied to frames composed of two rows of futtocks to distinguish them from filling frames, the single-rowed frames placed between them; it applies to larger vessels of the last few centuries. The term was also used infrequently to denote the **midship frame**.
- **Main piece**. The longest and largest timber in the knee of the head. Also, a term sometimes applied to the main vertical timber, or stock, of a rudder.
- **Mallet** A large hammer with a short handle and a cylindrical wooden head, sometimes hooped with iron to prevent it from splitting, used for caulking (caulking mallet) and general shipwrightery. The heaviest mallets were also called **beetles**.

- **Manger**. A small compartment, located just inside the hawse hole, whose after bulkhead (called a *manger board*) diverted water entering the hawse hole into the limbers.
- **Margin plank**. *See* **Nibbing strake**.
- **Mast carlings** Fore-and-aft beams that helped support a mast where it pierced a deck; also called **mast partners**. *See* **Partners**. Bow construction: (a) top view of port frames; (b) deck hook; (c) breast hook and hawse hole; and (d) one of many arrangements used for assembling the knee of the head.

Mast partner. *See* **Partners** and **Mast carlings**.

- **Mast step** A mortise cut into the top of a keelson or large floor timber, or a mortised wooden block or assembly of blocks mounted on the floor timbers or keelson, into which the tenoned heel of a mast was seated.
- **Maul** A heavy wood or iron hammer, primarily used to drive large bolts.
- **Meginhufr**. A thick plank separating the bottom, or *lower ship*, of a Viking hull from its sides. Either rectangular or L-shaped in cross-section, (p. 1134) meginhufrs evolved from the triangular-sectioned sheer strakes of earlier, simpler Norse hulls.
- **Metacenter**. The intersection of a vertical line drawn through the center of gravity of a vessel when it is stable with a vertical line drawn through its center of buoyancy when the vessel is heeled.
- **Midship** [Midships]. A contraction of **amidships** and consequently, in a general sense, it refers to the middle of the ship. In construction, however, it is often used as an adjective referring to the broadest part of the hull, wherever it may be.
- **Midship beam** The longest beam in a vessel, located at or near the **midship bend**.
- **Midship bend**. The broadest part of the hull; the widest body shape, formed by the centerline of the **midship frame**.
- **Midship flat** [Midship body, Midsection, Midship section]. The extent of the broadest part of the hull, formed by the midship frame and all adjacent frames of the same breadth.
- **Midship frame** The broadest frame in the hull; the frame representing the midship shape on the body plan.

Mold [Mould] A pattern used to determine the shapes of frames and other compass timbers. Molds were usually made from thin, flexible pieces of wood. Convex molds were called *bend molds*, concave molds were known as *hollow molds*, and *compound* or *reverse*

molds included entire frame shapes. The degree of bevel and other pertinent information was written on the molds. The process of shaping outer frame surfaces with molds was known as **beveling**.

- **Molded** [Molded dimension]. The various dimensions of timbers as seen from the sheer and body views of construction plans; the dimensions determined by the molds. Thus, the vertical surfaces (the sides) of keels, the fore-and-aft sides of the posts, the vertical or athwartships surfaces of frames, etc. Normally, timbers are expressed in sided and molded dimensions, while planks and wales are listed in thicknesses and widths. Molded and sided dimensions are used because of the changing orientation of timbers, such as frames, where "thick" and "wide" or "height" and "depth" become confusing.
- **Molded depth**. The depth of a hull, measured between the top of the upper deck beams at the side and a line parallel to the top of the keel.
- **Molding**. *See* **Mold** and **Whole molding**.
- **Mold loft**. A protected area or building in a shipyard where the hull lines, from which the molds were produced, were drawn full size on a specially prepared flat surface.
- **Oakum** [Oakham]. Caulking material made from rope junk, old rope, and rope scraps; it was unwound, picked apart, and the fibers were rolled and soaked in pitch before being driven into planking seams.
- **Oar port** An opening in a vessel's side through which the looms of oars or sweeps passed. *See also* **Sweep port**.
- **Orlop deck** The lowest deck of a large ship.
- **Outboard**. Situated near or on the outer side of a vessel; toward the outer side.
- **Outer stem.** A name sometimes given to the main stempost or to the forward layer of timbers in a double-layered stem.
- **Outfall**. The outward slant of a vessel's sides.
- **Overhang**. The part of a vessel's stern that projects aft of the rudder stock.
- **Packing piece** A short piece of timber used to fill open areas between structural timbers; used most frequently at the sides between deck beams or lodging knees.
- **Parcel**. To surround or enclose with strips of flexible material, as in the reinforcement of caulked planking seams (usually lead strips) or between ropes and their servings (usually strips of canvas).
- **Partners** The timbers surrounding the deck openings for masts, pumps, bitts, and capstans; their primary purpose was to strengthen the deck around the opening and

counteract strain. Partners were also used on occasion to steady masts on undecked vessels.

- **Patch tenon** In ancient vessels, a headed tenon inserted from the exterior or interior surface of a plank. Patch tenons were normally used in the replacement of rotten or damaged planking. The name comes from their installed appearance as square patches in the sides of hulls.
- **Pay**. To coat; to cover a hull bottom with a protective layer of pitch, resin, sulphur, etc.
- **Peak**. The upper portions of the narrow ends of a vessel; cited individually in some documents as **forepeak** and **afterpeak**. Also, a term used to designate the tip of an **anchor palm**.
- **Peg** [Tenon peg]. A tapered wooden pin driven into a pre-drilled hole to fasten two members or lock a joint. Pegs came in a variety of sizes and tapers; they could have square, round, or multi-sided cross sections. The important difference between dowels and pegs in ancient construction was that the former were of constant diameter and lightly set, while the latter were tapered and driven with appreciable force. The most common use of pegs in ancient construction was the locking of mortise-and-tenon joints.
- **Pillar**. Large vertical stanchion, usually turned or dressed for aesthetic reasons, used to support deck beams or reinforce potentially weak areas. By the seventeenth century, pairs of pillars, called cross pillars, were set diagonally across the hull to provide transverse strength.
- **Pin rail**. A long rack, usually attached to the inside of bulwarks, for holding belaying pins; a short pin rail was called a pin rack.

- **Port** [Port side, Larboard]. The left side of a vessel when facing forward.
- **Pump well** [Sump] (The cavity or compartment in the bottom of a hull, usually near amidships, where bilgewater collected and from which it was pumped out or bailed. Wells ranged from simple sumps between frames to watertight compartments extending the full height of the hold.
- **Quarter**. The after part of a vessel's side.
- **Quarterdeck**. The after part of the upper deck, from the mainmast to the poop.
- **Quarter gallery**. A small balcony on the side of a ship near its stern.
- **Quarter rails**. Rails, balustrades, or planking running along the quarterdeck.

- **Quarter rudder**. *See* **Rudder**.
- **Quarter timber**. A frame in a vessel's quarter.
- **Quickwork** The common ceiling of the orlop, berthing, and upper decks as well as the gundeck. It was so named because it did not require caulking or precision joinery and therefore could be erected comparatively quickly. *See also* **Lining**.
- **Rabbet** A groove or cut made in a piece of timber in such a way that the edges of another piece could be fit into it to make a tight joint. Generally, the term refers to the grooves cut into the sides of the keel, stem, and sternpost, into which the garboards and hooding ends of the outer planking were seated.
- **Rabbet plane** A plane used in smoothing rabbets.
- **Rag bolt** A bolt whose shaft was barbed to prevent it from working out of its hole.
- **Rail of the head**. *See* **Headrails**.
- **Rake**. The inclination of the stem and sternpost beyond the ends of the keel; also, the inclination of the masts from the perpendicular.
- **Ram**. A strong projection on the bow of an ancient warship, usually sheathed in metal, used as a weapon to strike another vessel. Specifically, the ram (p. 1142) included the ramming timber, the forward bow timbers configured to reinforce the ramming timber, and a metal sheath; in actual practice, the metal sheath is usually called the ram. Rams were also used, with little success, on iron warships after the middle of the nineteenth century.
- **Ram bow**. Any bow with a projecting forefoot or ram. Ram bows sometimes served non-military functions: a means of reinforcing the bow construction externally, a method of lengthening the waterline to improve lateral resistance and maneuverability, or a decoration or symbol.
- **Ramming timber**. The main timber of an ancient ram, projecting forward from its envelope of bow planks and timbers to reinforce the head of the ram.
- **Reaming beetle** [Reeming beetle]The heaviest caulking mallet, used with a reaming iron for opening seams so that caulking could be driven into them.
- **Reaming iron** [Reeming iron] An iron chisel used for opening planking seams for caulking.
- **Rib**. A small transverse member, often flexible and composed of one or several pieces, that stiffened the outer skin of a hull. Although often a layman's term for **frame**, rib is more properly applied to small craft, such as canoes, small boats,

certain heavy frames that run from gunwale to gunwale in clinker-built vessels, or vessels whose skin is made of material other than wood.

- **Ribband carvel**. The designation for a carvel-planked hull whose seams were covered with battens, or ribbands, to prevent the caulking from working out.
- **Ribbands** [Ribbons, Battens]. Long, flexible strips of wood most commonly used as temporary keepers by nailing them across the outside of standing frames while the vessel was being built. When the term *framed on ribbands* was popular in the last few centuries of wooden shipbuilding, the ribbands were sometimes carefully arranged to represent certain rising and narrowing lines, from which planking and intermediate frame shapes were derived.
- **Rider** [Rider frame] An internal frame seated atop the ceiling, to which it was fastened; riders could be single pieces, but more often they were complete frames composed of floor timbers, futtocks, and top timbers. Installed either transversely or diagonally, they provided extra stiffening.
- **Rider keel** One or more additional keels bolted to the bottom of the main keel to increase its strength. It should not be confused with a false keel, whose primary purpose was to protect the keel's lower surface.
- **Rider keelson** An additional keelson, or one of several additional keelsons, bolted to the top of the main keelson of a large ship. In some documents, it was called a **False keelson**. *See also* **Keelson**.
- **Riding bitts** Strong, upright timbers in the bow of a ship, to which the anchor cables and hawsers were secured.
- **Ripping iron** A claw-like tool used for removing old copper or wooden sheathing.
- **Rising line** . A curved line on the sheer drawing of a ship, designating the outer ends of the floor timbers or the height of maximum breadth throughout the length of the hull. The former line was called the *rise of floor line* or the *floor head line*; the latter was known as the *height of breadth line*. *See also* **Narrowing lines**.
- **Rising wood** [Deadwood, Hog] Timbers fastened to the top of the keel and notched into the bottom of the floor timbers to better secure those members to each other and give the proper rising to the floor timbers. Rising wood was located between the apron or forward deadwood and the after deadwood, and was sometimes referred to as the central or keel deadwood.
- **Rockered keel**. A keel that is curved longitudinally so that it is deeper at its middle than at its ends. The term also refers to keels that are molded to a greater dimension

amidships than at their ends. *Rocker* should not be confused with **sag**, which is an accidental rocker.

- **Room and space** The distance from a molded edge of one frame to the corresponding point on an adjoining frame, usually measured at or near the keelson. The part occupied by the frame is called the *room*, while the unoccupied distance between it and the adjacent frame is called the *space*. On large ships of the last few centuries, where filling frames were placed between double frames, the term applied to the distance between the molded edge of one double frame to the corresponding point on the next double frame. Because of the uneven Siding of forward frame faces, irregular spacing, and varying methods of fabrication, **room and space** is often a meaningless term in ancient hull documentation. A more definitive designation for ancient ships is **average frame spacing**, the average of distances between frame centerlines at a common appropriate location, taken throughout the hull or hold.

- **Round tuck stern**. *See* **Tuck**.
- **Rove** [Roove] A small metal washer, used in clinker-built hulls, over which nail or rivet ends are flattened to lock the fastening. The term was also applied to washers used in bolting scarfs, floor timbers, etc.
- **Roving iron** An iron, hollow-ended tool used to drive roves over the ends of nails and bolts before clenching.
- **Rudder** A timber, or assembly of timbers, that could be rotated about an axis to control the direction of a vessel underway. Until the middle of the medieval period, the practice was to mount rudders on one or both stern quarters; these were known as *quarter rudders*. By the late medieval period, however, it appears that most vessels of appreciable size were steered by a single rudder hung at the sternpost; these were known as *stern-hung rudders*. For a brief period, the two types were sometimes used in combination. Rudders were designed for the vessel and type of duty they served. In protected waters they could be made quite broad, while seagoing ships utilized longer, more narrow rudders. For the largest seagoing ships, rudder construction was complex and required huge timbers, the assembly sometimes weighing several tons.
- **Rudder blade** The flat part of the rudder that diverts the water.
- **Rudder breeching**. A strong rope with one end attached to the rudder and the other inside the stern, used to relieve some of the weight on the **gudgeons**.

- **Rudder chains**. Chains or ropes attached to each side of the rudder and to the stern, used to prevent the loss of a rudder if it accidentally became unshipped.
- **Rudder head** The upper part of the rudder stock.
- **Rudder hole** An opening in the stern through which the rudder stock passed.
- **Rudder post**. A term infrequently used to describe either the outer sternpost or the rudder stock.
- **Rudder sheath** A wooden or metal protective covering placed over the leading edge of a quarter rudder blade.
- **Rudder stock** A strong vertical piece to which the tiller was fitted; on large, post-medieval vessels it was the main vertical timber of the rudder, and it was also known as the **mainpiece**.
- **Rudder trunk**. A housing for the rudder stock, usually extending from the counter to the steering deck.
- **Runghead**. *See* **Wronghead**.
- **Sag** [Sagging]. The accidental rocker formed in a keel and bottom due to insufficient timbering or improper loading.
- **Scantlings**. The principal timbers of a vessel.
- **Scarf** [Scarph]. An overlapping joint used to connect two timbers or planks without increasing their dimensions. **Scroll** [Scroll head, Fiddlehead]. Ornamental molding used in place of a figurehead.
- **Scupper** A hole or channel cut in a vessel's side or waterway to drain off deck water.
- **Scuttle**. A small opening, usually covered with a lid, in the side or deck for utilitarian purposes, such as a ballast port.
- **Seam**. The longitudinal joint between two timbers or planks; the term usually refers to planking seams, the longitudinal juxtaposition of the edges of planks in the sides or decks, which were made watertight.
- **Shake**. A longitudinal crack or distortion in a timber, caused by sun, weather, or improper curing. Cracks occurring during curing are also referred to as *checks*.
- **Sheathing**. A thin covering of metal or wood, to protect hulls from marine life or fouling, or to stabilize and protect surface material applied for that purpose. Sheathing was most commonly used in the form of copper, lead, zinc, or alloy sheets, or thin wooden planks known as *furring* or *deals*.
- **Sheathing nail** A small nail or tack used to attach sheathing to a hull.
- **Sheer**. The longitudinal sweep of a vessel's sides or decks.

- **Sheer line**. Specifically, the line of the upper or main deck where it meets the side, but the term is often used to describe the sweep of the bulwarks or weather rail.
- **Sheer plan**. The side view of a vessel's hull plan.
- **Sheer plank**. *See* **Plankshеer**.
- **Shelf** [Shelf clamp, Shelf piece]. *See* **Clamp**.
- **Shelf wale**. On ancient and early medieval ships, a thick strake of external planking that supported through-beams and other timbers penetrating the outer planking.
- **Shell**. The external planking of a vessel.
- **Shell-first construction** [Shell-built]. A modern (sometimes misleading) term used to describe the process by which all or part of the outer hull planking was erected before frames were attached to it. In pure shell-built hulls, outer planking was self-supporting and formed the primary structure; the framework fastened to it formed the secondary, or stiffening, structure.
- **Shift**. The act of arranging butts and scarfs so that adjacent joints are not in vertical alignment, thereby avoiding possible hull weaknesses.
- **Shim**. A thin piece of wood used to fill a separation between two timbers or a frame and a plank.
- **Shipwright**. A master craftsman skilled in the construction and repair of ships. In many instances, the person in charge of a ship's construction, including the supervision of carpenters and other personnel, control of expenditures and schedules, and acquisition of materials. Probably in many more areas and periods than have been documented, the term designated a formal title, such as the shipwrights to the English monarchs, or a level of expertise qualifying admission to a guild or association.
- **Shoe** A term variously applied to the cover for an anchor fluke or a protecting piece at the bottom of a keel or rudder. *See* **Anchor** and **False keel**.
- **Shole** [Sole, Shoe] A horizontal piece of wood or metal fixed along the bottom of a rudder to protect the lower ends of the vertical rudder pieces and align the bottom of the rudder with the bottom of the false keel.
- **Shore**. A prop or pole used to brace a vessel in an upright position when not afloat or supported by a cradle.
- **Shot garland**. A rack with hollows cut into it for supporting a row of cannon shot.
- **Shot locker** A small compartment, usually located near the foot of the mainmast, where round shot was stored.
- **Shroud**. A rope or wire support used to steady a mast to the side of a hull.

- **Side**. Described variously as the part of a hull above the waterline or the part above the turn of the bilge.
- **Sided** [Sided dimension]. The dimension of an unmolded surface; the distance across an outer frame surface, the forward or after surface of a (p. 1146) stem or sternpost, or the upper surface of a keel or keelson. *See* **Molded** for further information on timber dimensions.
- **Side keelson**. *See* **Keelson**.
- **Side timbers**. In ancient and medieval vessels, one of a series of intermediate framing timbers inserted to provide stiffness along the line of wales. *See also* **intermediate timbers**.
- **Sill** The lower horizontal timber framing a gunport, large square light, or gallery door.
- **Sintel** [Batten clamp]. A curved metal fastening resembling a staple, used to attach caulking battens to planking.
- **Sister keel**. *See* **Bilge keel**.
- **Sister keelson**. *See* **Keelson**.
- **Skeg** A triangular piece, resembling external **deadwood** placed above the after end of the keel; used to reinforce the sternpost and improve sailing qualities of small craft and flat-bottomed vessels. Alternately, the angular after end of the keel, or an extension of the keel, on which the rudder post was mounted or which was used to protect the forward edge of the rudder.
- **Skeletal construction** [Frame-first construction]. A modern (sometimes misleading) term used to describe the procedure in which hulls were constructed by first erecting frames and then attaching the outer skin of planking to them.
- **Sleeper**. A seventeenth-century term for thick ceiling; a bilge stringer or footwale. In eighteenth-century English documents, a transom knee.
- **Sliding keel**. *See* **Centerboard**.
- **Snelle**. A winged, or partition-like, stanchion used to support beams in Viking vessels.
- **Sny**. An archaic term used to describe the upward sweep of bow and stern planking.
- **Spirketting** Thick interior planks running between the waterways and the **lining** or **quickwork**.
- **Square frame**. *See* **Frame**.
- **Square tuck stern**. *See* **Tuck**.

- **Stanchion** An upright supporting post, including undecorated supports for deck beams and bulkheads.
- **Standard**. *See* **Standing knee**.
- **Standing knee** [Standard] A knee mounted on a deck with its vertical arm pointed upward; most commonly used to reinforce the junction of the deck and side.
- **Staple** A metal rod or bar whose sharpened ends were bent at right angles, used to fasten false keels to keels or to secure planking seams that tended to separate. Staples were used from the classical period to the present century.
- **Starboard**. The right side of a vessel when facing forward.
- (p. 1147) **Station lines** [Body lines, Section lines]. The projections on a lines drawing that represent the various body shapes of a hull.
- **Stealer** A short plank inserted between two strakes of planking so that the regular strakes did not have to be made too wide; usually located at the bow or stern ends of bottom or lower side strakes.
- **Steering gear** The mechanism, consisting of chains, ropes, blocks, etc., used to transfer movement of the wheel to the tiller. In more general terms, the various components composing any steering mechanism.
- **Steering oar**. An oar used to steer a small vessel, either from the side or the stern. A steering oar should not be confused with a **quarter rudder**, which is the device commonly used to steer ancient vessels and is permanently mounted and turns about a fixed axis.
- **Stem** [Stempost]). A vertical or upward curving timber or assembly of timbers, scarfed to the keel or central plank at its lower end, into which the two sides of the bow were joined.
- **Stem head** The upper end of the stem.
- **Stemson** A curved timber mounted on the inner surface of the apron; usually, the forward and upward extension of the keelson.
- **Stern**. The after end of a vessel.
- **Stern framing** The assembly of timbers consisting of the sternpost, transoms, and fashion pieces.
- **Stern knee** An angular timber that reinforced the joint between the keel—or lower deadwoods—and the sternpost or inner sternpost. Also known as the knee of the post.
- **Stern port**. An opening in the stern for guns, cargo loading, or light and ventilation.

- **Sternpost** A vertical or upward-curving timber or assembly of timbers stepped into, or scarfed to, the after end of the keel or heel.
- **Sternson** A curved timber joining the keelson and inner sternpost; usually an extension of the keelson and was mounted on top of the deadwood.
- **Sternson knee**. A knee fitted atop or abaft the sternson to reinforce the upper part of the sternpost.
- **Stern walk** [Stern gallery]. A balcony mounted across the stern.
- **Stocks**. A structure supporting a vessel under construction or repair.
- **Stopwater** (A wooden dowel inserted athwartships in the scarf seams of external timbers to prevent shifting of the joint or to discourage water seepage along the seams.
- **Strake** [Streake]. A continuous line of planks, running from bow to stern.
- **Stringer** [Longitudinal]. A general term describing the longitudinal timbers fixed to the inside surfaces of the frames; the ceiling, other than the common ceiling.
- **Sump**. *See* **Pump well**.
- **Surmark** [Sirmark]. A mark denoting the location or sweep of a ribband or batten.
- **Sweep port** An opening in the bulwarks to accommodate a sweep (large oar).
- **Tabernacle**. A timber assembly or housing that supported a mast or post at deck level. A common support for a hinged mast.
- **Taffrail** [Tafferal]). Variously, the upper part of the stern or the rail on top of the stern.
- **Tenon** A wooden projection cut from the end of a timber or a separate wooden piece that was shaped to fit into a corresponding mortise. *See* **Mortise-and-tenon joint**.
- **Tenon-built**. A term used to denote vessels whose planking edges were joined by means of **mortise-and-tenon joints**.
- **Thick stuff** . A term referring to the thick ceiling of the bottom.
- **Thole** [Tholepin]. A pin, or one of a pair of pins, set vertically in the gunwale to serve as the fulcrum for an oar.
- **Through-beam** An athwartships timber that extended through and beyond the outer hull planking. Through-beams were most common on ancient and medieval hulls, where they supported the quarter rudders or provided athwartships stiffness to the upper part of the hull.
- **Thwart**. A transverse plank in a boat or galley; used to seat rowers, support masts, or provide lateral stiffness.

- **Tiller**). A wooden or metal level fitted into the rudder head, by which the rudder could be moved from side to side.
- **Timber and room**. *See* **Room and space**.
- **Timber head** The upper extremity of a hull timber.
- **Timber heel** The lower extremity of a hull timber.
- **Timbers**. In general context, all wooden hull members; specifically, those members that formed the frames of a hull.
- **Tons burden**. *See* **Burden**.
- **Top and butt** A method of planking whereby one edge of the planks were straight while their opposite sides had two sloping edges of unequal length, reducing the plank widths to half. It was used to increase longitudinal strength and to prevent shifting of wales and other stress-bearing planks.
- **Top timber** The uppermost member of a frame.
- **Transom**). One of the athwartship members, fixed to the sternpost, that shaped and strengthened the stern.
- **Transom beam**. *See* **Transom**.
- **Transom knee** An angular, horizontal reinforcing timber bolted to a transom and the side.
- **Treenail** [Trunnel, Trennal] A round or multi-sided piece of hardwood, driven through planks and timbers to connect them. Treenails were employed most frequently in attaching planking to frames, attaching knees to ceiling or beams, and in the scarfing of timbers. They were used in a variety of forms: with expanding wedges or nails in their ends, with tapered or square heads on their exterior ends, or completely unwedged and unheaded. When immersed, treenails swelled to make a tight fit.
- **Tuck** The place where the ends of the bottom planks terminated under the stern or counter. When planks ended in a convex curvature, a vessel was said to have a round tuck; when the stern and counter lay perpendicular to the posts, the vessel was said to have a square tuck.
- **Tumblehome** [Fall home]. The inward curvature of a vessel's upper sides as they rose from the point of maximum breadth to the bulwarks. Tumblehome reduced topside weight and improved stability.
- **Turn of the bilge**. The outboard part of the lower hull where the bottom curved toward the side.

- **Underwater body**. The portion of the hull below the waterline.
- **Upper deck** The highest deck extending unbroken from bow to stern.
- **Upper wale**. The highest wale.
- **Waist**. The part of a vessel between the quarterdeck and the forecastle.
- **Wale**. A thick strake of planking, or a belt of thick planking strakes, located along the side of a vessel for the purpose of girding and stiffening the outer hull.
- **Waterlines** [Level lines]. Lines on a hull drawing representing the horizontal sections of the hull.
- **Waterway** A timber or gutter along the side of a deck whose purpose was to prevent the deck water from running down between the frames and to divert it to the scuppers.
- **Way**. The stocks; a structure on which a vessel was built.
- **Weather deck**. Any exposed deck.
- **Well**. *See* **Pump well**.
- **Wheel** [Steering wheel]. A vertical steering device, fixed to a deck and linked to the tiller by ropes, chains, or gear.
- **Whipstaff**. A vertical steering lever that preceded the wheel; it was connected to the tiller by a toggle arrangement, and it was mounted in a bearing on the deck above the tiller.
- **Whole molding**. A process to determine the transverse shapes of hulls by means of one or more standard molds, which were shifted as necessary to produce fair shapes without the use of compasses and complex drafting methods. The process was not as precise as determining individual hull shapes from lines drawings or with compasses and scales, and it was usually limited to the production of small craft after the seventeenth or early eighteenth century.
- **Windlass** . A horizontal cylinder, supported by bitts or brackets, used to haul anchors and hawsers.
- **Wing transom** The major transom, mounted on the inner sternpost, which formed the foundation for the counter and stern.
- **Wronghead** [Runghead] The head, or extremity, of a floor timber.

Video Link:

https://www.youtube.com/watch?v=BXnpSzL7mOo&t=400s&ab_channel=marineinsight

15. Types of marine engines

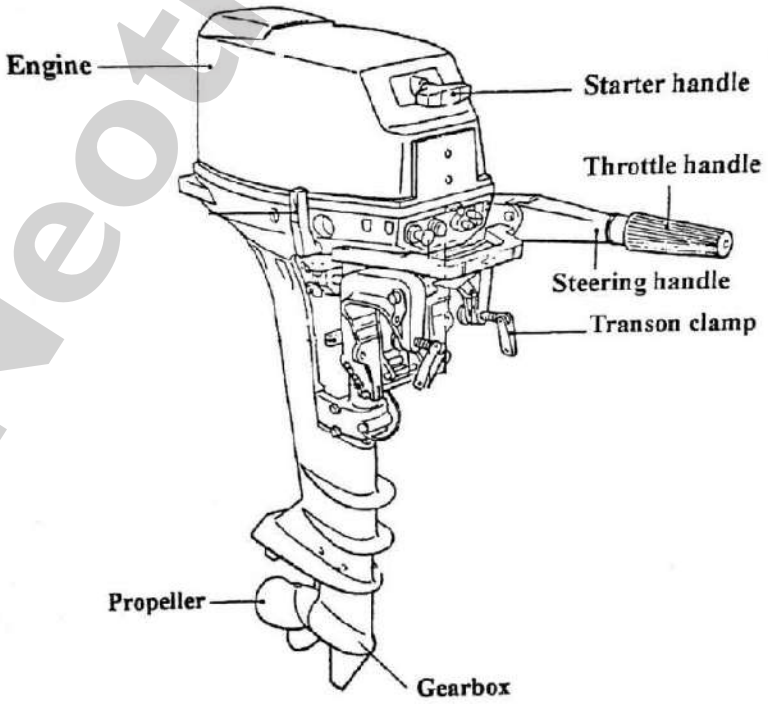
❖ **Power Transmission:**

Propellers are used for the movement of the vessels. These propellers are rotated by power developed by prime moves like internal combustion engine. There are two types of prime movers for transmitting power required for propulsion:

1. Out-board motor.
2. In-board engine.

A. Out-board motor:

- Out-board motors are machines which is fixed outside the hull of the boat and which drives the propeller and moves the boat. They are integral mechanism which has an internal combustion engine and the propeller unit coupled together as a compact unit.
- The engine and the propeller are coupled by a gear mechanism in these types of motors. The gear mechanism has the forward and reverse gear inside it and the control for movement of the propeller in forward, astern and neutral positions are also embodied in the motor mechanism.



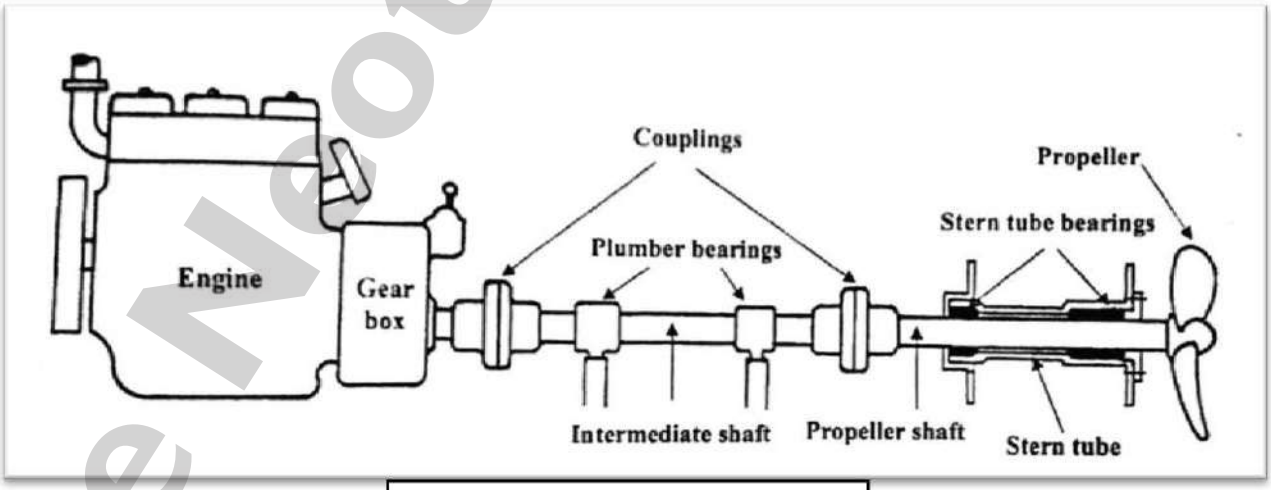
Out-board motor

B. **In-board engine**:

- For transmitting the power to propeller in In-board engine a series of transmission machinery are used in a vessel. The propeller should be able to give both ahead and astern movement to vessel. As well the propeller should give enough thrust to the vessel to increase its pulling power. The ahead and astern movement is achieved by a reverse gear and the thrust is increased by a reduction gear.

- The power transmission machinery of a vessel thus comprises of reduction / reverse gear, plumber bearing, intermediate shaft, stern tube, stern tube bearing, propeller shaft, propeller.

- The power developed by the prime mover is transmitted to the reduction / reverse gear box where the speed is reduced and at the same time reversing of direction of rotation is carried out. The gear box is connected to an intermediate shaft which is supported by plumber bearings. The intermediate shaft is connected to the propeller shaft. The propeller shaft is passed through the stern tube and is supported by the stern tube bearing. Propeller is coupled to the propeller shaft. Thus the motion created by the prime mover is transmitted to the propeller.



Stern Tube Arrangement

Video Links:

https://www.youtube.com/watch?v=mb-NjsxxOcc&ab_channel=MarineOnline

16. Engine Installation

The installation details are basic guidelines to assist installation, however due to the great diversity of marine craft it is impossible to give definitive instructions.

• All engines shall be placed within an enclosure separated from living quarters and installed so as to minimise the risk of fires or spread of fires as well as hazards from toxic fumes, heat, noise or vibrations in the living quarters.

• Unless the engine is protected by a cover or its own enclosure, exposed moving or hot parts of the engine that could cause personal injury shall be effectively shielded.

• Engine parts and accessories that require frequent inspection and / or servicing must be readily accessible.

• The insulating materials inside engine spaces shall be non-combustible.

ENGINE MOUNTING

To ensure vibration free operation, the engine must be installed and correctly aligned on substantial engine bearers, extending as far forward and aft as possible, well braced and securely fastened to form an integral part of the hull.

- The engine must be installed as low as possible on the flexible mount pillar stud.
- This will limit vibration and extend the life of the flexible mount.
- To assist with engine replacement we offer 'Special Engine Feet' manufactured to your dimensions, as an optional extra to suit your existing engine bearers and shaft alignment / installation.
- Do not set the engine feet high up the flexible mount pillar stud. This will cause excessive engine movement and vibration. Pack steel shims under the flexible mount and ensure that the flexible mounting is securely bolted to the engine bearer.
- The pillar stud on the flexible mount is secured into position by the lower locknut, do not forget to tighten this. Also ensure that the stud is not screwed too far through the mounting body so that it can touch the bearer. This will cause vibration and knocking noises which are very hard to find! If the flexible

mounting is too far offset then the loading on the flexible mounting will cause premature failure, modifications are needed.

ENGINE INSTALLATION AT AN ANGLE

- Marine propulsion engines can be installed at angles up to a maximum of 15° flywheel up or flywheel down when static, and can be run at up to 25° when heeling.
- It is probably better to totally drain the sump, and completely refill the engine sump with the recommended quantity / volume of lubricating oil - noting its position on the dipstick - and then marking the dipstick accordingly (don't forget to replace the oil filter).

ALIGNMENT

- To obtain accurate alignment the flexible mountings must be adjusted until alignment is attained, and the mountings must be locked in position.
- The engine / gearbox unit has to be aligned with the propeller shaft in two ways.
- The traditional engine alignment method involves measuring with either feeler gauges or a DTI (Dial Test Indicator) mounted on a magnetic foot so that they are aligned within 0.125mm (0.005"). (Obviously the propeller shaft must be centered in the stern tube and running true - through the cutless bearing; if the propeller shaft is not correctly centered you will experience vibration).

Video Links:

https://www.youtube.com/watch?v=a73sFmnhBFY&ab_channel=CaptainValentine