



**Royal Australian Navy Apprentice Training Establishment**

**LOFTING**

## MOULD LOFT

<u>CONTENTS</u>	<u>PAGE NO.</u>
1. The Mould Loft	1
2. Loft Tools	2
3. Definitions (Hull Shape)	4
4. Tonnage Definitions	7
5. Line Work	8
6. To Draw A Layout Grid	11
7. Definitions (Lines Plan)	12
8. Laying Off The Sheer Draught On Loft Floor	13
9. Fairing Ships Lines	14
10. Contracted Fairing	19
11. Moulds	20
12. Deck Camber - Method 1	21
Method 2	22
Method 3	23
13. Scribe Board	24
14. Taking Off The Plank	25
15. Lifting Off Bevels	26
16. Method Of Lifting A Bevel For A Frame Or Floor	28
17. To Lay Off Cant Frame And Obtain Its Bevels	30
18. To Take Off Plank Forward And Obtain The Beading Line	31
19. Half Block Model	33
20. Setting Off Draught Marks On The Stem and Stern	35
21. 10Th. Scale Lofting	37
22. Shell Expansion - Diagonal Method	40
Triangulation Method	42
Centre Square Method	44
23. Expansion Of Margin Plate	47
24. Expansion Of Curved Raked Transom	49

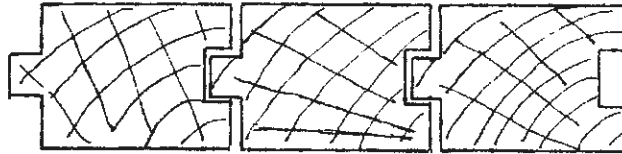
## THE MOULD LOFT

The traditional Mould Loft used in shipyards enables the shape of various parts of the vessel to be drawn full size.

It must be appreciated that the provision of adequate natural and artificial lighting is essential for work of this type.

The most important part of the loft is the working floor area on which the lines of the ship and the shape of the various structural items are drawn out full size.

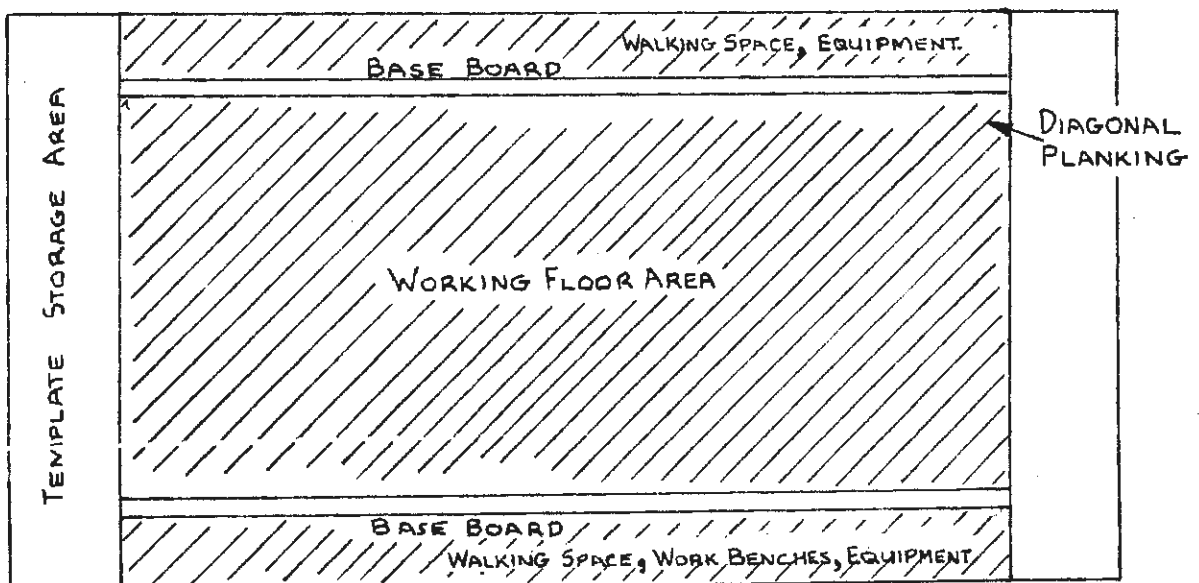
The floor, constructed of wood planks, should be laid diagonally. Straight lines drawn in longitudinally and transversely on the floor might otherwise fall at the same places as the joints between planks and so become obscured; planks laid diagonally enable the majority of lines drawn to cross the joints at a reasonable angle.



TONGUE AND GROOVE FLOORING

The diagonal planking may be laid directly on the joists or on top of an ordinary planked wood floor. Planks 50 mm x 150 mm are used, tongued and grooved to ensure that one plank cannot move in relation to the next, holding a true surface. The foundation for the floor must be substantial and level. In order that the white chalk lines are clearly visible the surface should be painted with flat black paint.

Along each side of the working floor area runs a 150 mm wide by 50 mm deep board known as the Base Board; this is fastened permanently and checked periodically to ensure straightness. It is from this Base Board that all vertical dimensions are taken eg, waterline heights, vertical offset dimensions. The centreline, buttock line in the body plan and station lines in half breadth and profile are drawn perpendicular to the base line.

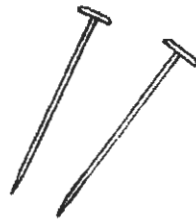


LOFT FLOOR

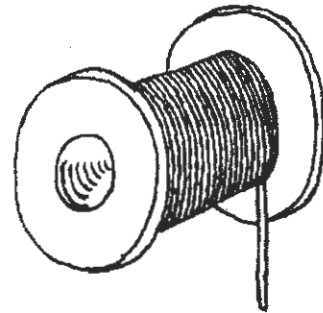
## LOFTING TOOLS

Tools used on mould loft floor are:

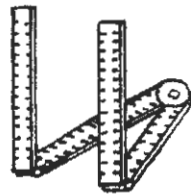
1. Lofting pins, to pin batten to required shape.
2. Chalk line, used to mark straight lines on the floor.
3. Steel tape. The zero mark is some way from the end, so that it can be placed exactly.
4. One metre folding rule.
5. French chalk, sharpened to chisel point, for drawing in curves around battens.
6. Heavy steel rule.
7. Loft hammer with large claw.
8. Trammel - a stiff batten some 3 metres in length on which points are clamped at the required distance apart. It has the same use as a pair of compasses.
9. Scrieve knife, for scrieving, cutting in, lines some 1.5 mm of an inch deep on floor to provide a permanent record of the vessels flaired lines that will not become obscured through use and dirt.
10. Pinning battens, of various shapes and sizes, for laying down and fairing curved lines.
11. Tangent square "T" square, used to draw a line "normal" or square to the tangent of a curve.
12. Clincher, a steel plate which slips under the template wood to nails or tacks entering the floor when template is nailed together.
13. Taking Off Battens, straight lengths of timber used for transferring offsets.



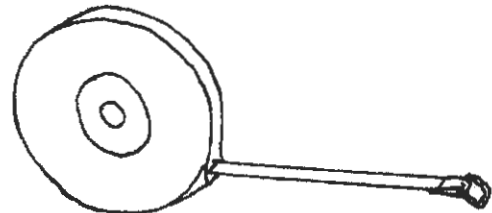
LOFT PINS.



CHALK LINE AND REEL



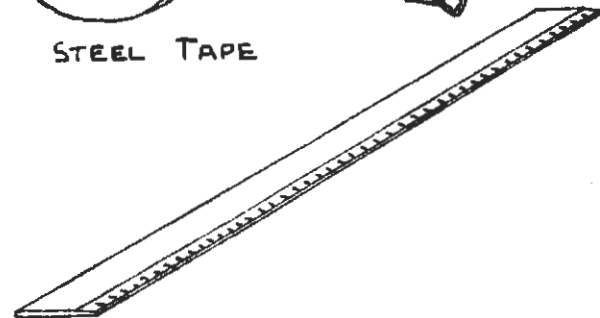
FOLDING RULE



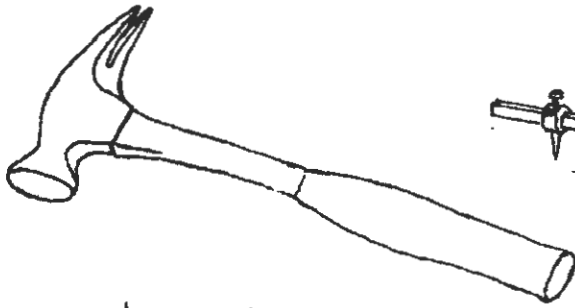
STEEL TAPE



FRENCH CHALK



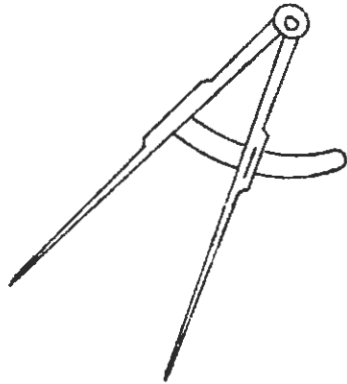
HEAVY STEEL RULE.



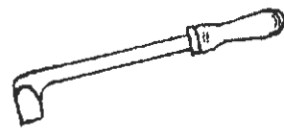
LOFT HAMMER



TRAMMEL



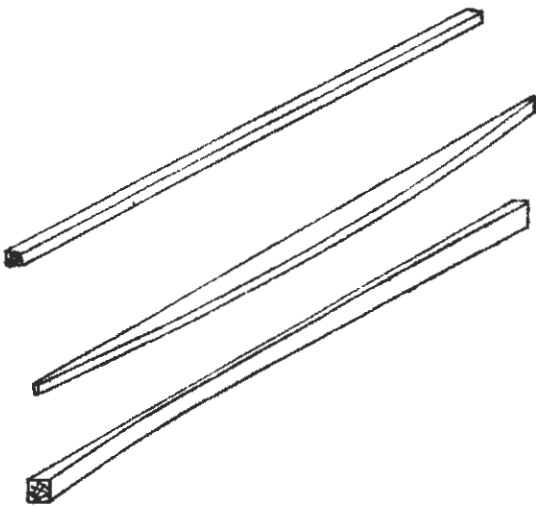
STEEL COMPASSES



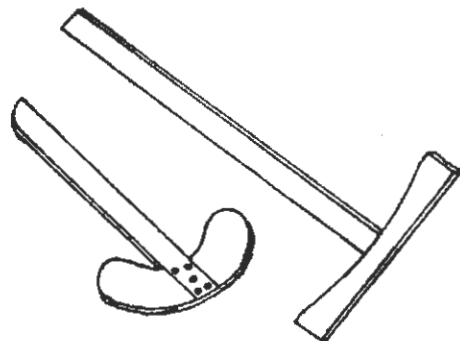
SCRIBE KNIFE



SCRIVER.



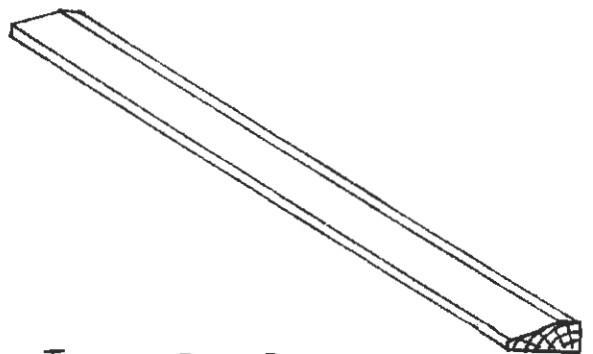
PINNING BATTENS (OF VARIOUS SHAPES) AND SIZES



TANGENT OR "T" SQUARE



CLINCHER



TAKING OFF BATTENS

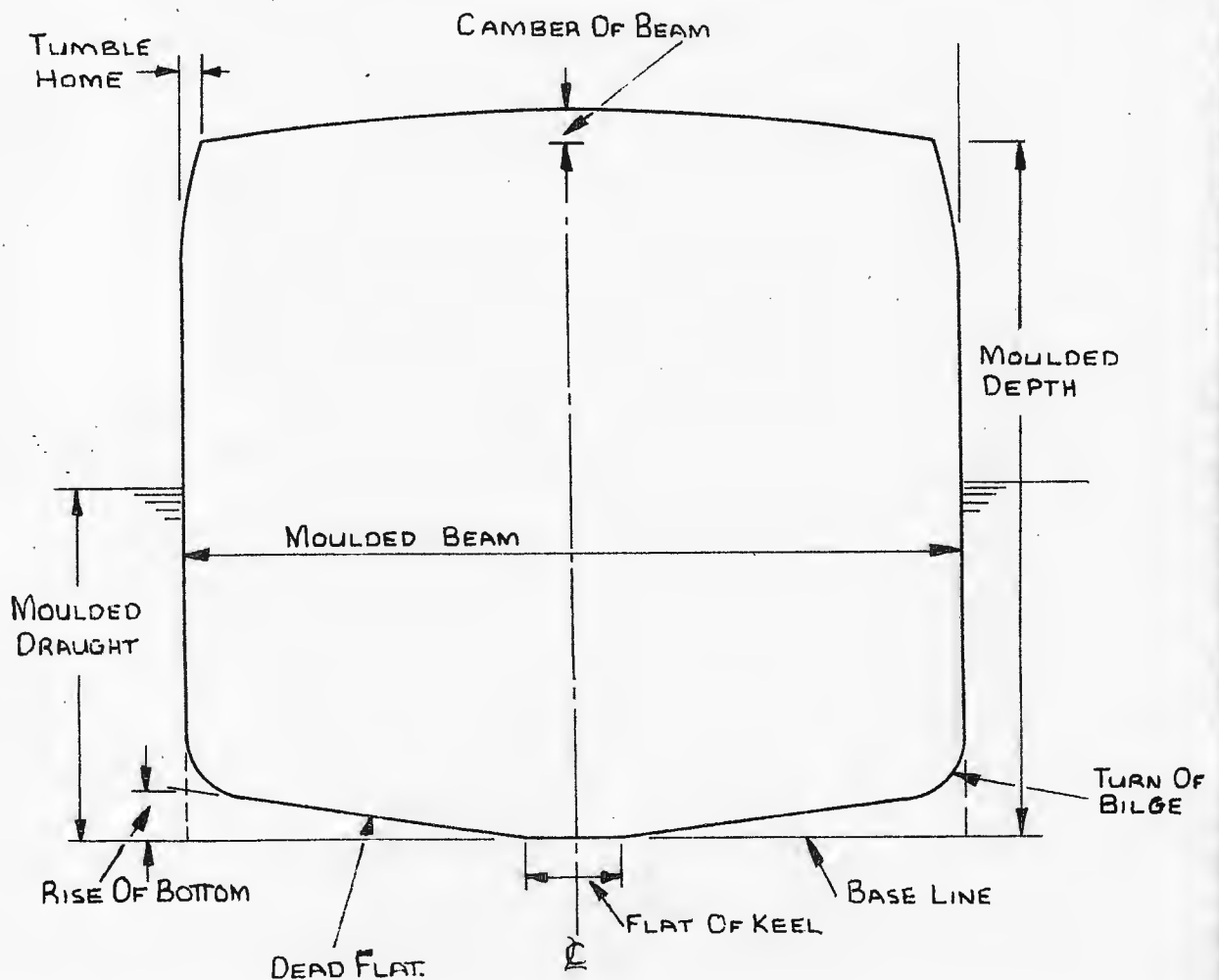
**FLARE:** is the opposite to tumble home, that is the fall out of the ship's side, seen in most vessels at the fore end.

**CAMBER OF BEAM:** The transverse curvature of the deck from the centreline down to the sides. This camber is used on exposed decks to drive water to the sides of the ship. Other decks are often cambered. Standard camber allowed in freeboard calculations is one fiftieth of the beam.

**SHEER:** The curvature of the deck in a fore and aft direction, rising from midships to a maximum at the ends. The sheer forward is usually twice that aft. Sheer on exposed decks makes a ship seaworthy by raising the deck at the fore and after ends further from the water and by reducing the volume of water coming on the deck.

**FORE FOOT:** is the part connecting the keel with the stern.

**CHANGE OF FRAMES:** The bosom of the fore body frames look toward midships and the after body frames do the same.





## TONNAGE DEFINITIONS

The amount of water displaced or put aside by a vessel is termed her displacement. The total weight of a vessel is equal to the total weight of the water displaced when the vessel is floating in still waters and is at rest. The tons displacement is equal to the under water volume of the vessel divided by 35 for salt water or 36 for fresh water.

### Gross Tonnage

Is the total capacity of the ship in cubic feet divided by one hundred. It should be noted that gross tonnage is a unit of volume and hence an expression of capacity. There are three main divisions, (1) the upper deck, (2) between decks, (3) deck houses and spaces on the upper deck.

### Net Tonnage

Is obtained from gross tonnage by deducting certain spaces from the gross tonnage. The principal deductions are crew spaces, navigating space and allowance for propelling power. Broadly speaking, net tonnage is gross tonnage less the non earnings capacity of the ship.

### Load draught

Is the maximum draught to which the vessel is allowed to sink and is dependant on the freeboard.

### Light Draught

Is the draught at which the vessel floats with steam up ready for sea but without stores, cargo, fuel, water, crew and their effects, passengers, luggage and provisions.

### Dead Weight Tonnage (D.W.T.)

Is the difference between light draught and load draught weight with fuel, passengers, stores, etc.

### Net Dead Weight Tonnage

Is the weight of cargo only.

### Cubic Capacity

This is given in grain or bale measurement.

### Grain Capacity

This is the maximum space available for cargo measured in cubic feet. The measurement being taken to the outside of the frames, (mould line of ship) and to the top of the deck beams. The grain is assumed to flow between the frames and to the top of the deck beams and occupies the maximum space available.

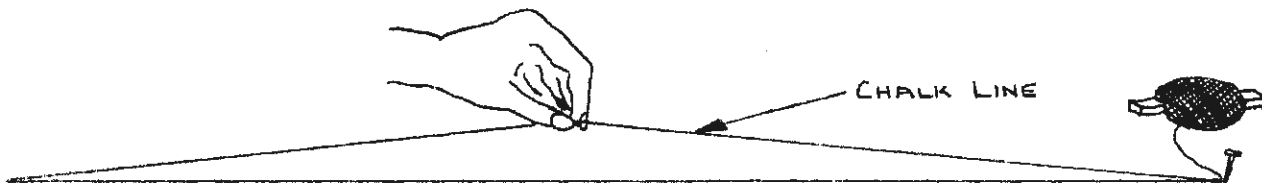
### Bale Capacity

Is the space available for cargo measured in cubic feet. The measurement being taken from the inside of the cargo battens on the frames and to the underside of the deck beams. This applies to a cargo of mixed commodities or when stowed comes into contact with cargo battens and as a rule does not extend to the shell plating.

## LINE WORK

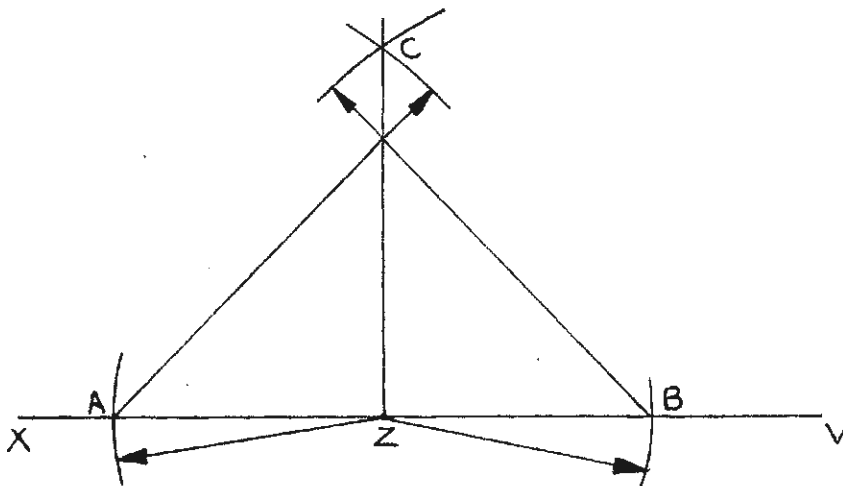
The importance of laying out the datum lines correctly cannot be overstressed, and meticulous care must be taken to ensure that measurements are exact and that square lines are truly square. If these lines are not set out exactly the ship may not be finished to the correct fair shape, and the structure may not align correctly.

**STRAIGHT LINES:** The usual method is to use a chalk line and this is essential if the line is a long one. To strike in a long straight line, the line (well chalked) is stretched tightly between the extreme points desired and raised above the floor at its center. The cord is suddenly released and allowed to snap down to the floor; the sudden impact jars loose the chalk particles adhering to the cord and a straight line is imprinted where it strikes. It is important that the cord be raised square off the floor, otherwise a slightly curved line is the result of its striking the floor at an angle.



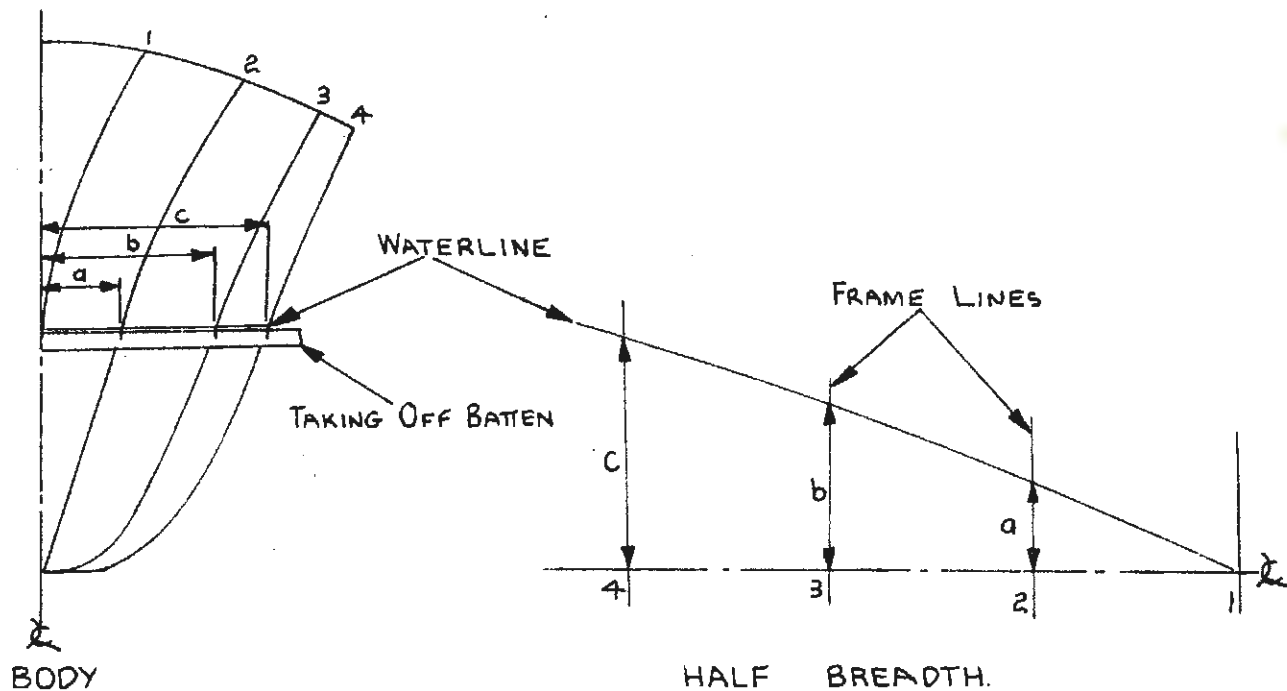
To draw a line square to another line. The method to be adopted should be as follows:

Suppose it is required to draw a straight line perpendicular to  $XV$  through the point  $Z$ . Mark off on each side of  $Z$  equal distances  $Z.A$  and  $Z.B$ . With  $A$  and  $B$  as centres respectively and at any convenient radius make small arcs at  $C$ . Then the line joining  $CZ$  will be perpendicular to  $XV$ .

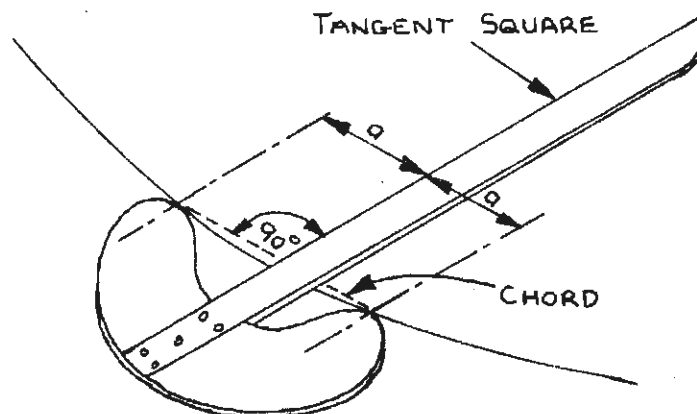




Distances are transferred from one part of the floor to another by using take off battens. They are either of flat triangular or of a square section.



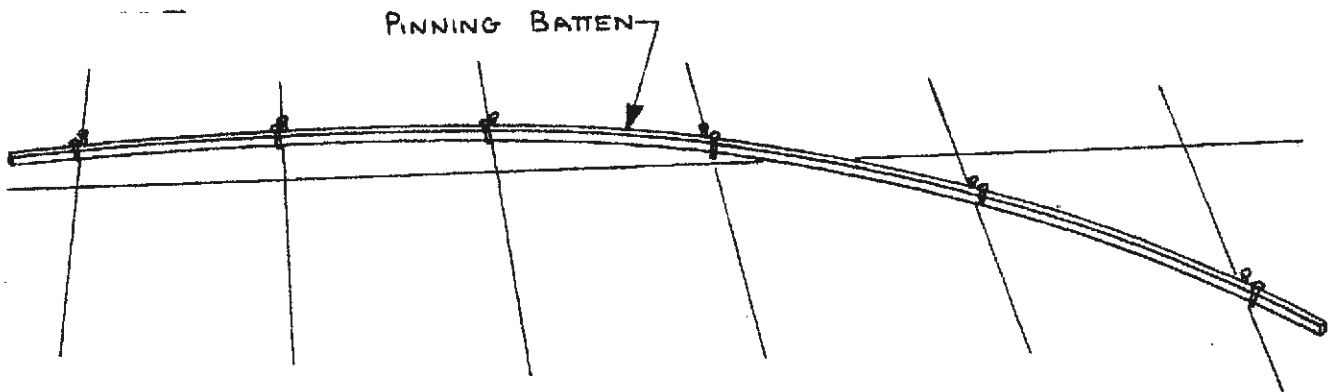
To draw a normal to a curved line a Tangent square is employed. The head is rounded terminating at two points which are equidistant from the drawing edge of the square. Therefore, by placing the square on a curved line the edge bisects and is normal to the chord joining the points where the head touches the curved line. The centre of curvature of the curved line will be in this normal.



**CURVED LINES:** Curved lines are drawn by pinning battens made of pine of rectangular section. They are of various size and lengths. There are three classes of pinning battens:

1. Parallel used for regular curves
2. Tapered at one end for curves of gradually increasing curvature
3. Tapered in the middle for curved lines which are desired to be drawn in one length, but which have a sharp curvature on the middle portion such as the sections of a ship near midships which are usually sharp at the bilges.

The battens are held in position to the required shape by means of floor pins nailed into the floor each side of the batten at convenient intervals. It is important to note when bending a batten that the lowest number of pins possible should be used in order that the batten may take up an easy natural curve. When the (natural) curve is satisfactory then extra pins may be added to stiffen the batten while marking in the line with french chalk. The pins should be placed in pairs each side of the batten. It is always desirable to use the stiffest batten that will take the curved desired as there is a better chance of fairness by this means.

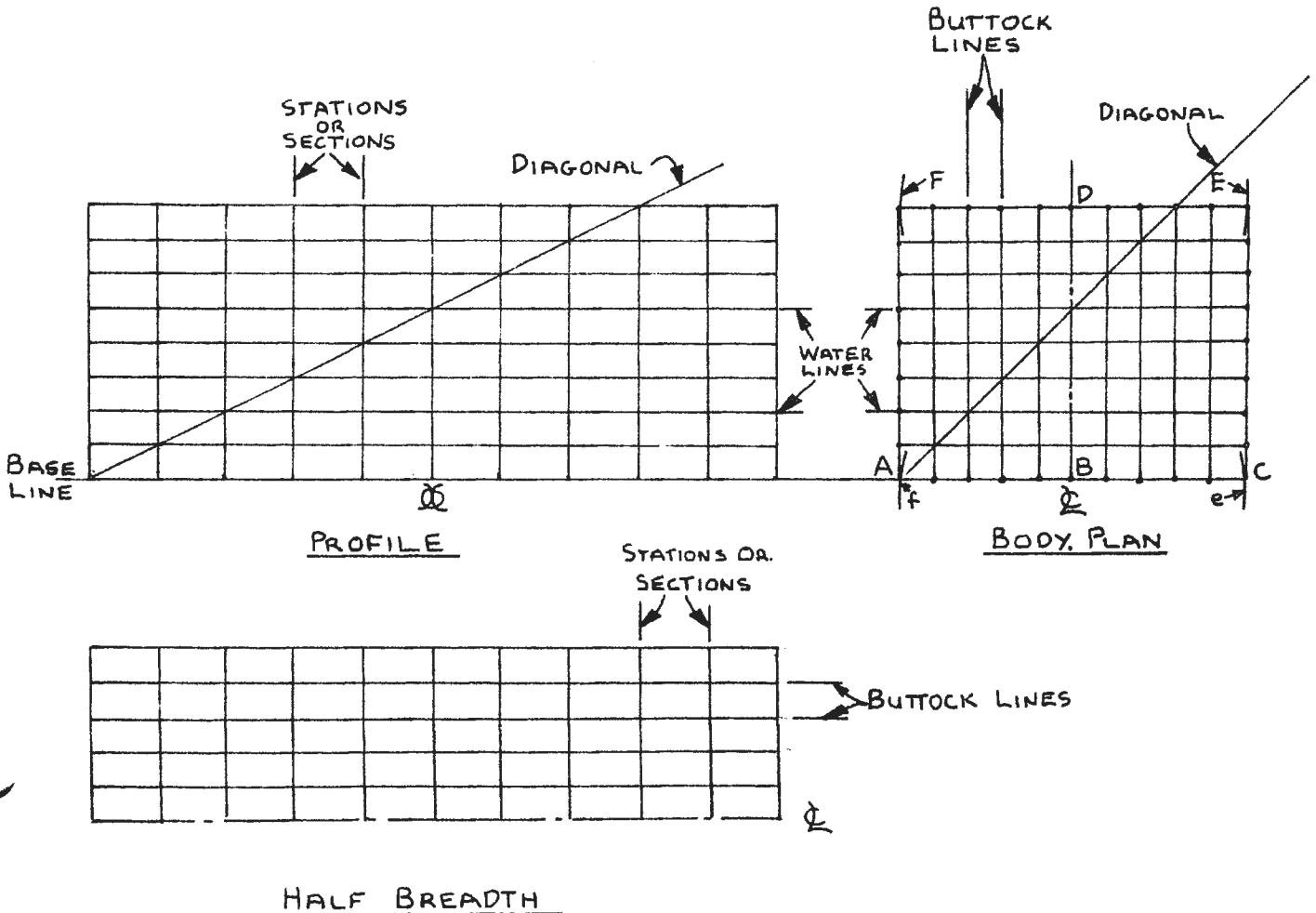


Trammels and Steel Compasses are used to draw curved lines which are arcs of large and small diameter circles respectively.

TO DRAW A LAYOUT GRID

In ship work where the offsets are given on waterlines and buttocks, it is necessary, before the curves of the profile, half breadth and the body plan are drawn, to prepare a grid of square lines for the offset dimensions. A perpendicular is first erected above the base line A-B-C at the point B which should be the centreline of the hull. At the point of greatest depth of the hull D on the centreline, arcs D-E and D-F are swept equal to the half beam. The same radius (B-e and B-f) is used to lay out the half beam on the base line. The beam lines on the extreme right and left sides of the grid are now drawn. The heights of the various waterlines are now laid off on the beam lines and the centreline. These are now connected with straight lines. The spacing of the buttocks is now laid off on the base line and the uppermost waterlines. These points connected by straight lines will give the buttock lines.

The grid can be checked by laying a diagonal line across the intersections of the waterlines and buttocks and, provided that they are of equal spacing, the diagonal line will exactly cross every intersection. When the waterlines and buttocks are not of the same spacing, but are equally spaced in each system, the diagonal will still cross every intersection. The grid for the longitudinal layout can be drawn in a similar manner, using the midship frame for the centreline and the fore and after perpendiculars in the same way that the half beams were used. The station or frame spacing is laid out according to the figures given on the lines plan for these ordinates.



## DEFINITIONS (LINES PLAN)

**BASE LINE:** A horizontal line set underneath the profile, sheer, drawing.

**WATER LINES:** Are horizontal planes parallel to the base line and at given intervals.

**STATIONS OR SECTIONS:** Are vertical planes erected from the base line at convenient intervals (usually LWL) which cut the vessel transversely.

10

**BUTTOCK LINES:** Are the vertical planes parallel to the centre line.

**DIAGONALS:** Are longitudinal planes set at an angle other than  $90^{\circ}$  to the centre line intersect as many sections as is possible. These lines are mainly used for checking the fairness of the design.

## LAYING OFF THE SHEER DRAUGHT

## ON THE LOFT FLOOR

THE TERM LAYING OFF is used to express the method adopted for laying off the vessel to full size on the loft floor. The drawings from which the particulars are taken for laying off the vessel on the loft floor is the Sheer Draught which is composed of three plans, the Profile or Sheer, the Half-breadth Plan and the Body Plan, showing the moulded form of the vessel, that is the form to the outside, heel, of the steel frames.

THE PROFILE: Usually called the sheer is a longitudinal elevation with the stern placed on the right hand side. It shows the sheer of the rail, knuckle and decks at side, the position of the frame stations or sections, the level of water lines, the form of the ship at the centre line and at fixed longitudinal vertical planes, parallel to the centre line, called bow or buttock lines.

THE HALF BREADTHS: Made for the Port side only represents the form of the rail, knuckle and deck in plan, the longitudinal horizontal shape of equidistant parallel planes from the top of the keel to an assumed load line, also the position of the frame stations, the buttocks and bow lines.

THE BODY PLAN: Is the shape of the vessel at transverse vertical planes at different frame stations in length, taken square to the keel and centre line upon which is also indicated the deck, rail and knuckle (if any). In the case of yachts warships and other craft with a fixed trim the frames are usually made square to the load line. These sections show the shape of the vessel for one side only. Those which come aft of the midship section being shown on the left hand side of the centre line and those forward on the right hand side.

LINES	IN PROFILE	HALF-BREADTH	BODY PLAN
RAIL	CURVED	CURVED	CURVED
KNUCKLE	CURVED	CURVED	CURVED
DECK	CURVED	CURVED	CURVED
WATER-LINE	STRAIGHT	CURVED	STRAIGHT
BUTTOCK LINE	CURVED	STRAIGHT	STRAIGHT
DIAGONAL	CURVED	CURVED	CURVED
FRAME STATIONS	STRAIGHT	STRAIGHT	CURVED

## FAIRING SHIPS LINES

The Lines Plan as supplied by the Drawing Office is drawn to a small scale so that even the thickness of an line may represent 25 mm or more full size depending on the size of the ship and the scale used in the Lines Plan. This means that although the Lines Plan may appear fair at its small scale when it is translated to full size, it will prove to be unfair. Before the ship can be laid off, it is therefore necessary to "fair the lines" full scale, and hence ensure that the hull surface is smooth.

As ships are usually too large to allow the setting out to be done in separate Plans as in the Lines Plan, it is usual to combine the Half-Breadth Plan and Shear on a common base line, so that they are superimposed.

**DATUM LINES:** The first step is to put in the base line for the combined Half Breadth and Sheer parallel and about 300 mm from the base board on one side of the loft: waterlines and buttocks are then placed parallel to this line.

Frame lines are then drawn square to these by means of a trammel. The datum lines for the body may be drawn in the desired position using the same methods.

**BODY PLAN:** Now using the half-breadths of "offsets" given in the Loft Book, supplied by the Drawing Office with the Lines Plan, the Body Plan can be drawn.

From the Loft Book, offsets of the frame considered can be read off at each waterline and measured along the corresponding waterline in the Body on the floor; the deck edge position at this frame can also be read from the Book and put in. Heights above the base line where the frame crosses the buttocks are also put in; a wood batten is then pinned round the curve and the frame shape drawn in with French chalk.

This procedure is followed with the remaining frames in the fore and after bodies. In practice, waterlines and buttocks about 600 mm apart might well be used for the larger type of vessel.

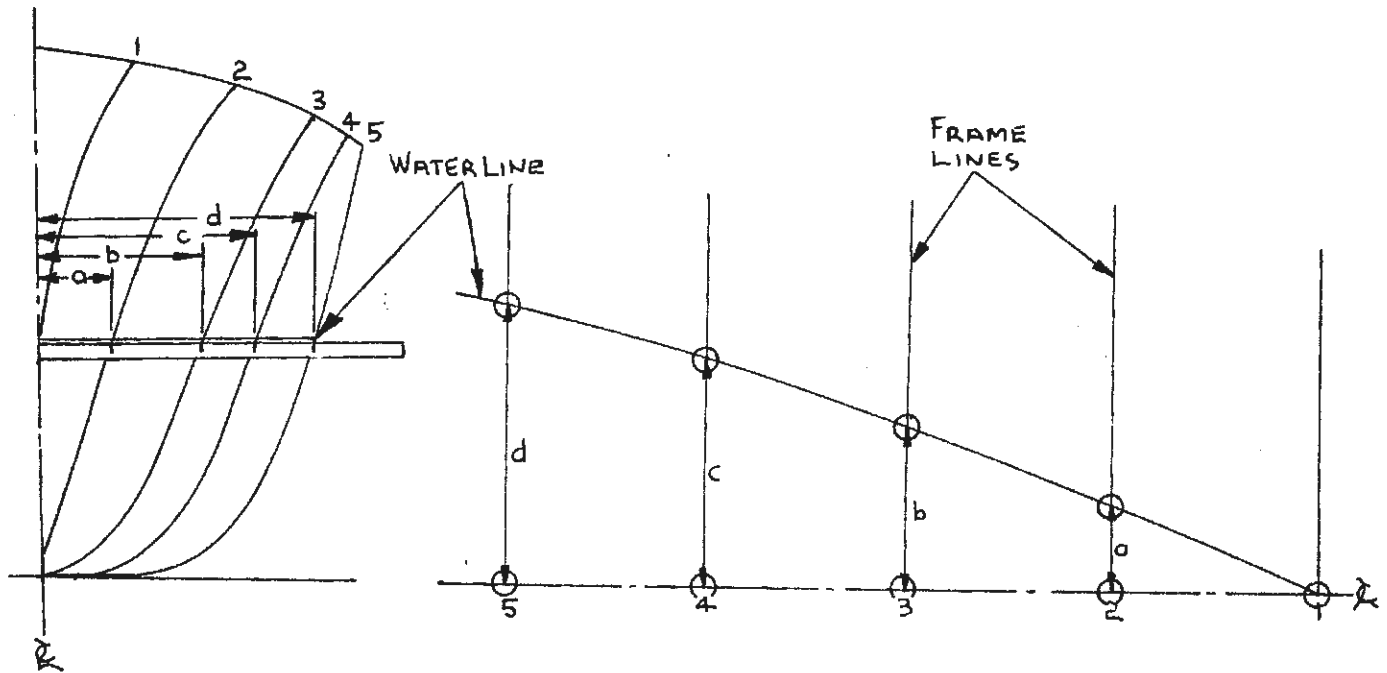
The deck at side can now be drawn in and the frame will run into the rise-of-floor at the bottom.

**THE SHEER:** The operation is to put in the outline of the centreline plane of the hull on the sheer, using contours of stem and stern and deck sheer as supplied in the Loft Book.

## SETTING THE WATERLINE

The shape of the waterline may now be transferred from the Body Plan to the Half Breadth. The principle of this is illustrated in the figure below which shows frame lines (full lines in the Body) near the forward end of a vessel and a waterline.





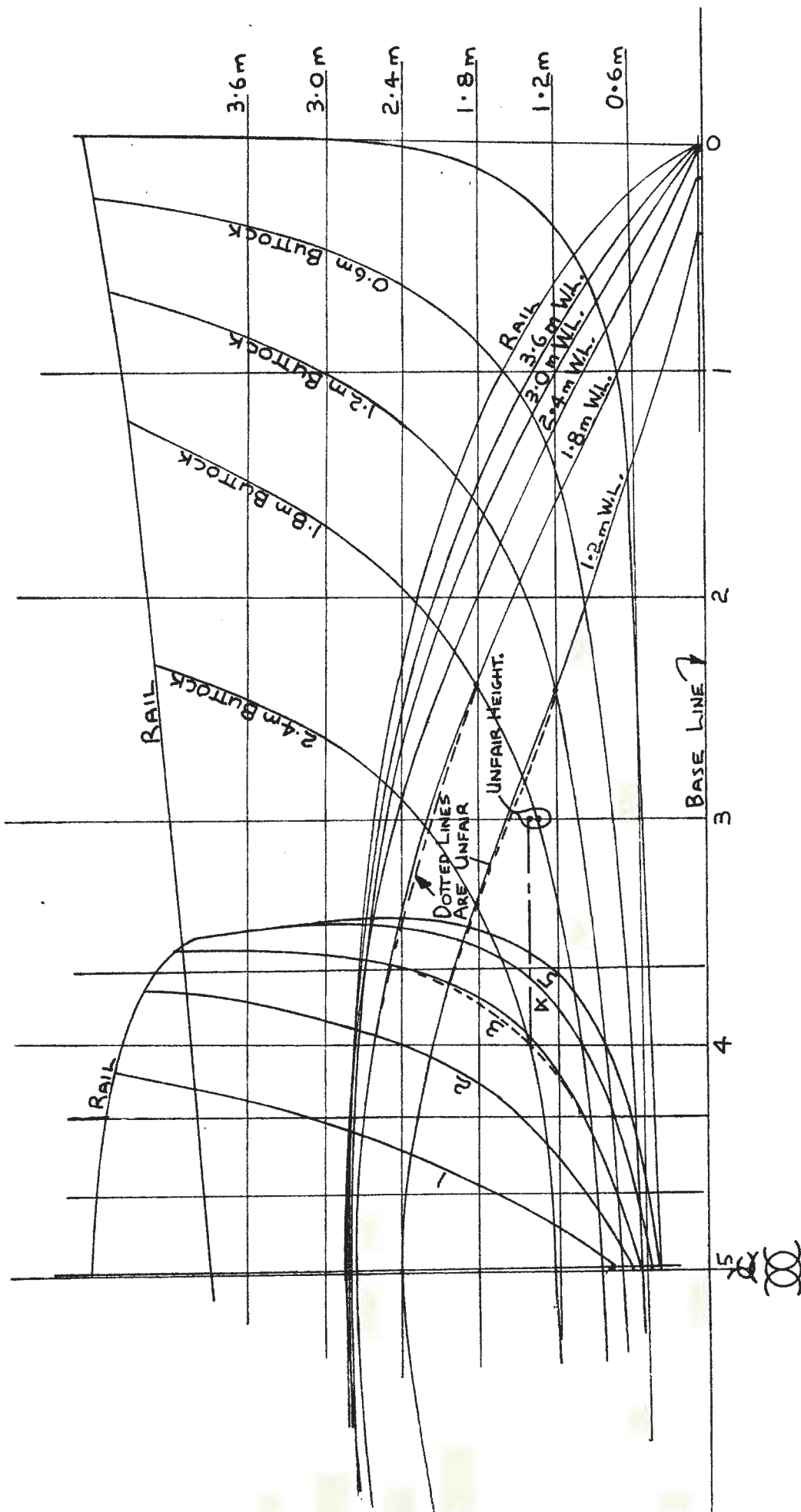
A batten is laid along the waterline in the Body and distances a, b, c, d etc marked on it as shown. These offsets are now transferred to the appropriate frames in the Half Breadth marked by circled points. A batten is now pinned round the curve so formed, and the waterline drawn in with French Chalk; the batten follows a fair curve without bumps and allows a curve to be drawn in through as many points as possible, and it is important that the curve of the batten is "sighted" by the loftsman to ensure that it is a fair curve with no sudden discontinuities.

As so often happens at this stage, it can be seen that, at frame 3, the point transferred from the Body is inside the fair curve, indicating that the offsets sent from the Drawing Office may be wrong at that frame; the distance b is therefore lifted from the Half Breadth and transferred back to the body. Other waterlines are transferred similarly, and if the fair waterlines show a similar trend at frame 3 then the revised frame line may be drawn in as shown by the broken line.

In many cases it will be necessary to change both some waterlines and some frame lines in order to ensure that the offsets "marry up" in Body and Half Breadth. This process marks the first stage in "fairing the lines".

#### FAIRING THE BUTTOCKS

When the waterlines and frames are fair, the buttocks may be drawn on the Sheer by transferring the heights above the base line at which they cross the frames in the Body, in the same manner as for the waterlines. The fairing process must now be repeated taking into account frames, waterlines and buttocks; it will be appreciated that the buttocks must cross waterlines in the same longitudinal position on both Half Breadth and Sheer, in addition to their heights of crossing the frames being correct.



Let us assume, for instance, that the spot off on frame 3 for the 1.8 metre buttock, as measured from the body plan cannot be made to fair. We would also note that the intersection of this buttock with the 1.2 metre waterline will not exactly make a fair curve. In this case the batten is allowed to run fair, and frame 3 in the Body Plan is altered to allow the buttock to run fair in the Profile. Now we note that there appears to be unfair spots in the waterlines in the proximity of this frame so the 1.2 metre and 1.8 metre waterlines are also altered from the new frame line in the Body Plan to make all lines come fair.

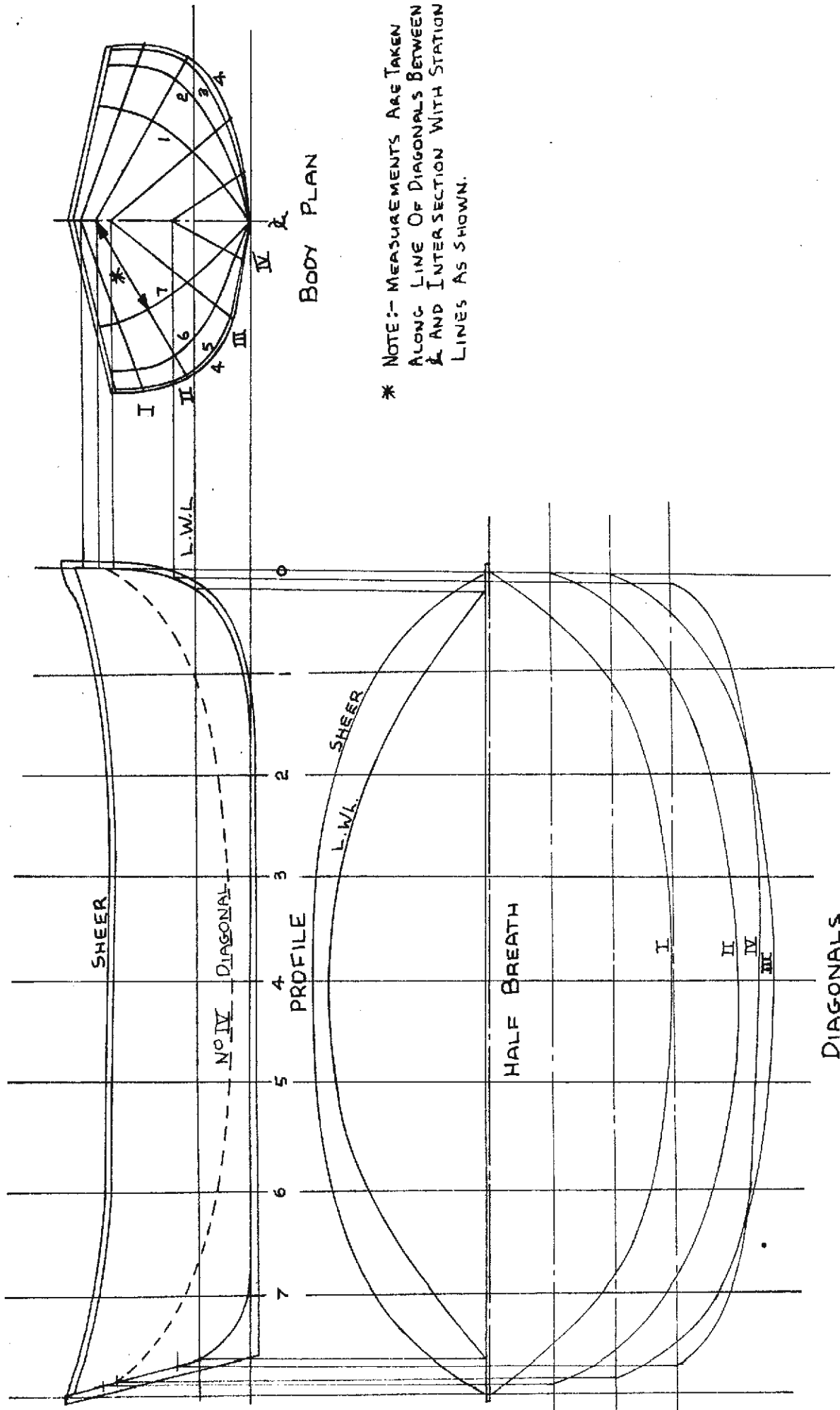
The dotted lines show the effect of the unfair spot in the height of the buttock. The full lines are fair. While the sketch only shows the forebody lines, the after lines are treated in a similar manner. Where it is only possible to lay down half the length of the ship on the floor the overlap of the lines fore and aft should encompass several frames.

#### THE DIAGONALS

The fairing is completed by the setting out of one or several diagonals, to ensure that the sharp bilge curvature of the frames is correct; because of the very sharp and changing curvature in this region, waterlines and buttocks alone may miss an important unfairness, but diagonals ensure complete coverage.

The endings of the diagonals in the Half Breadth are determined by the intersection of their heights on the centreline of the boat in the Body Plan. The heights are projected from the body plan to the profile, and where they meet the slope of the ends of the boat, they are projected down to the Half Breadth.

The offsets for the diagonals in the Half Breadth are measured from the body plan along the run of the diagonal. These are now laid out in the Half Breadth in the same manner that waterlines would be. It is often necessary to lay each diagonal off on a separate datum to keep the diagonals from overlapping. The diagonals must be fair in the Half Breadth and Sheer, passing through all points; if as sometimes happens, the diagonal is not fair, then small adjustments must be made to the lines until fairness is obtained.



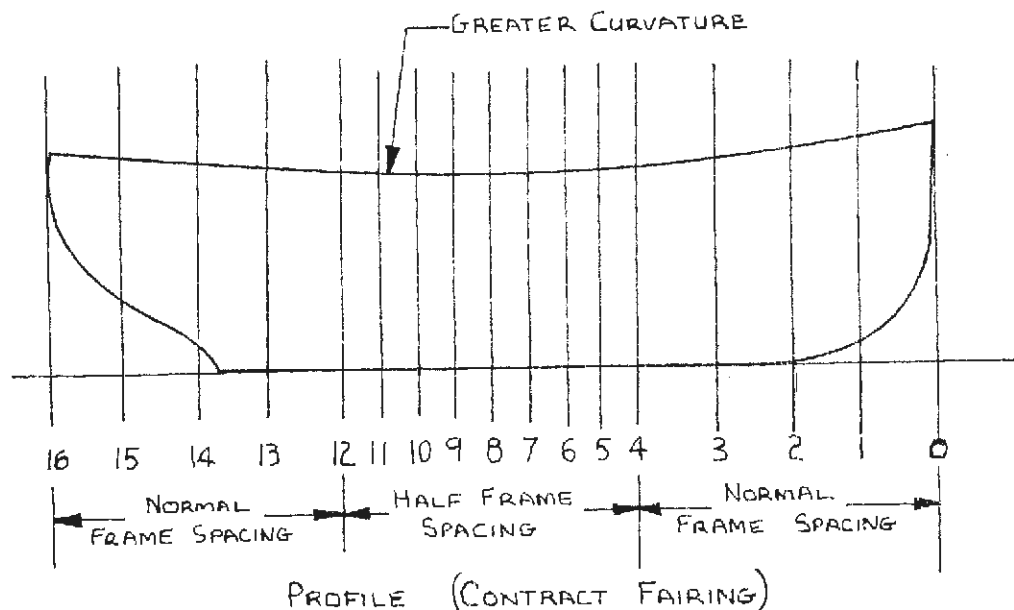
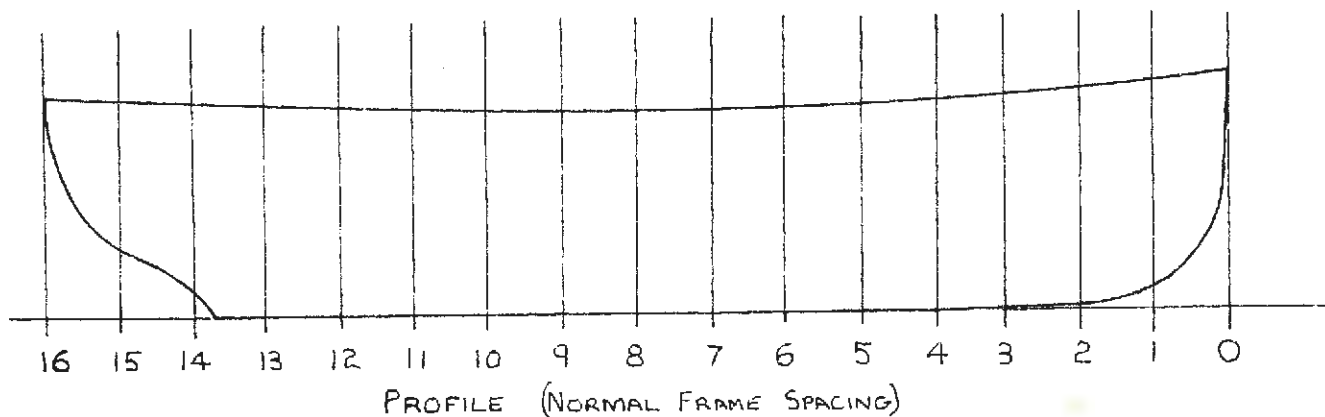
## CONTRACTED FAIRING

In order to ensure that a batten is fair when pinned round points marked on the floor, it must have a reasonable amount of curvature; this is difficult to achieve in the amidships region of the ship, as most of the waterlines and buttocks are practically straight lines.

These lines can be given greater curvature by reducing the spacing of the frames in the Half Breadth and Profile, over much of the vessel's length to a half or a quarter of the actual. As the buttock crossings, heights and offsets are maintained full size, the actual fairing process is correct, but the waterlines and buttocks are given greater curvature so that a batten pinned around them is more likely to set a fair curve.

If the reduced spacing is adopted, it is usual to lay out the fore and after ends of the ship separately, due to the large natural curvature in these parts and in order to provide information on the true shape of these regions needed in later work.

This whole process is known as "contracted fairing" and it also has the advantage that one batten can cover a greater length of each curve, so saving time in ensuring that the joining of the lines is correct and fair. In addition larger vessels can be set out in the Loft than would otherwise be possible and due to the working area being reduced, less time and effort is wasted by the loftsmen being forced to walk considerable distances in order to transfer measurements.



## MOULDS

After the ship is faired up on the loft floor wood moulds or templates are made and supplied for constructing many of the parts.

Owing to the close accuracy required in warships they are more numerous than in merchant work. It is scarcely possible to state all the moulds, for every vessel will create its own necessity; but the following are some of the principal named in order of sending out:

1. Flat Keel Plate
2. Vertical Centre Keelson
3. Stern and Stern Posts
4. Stern tubes and struts in twin screws
5. Beam camber
6. Longitudinals and Armour Shell
7. Protective Deck and Stringers
8. Backing Plating
9. Belt Deck
10. Barbette or Redoubts
11. Gun Galleries
12. Conning Tower
13. Pilot Bridge
14. Boat Davits and Chocks.

## TEMPLATES OR PATTERNS THAT ARE MADE FOR BOATWORK

Set of moulds for the stations required. Stern template, Transom template, Apron, Forward Deadwood, Stern knee, Shape of Keel.

Templates for sawn frames "if any" with the various bevel spots marked on them.

All templates must be clearly marked with all identifying lines scribed.

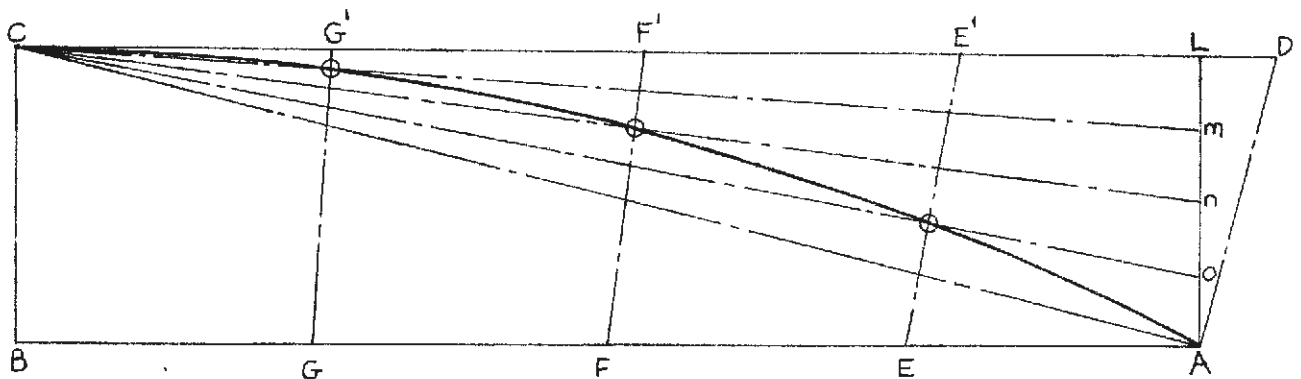


## DECK CAMBER

Two pieces of work remain to be completed before preparation of the Scribe Boards can begin, the first being to lay off the "camber" or "round of deck" which is worked at the upper deck. The amount of camber (transverse curvature of the deck) varies according to the vessel's breadth, and usually takes the form of a circular arc; it is defined as the amount by which the deck at centreline lies above the deck at the ship's side, and common amounts for merchant vessels are 6 mm per 300 mm of Moulded Breadth or 1/50 of the Breadth Moulded.

A number of methods are in common use to lay off the shape of this circular arc, and three of these are given here. The first two methods construct the camber on one side of the centreline, so saving floor space and enabling shorter battens to be used. The third method, which draws the whole curve for both sides of the centreline, involves less work when building the Camber Mould.

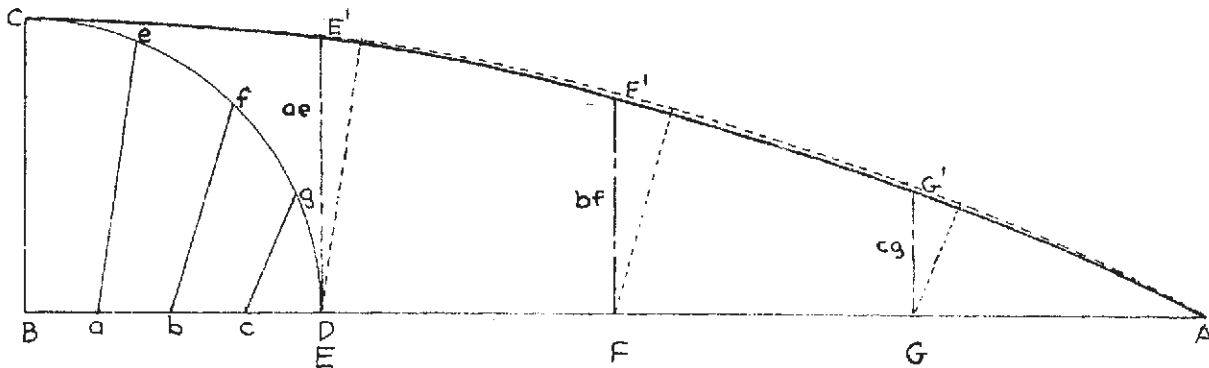
## METHOD 1



1. Let AB equal half the Moulded Breadth of the ship at the deck on the midship frame.
2. Set up perpendicular BC equal to the required camber.
3. Join C to A and erect AD perpendicular to CA at point A.
4. Draw AL perpendicular to AB at point A and equal to BC. Produce CL to D.
5. Divide AB into say four equal parts with the points E, F, G.
6. Divide CD into the same number of equal parts with the points E', F', G'.
7. Join EE', FF', GG' by straight lines.
8. Divide AL into the same number of equal parts, as AB and CD with the points M, N, O.
9. Join M, N, O to C.
10. The points on the camber curve shown ringed are given where CM cuts GG', CN cuts FF', CO cuts EE'; the points C and A are the end points of the curve.  
Repeat process for the other side.

In the sketch, four divisions have been used so that the picture is not confused; in practice more points would be taken, the number depending on the vessel's beam.

## METHOD 2



(a) Solid Lines

1. Let AB equal half the Moulded Breadth of the ship at the deck on the midship frame.
2. Set up perpendicular BC equal to the required camber.
3. Describe from B a quadrant of a circle with BC as the radius to cut AB and D.
4. Divide DB into say four equal parts with the points a, b, c and the arc CD into the same number of equal parts e, f, g.
5. Join ae, bf, cg.
6. Divide AB into four equal parts with the points E, F, G. Erect perpendiculars to AB at these points.
7. Using the lengths under the arc step off along perpendiculars ae on E, bf on F and cg on G to give point E', F' and G' in the camber curve.
8. Using point A and C as the end points draw a curve through E', F' and G'.  
Repeat process for the other side.

This method is regarded as only approximate but it is very near the truth and because of its simplicity is often used on the Loft Floor.

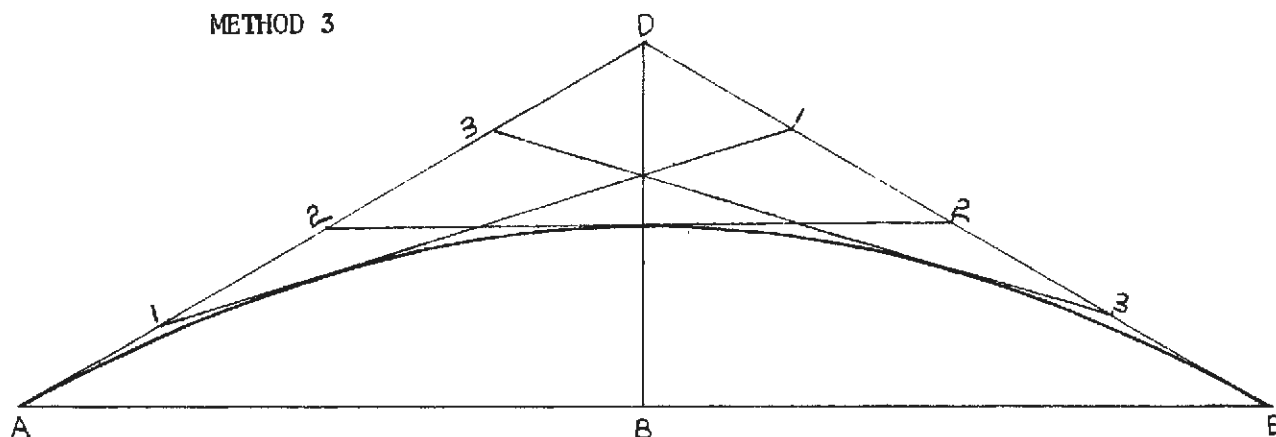
## (b) Broken Lines.

Steps 1 to 5 inclusive are the same as for (a).

6. Divide AB into four equal parts with points E, F, G.
7. Draw lines parallel to lines ae at E, bf at F and cg at G.
8. Using lengths under the arc step off distances ae on E, bf on F and cg on G. to give points on the camber curve.

This variation of method 2 is more accurate than the one given above but is by past for the simpler method in practical circumstances.

## METHOD 3



In this case the whole camber curve is drawn.

1. Point B is the vessel's centreline, draw AE equal to the Moulded Breadth of the ship at the deck on the midship frame.
2. At B erect a perpendicular BD equal to twice the camber.
3. Join D to A and E.
4. Divide DA and DE into a number of equal parts, four shown.
5. The points are number 1, 2, 3 from A to D and 1, 2, 3 from D to E.
6. Join the points of the same number together to give the lines 1-1, 2-2, 3-3; these lines are tangents to the round of the beam curve ACE, which is drawn in by a batten pinned so that it touches all the lines.

In the sketch only a small number of tangents have been shown in order to avoid confusion; in practice DA and DE would be divided into a large number of parts and when the points are joined the camber curve will be seen to 'form itself.'

## CAMBER MOULD

For much of the work in the Mould Loft it is necessary to use the camber curve and a mould is therefore constructed to its shape from timber. The centre-line of the camber and a horizontal datum line are scribed on the mould to enable the curve to be lined up easily.

The first use of the camber mould is for fairing the deck at centre and deck at side lines in the Sheer and the Body. As the width of the deck varies in the vessels length, the amount by which the deck at centre is above the deck at side will vary until at each end of the ship the lines will run into a common point.

## SCRIEVE BOARD

The Scrieve board consists of a large pointed floor on which is copied the complete Body plan both sides for the fore and after bodies. The lines are cut in with a "Scrieve knife" so that they become permanent and will not be obscured through use and dirt.

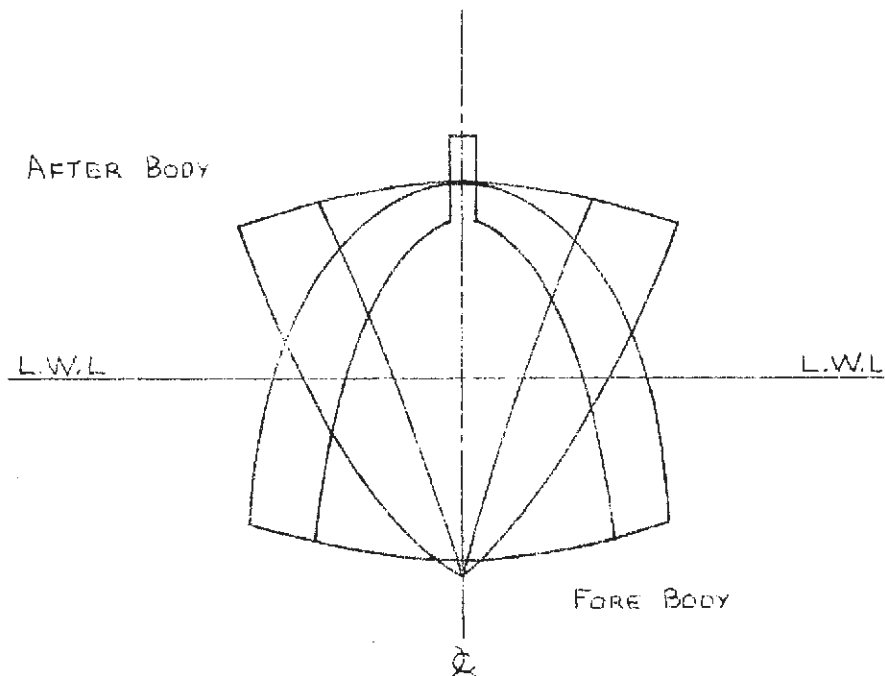
The Scrieve Boards are made up of a number of sheets of 12 mm plywood which, when laid out cover adequately the area of the body plan.

Unless there is room for two complete body plan (and there rarely is) overlapping must occur. The figure below gives one method of doing this which has considerable merit, the same centreline is used for both bodies and also the same LWL (load waterline). The after body is placed inverted to the fore body and the places where congestion occurs (viz, at the floors on the lower frame) are well separated and these are in places where comparatively few other lines cross the work.

## INFORMATION PLACED ON THE SCRIEVE BOARD

The moulded shape of every frame, floor and tank knee. The position of the frames of all decks, platforms, shell plate edges, keelsons, keels, ribbons, side stringers and girders, all fore and aft bulkheads, traces of bilge keels, stern cants and propeller boss.

ITS PURPOSE: is that every frame, reverse frame, floor and beam, may be turned to their proper shape, punched and marked for receiving the other parts of the structure.



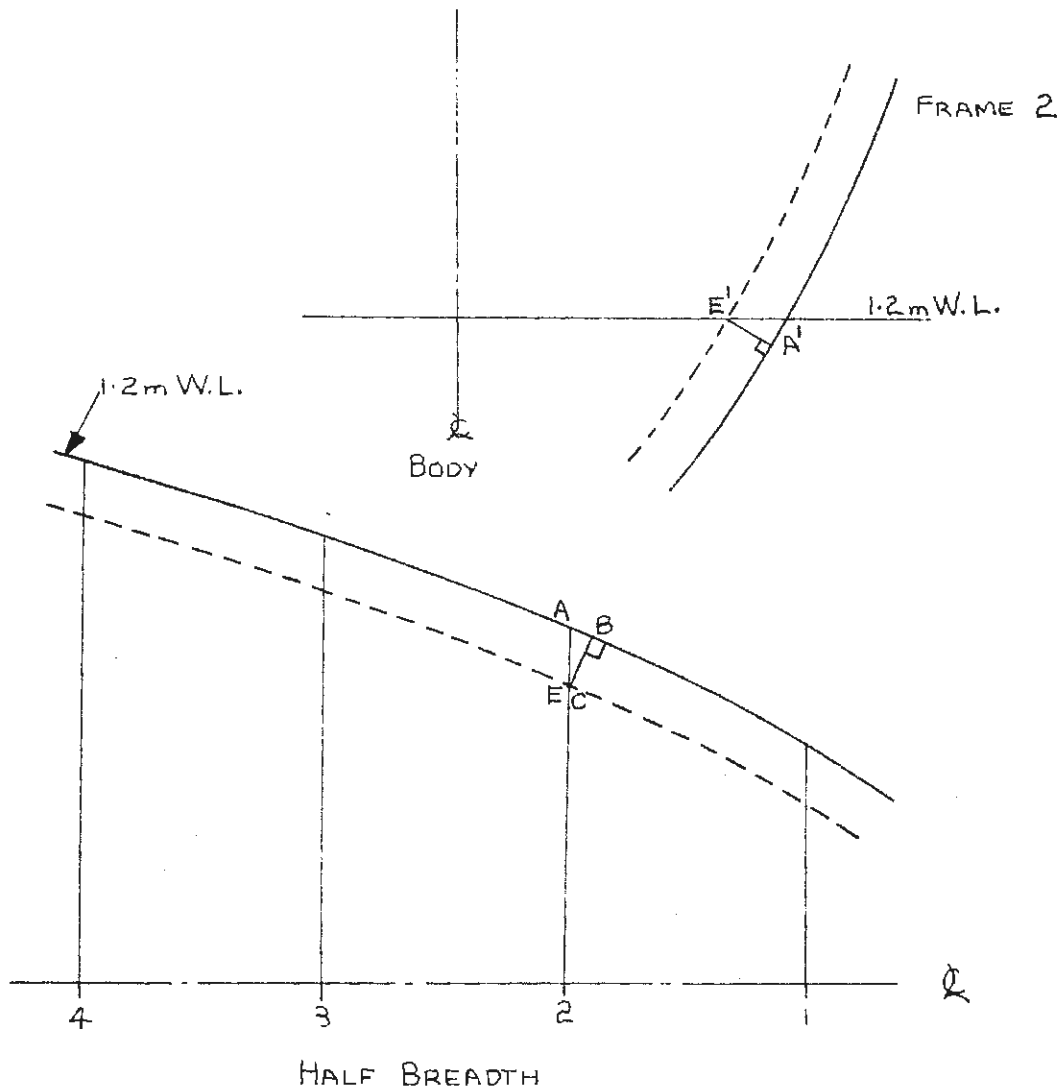
## TAKING OFF THE PLANK

With a Sheathed or Composite ship the Sheer drawing is drawn to the outside surface and it is necessary in order to obtain the moulded surface to "take off" the plank.

Forward and aft of amidships a normal to the ship's surface will generally not be either in a level or transverse plane. To "take off the plank" accurately is a problem of some difficulty. The following approximate method is found to be sufficiently accurate:

Let the waterline and frame be as in the sketch below.

1. Square in from the run of the waterline BC (equal to the thickness of planking) to cut the frame at E.
2. Take AE to the body and square in to the run of the frame to obtain the point E'.
3. A line through all such points as E will give approximately the moulded waterline shown as the dotted line.
4. A line through all such points as E' will give approximately the moulded breadth of the frames shown as the dotted line. Where outside of planking intersects half siding of the stern describe a circle of radius equal to thickness of planking. Then draw a tangent inside of planking to cut circle.

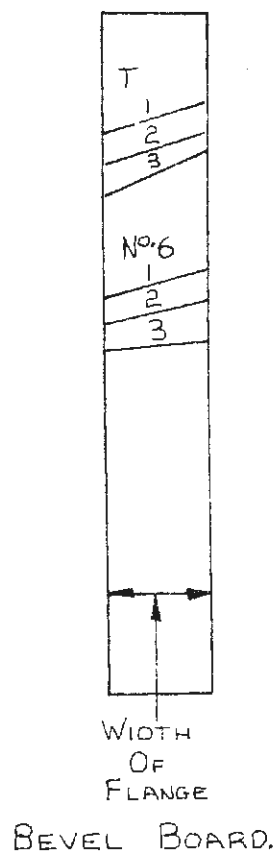






A bevel board is made of soft wood 1 metre to 1½ metre long and of a width equal to the flange of the frame.

The bevel board is placed behind the moveable arm of the wooden machine. The front edge of the moveable leg is moved to the distance between the scribes given above and a line drawn across the board and numbered. This mark gives the distance the bar has to be opened from the heel to the top, or the angle of opening "a". The process is repeated until the bevels on all the frames are lifted.



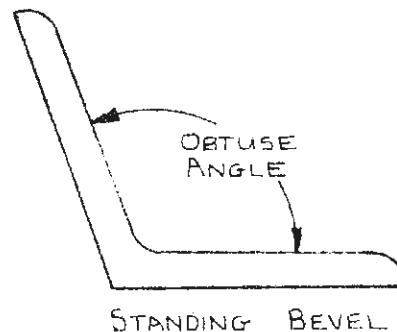
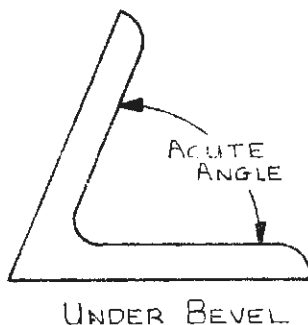
## METHOD OF LIFTING A BEVEL FOR A FRAME OR FLOOR

Take a piece of timber, cardboard or plywood about two frame spaces long and about 300 mm wide. Down the centre of this strike a base line the length of the board then erect perpendiculars to this at three points measured off to equal the spacing of three frames, edge to edge or centre line to centre line. Extend these perpendiculars across the board. Mark the middle perpendicular, with the frame number whose bevels are required.

Turn to this particular frame on the Loft Body plan and make marks on its outline, which are spaced to give the desired number of bevel points on the frame.

Lay a rule on one of these marks, laying the rule as nearly at right angles as possible to the frame outline at the marked point and noting the exact measurements to the intersection of the rule with the frames on each side of the chosen one.

Now take notice of the chosen station in regards to the position of it to the side of the boat, that is, which way the bevel must slope. If the bevel formed is an acute angle, it is an under bevel, if an obtuse angle it is a standing bevel. Bevels are always taken from the side of the frame that has been represented in the body plan.



Now take the board and set off the distances measured on the body plan from the chosen frame to the adjoining ones on either side of the middle perpendicular (which represents the chosen frame), one dimension will be above the base line and the other below, according to which way the bevel stands.

A line is now drawn with a batten from the measurement on one perpendicular to the other with the line passing through the point of intersection of the base line with the perpendicular representing the chosen frame. This line is usually straight but may be curved if necessary to pass through the three points.

To illustrate suppose that three frames or floor timbers are taken as examples A, B and C. These are in the forebody and C is the farthest forward, B is the frame on which the bevels are required.

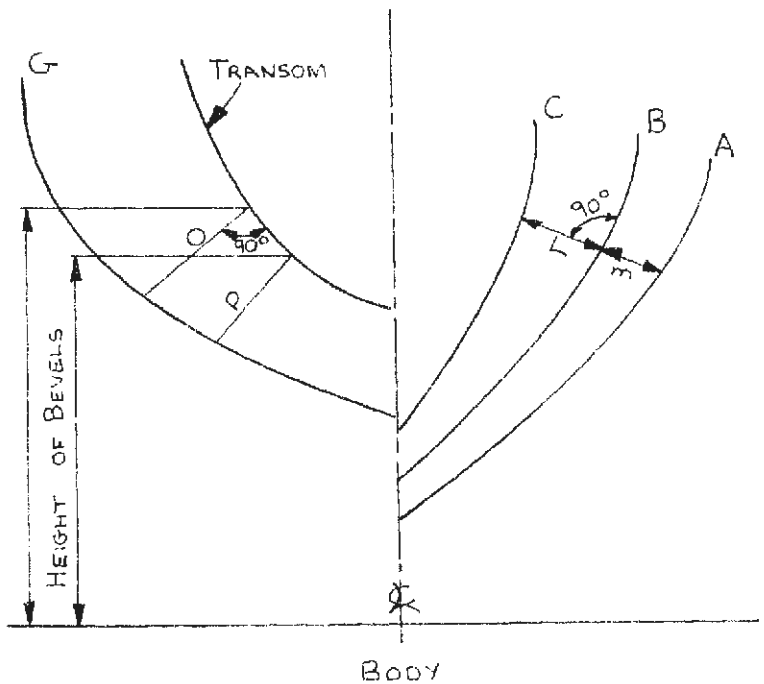
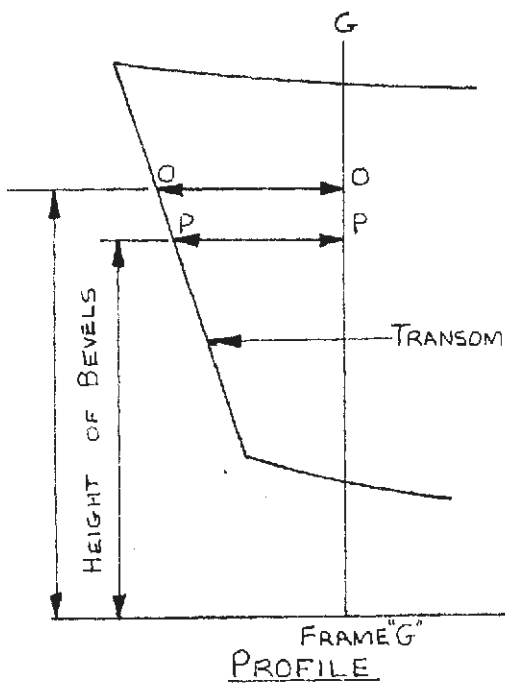
The bevels board has been laid out and the perpendiculars representing the frames drawn.

The bevel points on B are marked in the Body plan and the measurements to the frames adjoining (A and C) have been there, for one bevel mark. It is found that B in the Body plan is the after face of the frame, which will make the bevels "under" since the forward face must be smaller due to the run of the sides of the hull towards the bow.

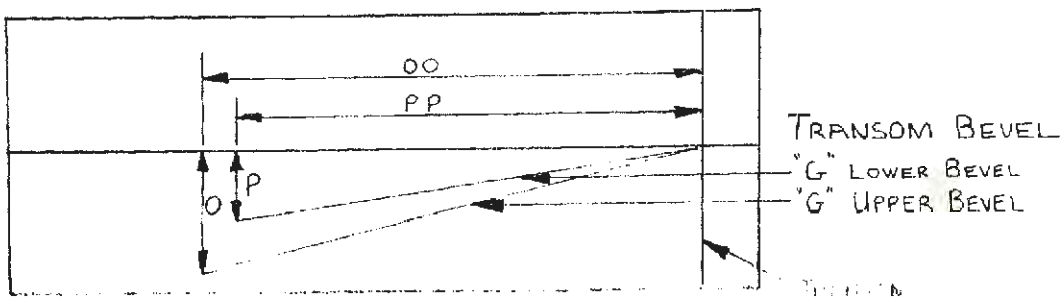
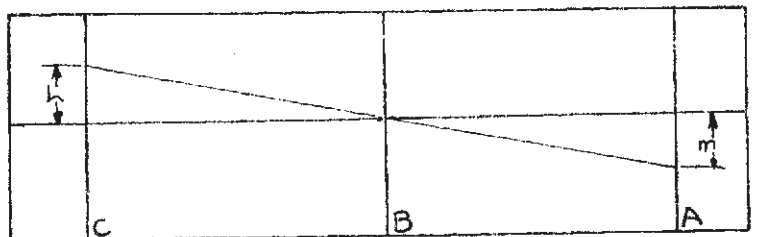
Therefore, the measurement on "C" on the bevel board will be taken above the base line and that on "A" below. Since "B" is the face from which the bevels are set off, strike in the forward side of the frame.

Now the bevel line is drawn from "A" through "B" to "C". From this board then, can be measured the amount of timber to be cut from Frame "B" on its forward edge to get the proper bevel at that particular spot.

The bevels for the transom may be taken in the same way but the spacing of the perpendiculars of the bevel board must vary with each mark plotted when the transom rakes or curves. The reason for this is the variation in distance between the transom and after frame.



FRAME BEVELS STATION "B"



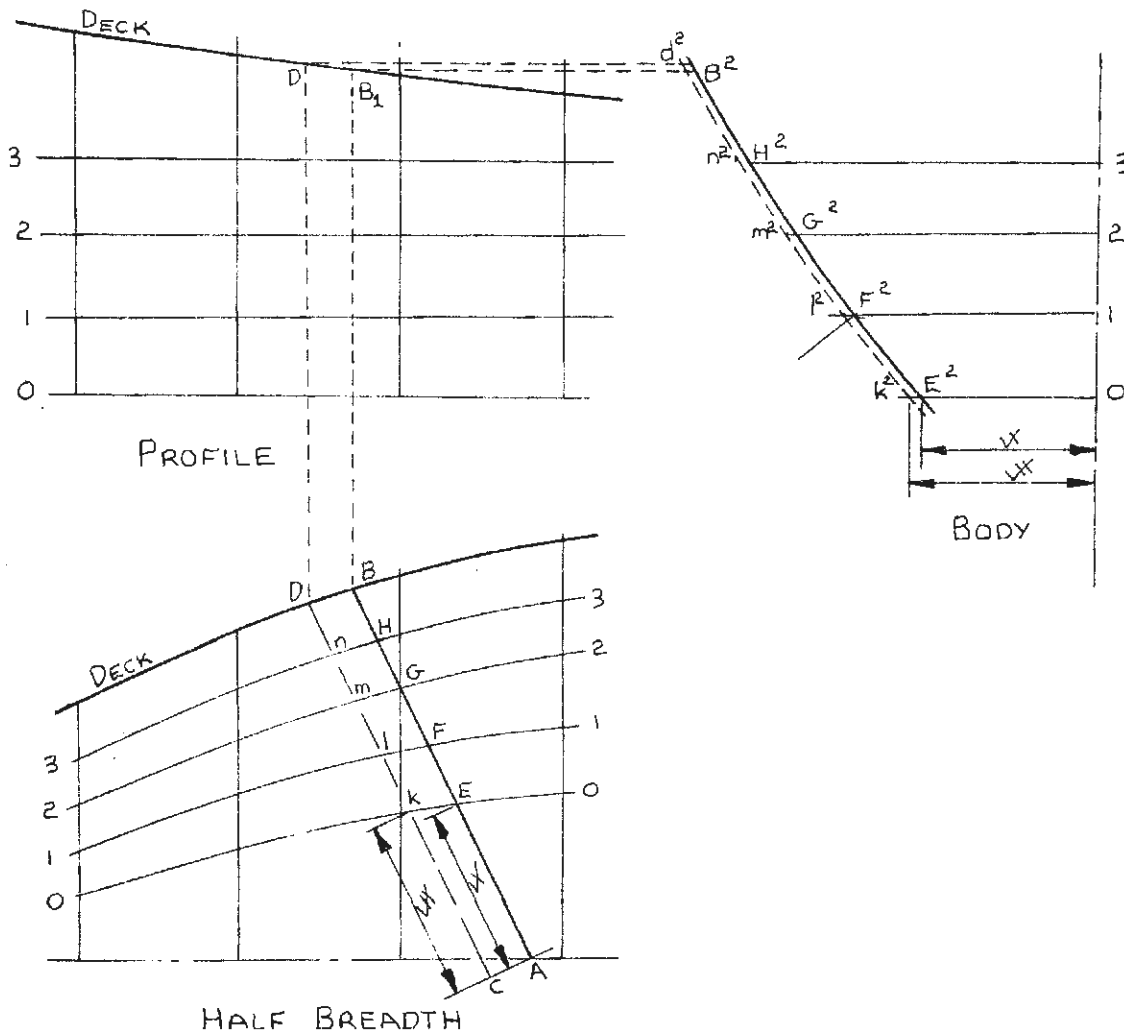
TO LAY OFF CANT FRAME AND OBTAIN ITS BEVELS

An ordinary Cant frame lies in a plan which is vertical but inclined to the sheer, it is adopted in order to avoid excessive beveling. The principle place in which it is now employed is for frames to an overhanging stern.

In the figure let AB be the plan of the Cant frame cutting the level lines at E, F, G, H and the deck at B, square B up to  $B_1$  to the deck at side and level across to the body. Lift the intersections of the mould edge in the half breadth by placing a batten on the run of the line and marking on it the centre A and the points E, F, G, H and B and set out these points at their respective positions  $E^2, F^2, G^2, H^2$  and  $B^2$  then  $E^2, F^2, G^2, H^2$  and  $B^2$  is the shape of the true expanded edge.

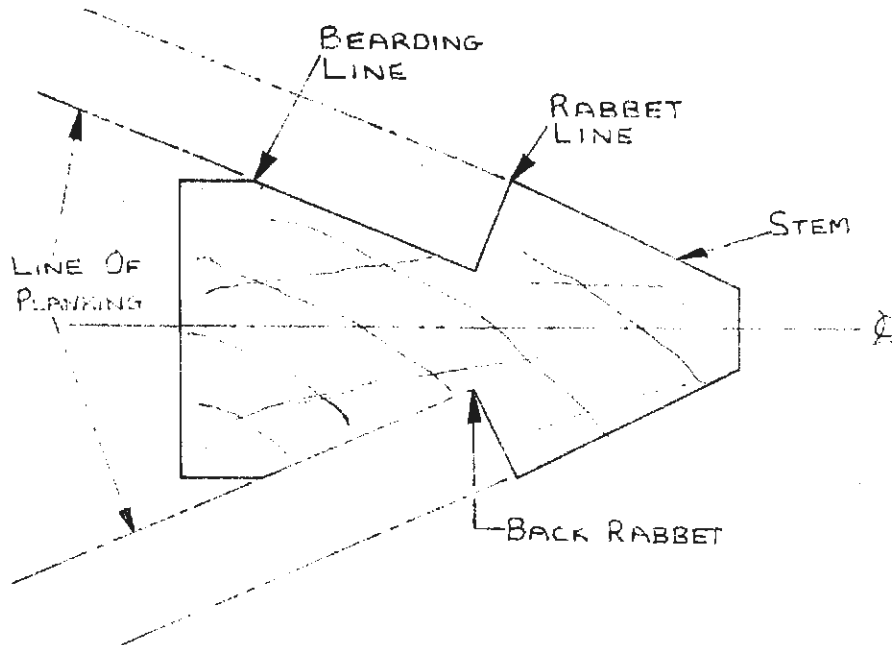
TO OBTAIN THE BEVEL: Draw AC perpendicular to AB, AC being the width of the flange frame or some convenient length (say 150 mm). Draw CD// to AB cutting the bevel lines at  $k^2, l^2, m^2, n^2$  and  $d^2$ . Then a bevel at any point such as  $f^2$  is the square distance from the bevel edge to the moulded edge on a base equal to AC.

NB the bevel is always taken square to the frame so that it is the square distance that is required and not the distance  $F^2$  or  $l^2$



## TO TAKE OFF THE PLANK FORWARD AND OBTAIN THE BEADING LINE

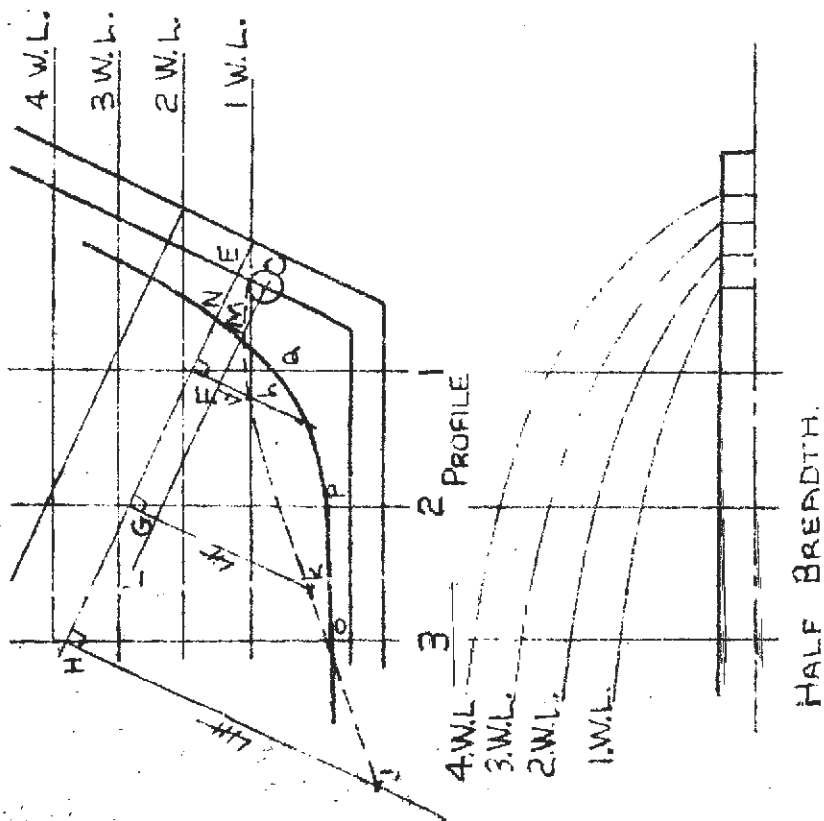
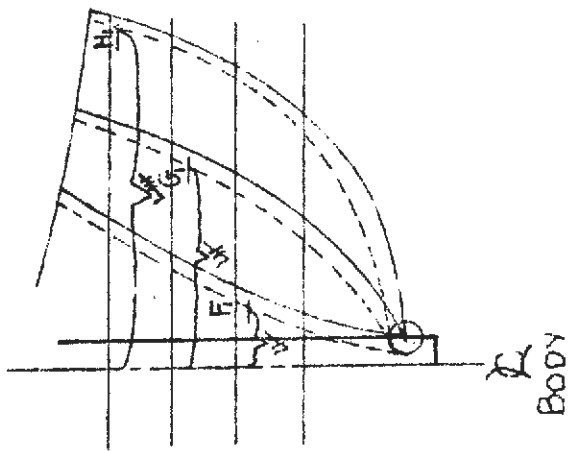
The beading line is the intersection of the moulded or framed surface of the ship with the stern, keel and stern post, the intersection of the outer surface with these being termed the fore edge, bottom, or aft edge of the rabbet as the case may be.



In the sketch the shape of the ship forward is defined by the full lines BC being the fore edge of the rabbet. Up to the stem the plank is taken off in the manner as described previously resulting in the dotted moulded surface and the problem is to find the ending of this surface at the keel and stern.

The step by step method of obtaining the beading line is set out below:

1. In the body plan, with the rabbet line as centre, scribe a circle with radius equal to normal thickness of planking.
2. Produce the inside edges of planking to meet the circle at a tangent. Where these lines cross the half siding of stern and keel, project these intersections O, P, Q, over to the profile to the corresponding frame.
3. Square a line from any point E on the water line normal to the stern to cut the frames 1, 2 and 3 at F, G, H.
4. From points F, G and H in the Profile draw lines square to the original normal.
5. Project the height of points G, F, and H in the Profile to the moulded surface at frames 1, 2 and 3 in the body plan. These points being called  $G_1$ ,  $F_1$  and  $H_1$ .
6. Take half breadths of  $G_1$ ,  $F_1$  and  $H_1$  and set in Profile from G, F and H respectively. Giving points h, k, j.
7. From the point E set off the distance equal to the half siding of the stern E.C. From C draw a line (C, L) parallel to our original normal. At point C on the rabbet line draw a circle radius equal to the nominal thickness of planking.
8. Take a fair line through h, k and j and finish as a tangent to the circle and cutting CL at M.
9. From point M square up a line till it cuts the original normal at point N.
10. The faired line through points O, P, Q and N is the beading line.



## HALF BLOCK MODEL

There are two main types:

1. Where the model is made to a set of lines
2. Where the model is made first and the lines lifted from it.

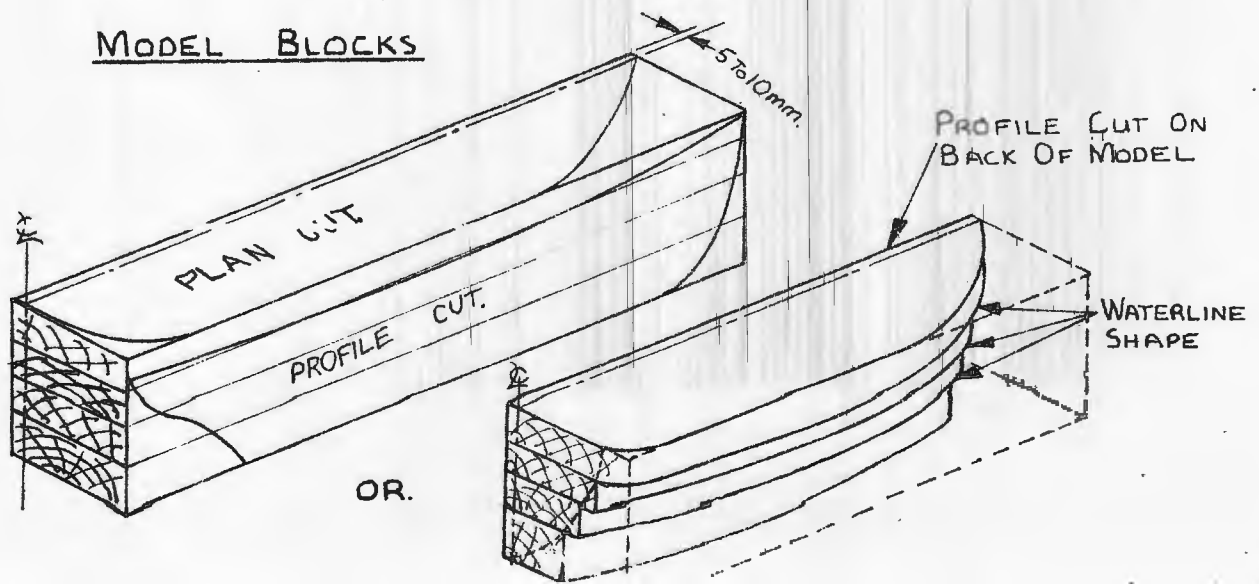
1. Taking the first case:

The model is made to the lines so that the different information may be found:

- a. In the case of steel vessels plate sight edges, butts, decks, bulkheads are marked onto the hull of the model so that shell plate etc may be ordered well before it will be used. The sight edges are marked on with the help of thin battens which are laid on in their natural positions and held in place with elastic bands and the edges marked in with Indian Ink.
- b. Other information found, the comparison of one hull design against another (this would be in the case of large pleasure yacht through to commercial vessels). This is done by tank testing a full model in a long tank in which all sorts of conditions that the ship in real life is likely to encounter are assimilated. (This includes waves, wind, heel angles, various changes of trim and stability tests, etc) - all to scale and calculated electronically.

2. Taking the second case:

In the second case the model is made first until a desirable shape is obtained, in this case there may be quite a few models made. Designing a boat by this method is good practice because a three dimensional picture may be seen and is of good value to a customer who cannot understand a lines plan. From the model the lines are taken off either by the use of a base board, horse and pointer or by cutting the model at each section and plotting the measurements from the waterlines and buttocks which are drawn onto the section. The offsets are tabulated and the design is lofted on the loft floor full size and faired in.







## SETTING OFF DRAUGHT MARKS ON THE STEM AND STERN

These are placed on both sides of the stem and stern, by means of which the draught of water that the ship draws at any time when afloat may be correctly ascertained.

Figure 1 shows the outline of a vessel on the stocks. The bottom of the keel should be a straight line. It is tested by placing "dark sight" boards, like H in Figure 2 with an open space P of about 5 mm on a level with the bottom of the keel at various positions in the length of the vessel A, B, C and adjusting A and C until the sight holes are in a line with B and each other, and so that the sight edge embraces the extreme bottom points of the keel.

The sight line may then be produced on to D, any upright at the stem, and a temporary shore placed in for the purpose will secure L in the same way. To these points L and D a straight edge is attached. Then stand the measuring batten G as shown, on top of this keeping it square to the edge LD with set square K, and a line off the marks on the stern to about 1 metre above the load line.

It is not necessary to place any figures, except in shallow draught boats, below about 1 metre, as the ship is never likely to draw less water. The after end may be lined off in the same manner.

The figures are stencilled in and then cut with a chisel. The figures are 100 mm deep and are set out as shown below.

DRAUGHT MARKS

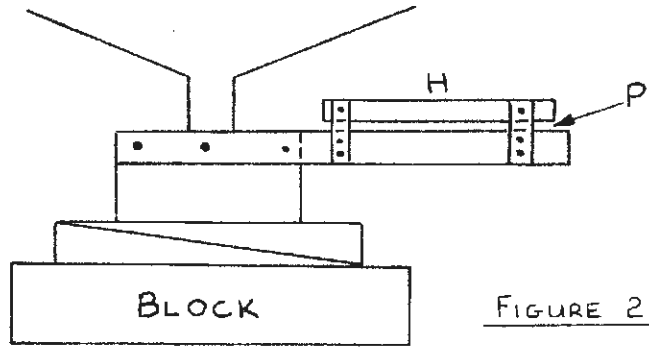


FIGURE 2

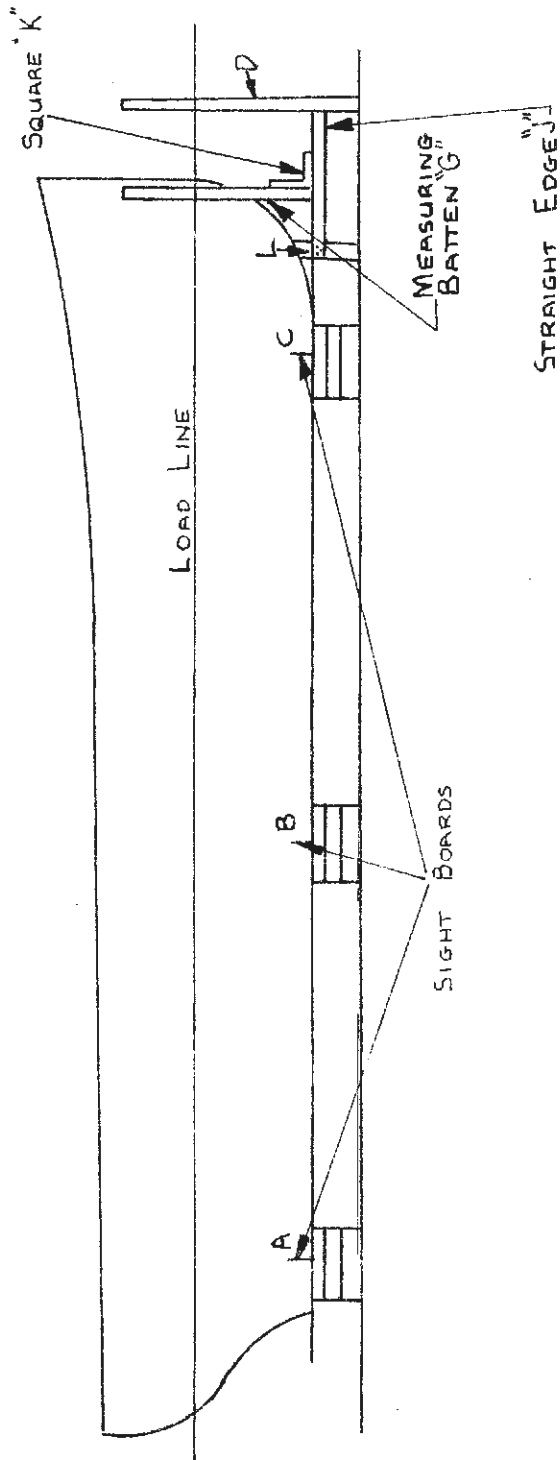


FIGURE 1

## 10TH SCALE LOFTING

## OPTICAL MARKING OF PLATES

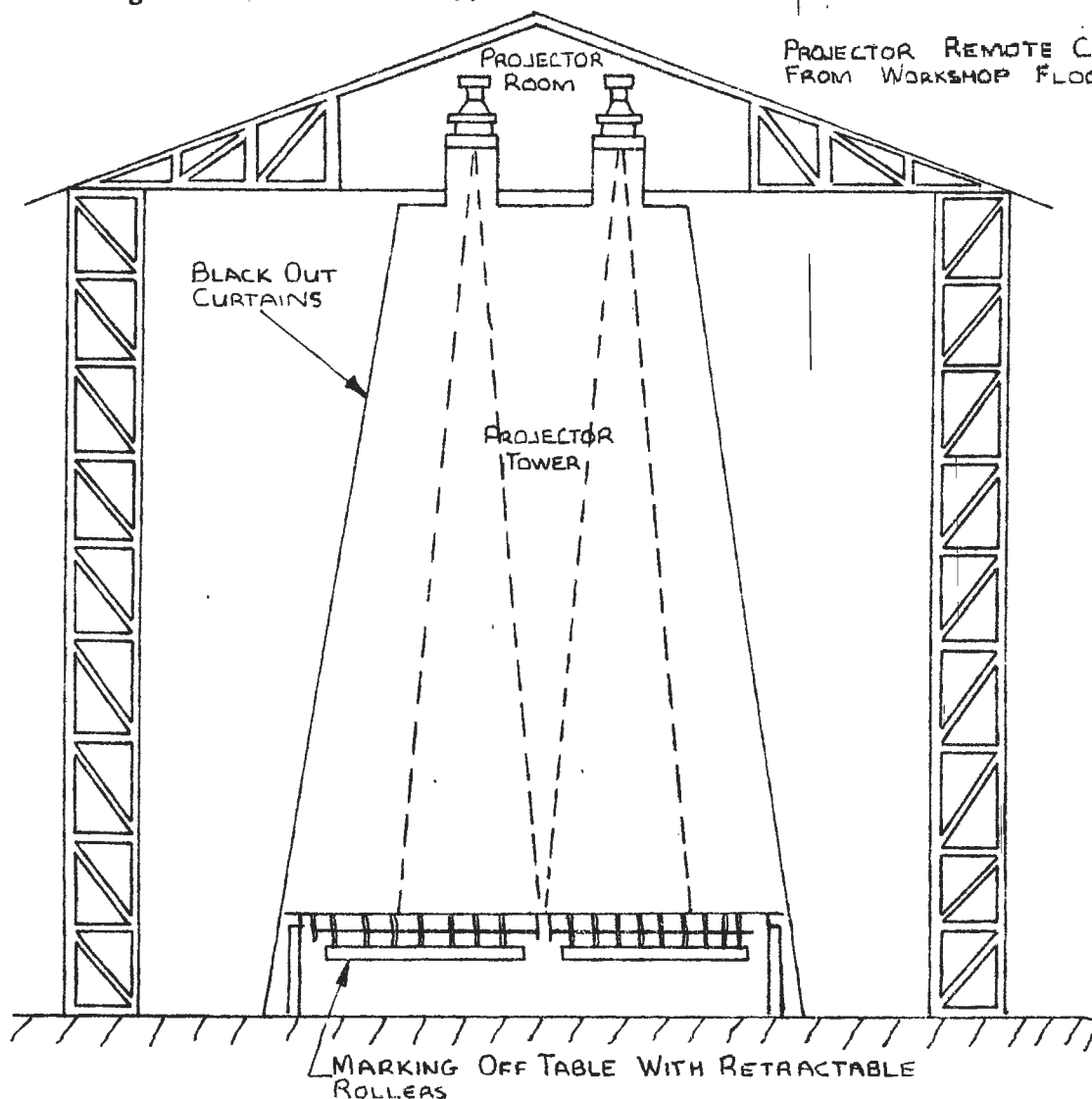
A drawing, 1/10th full size is made of each portion of the structure and this drawing is photographed on a glass plate negative 1/10th the size of the drawing, or 1/100th full size. The thickness of the lines drawn is as fine as practicable and corners are drawn as sharp and square as required.

The process of marking out the plates takes place in a darkened tower at the top of which is a projector which projects the slide on to the plate lying horizontally beneath. The outline of the plate is then marked in the conventional manner by centre punching.

Obviously any slight shrinkage of the paper or tracing film during the drawing of the original will result in considerable errors in the marked off plates; standard marks are therefore put in on the drawing at specified distances apart. When the image is projected adjustments can be made so that the marks show their correct spacing on the plate being marked off.

Optical lofting is not widely used, but besides its modest cost it can be used to mark out thin plate or sheet, which cannot be easily profiled burned automatically without severe distortion. It can be used as a very economical method of marking out rectilinear plates which can be cut by shears or guillotine.

Special precautions are to be taken to avoid trouble from vibration and building distortion from wind.

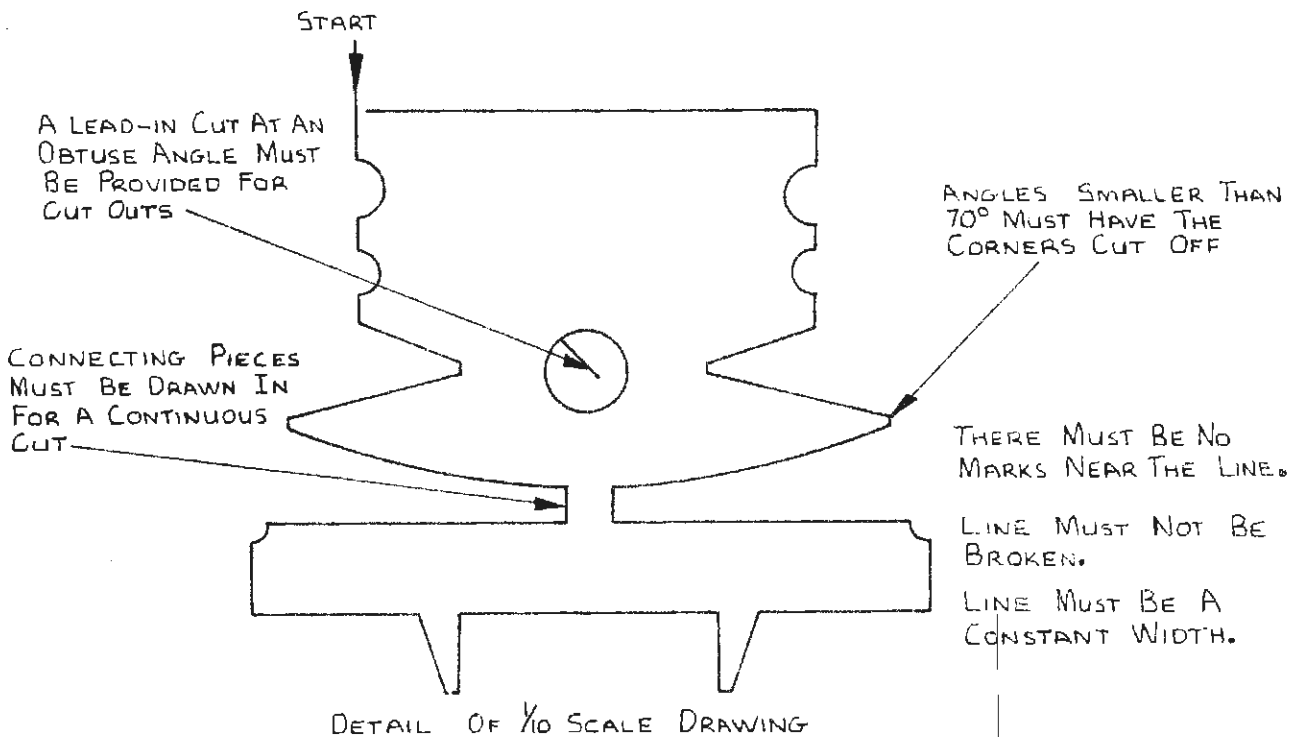


## SMALL SCALE LOFTING FOR AUTOMATIC CUTTING MACHINE

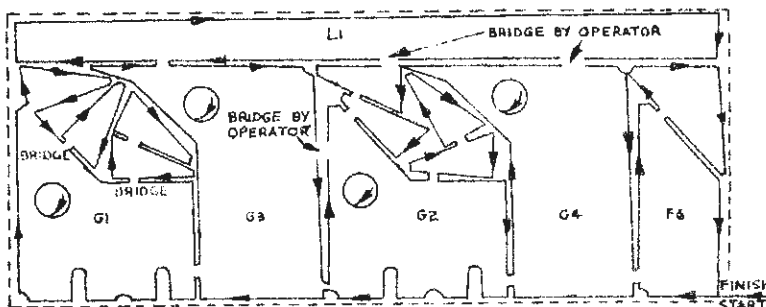
In this system the shapes of the plates are drawn 1/10th full size, exactly as they are required to be cut (with certain exceptions mentioned below) on sheets of treated aluminium, plastic or stabilized plastic film.

Care must be taken with the inking of these lines as the cutting machine is very sensitive to change of thickness. Extreme care is required in the preparation of the drawings and it is a common practice to use a pair of magnifying lenses or other form of magnification to reduce eye strain.

The exception regarding the actual drawing work is that nominally sharp corners are carefully tailored with a knife to enable the sensing cell of the cutting machine to follow a smooth curve. If the corners are drawn absolutely square, the machine over-runs, loses the line, and stops.



Drawings are also prepared to show the method of resting the pieces to be cut from the plate and the technique is to arrange these in such a manner that the machine makes the longest single cut on one plate without stopping (see sketch). This holds all the pieces together and prevents them falling away from the supports, but in some cases it is necessary to add bridges at strategic points around the cut to hold the pieces in position. These bridges are later cut by hand when the plate is removed from the machine.



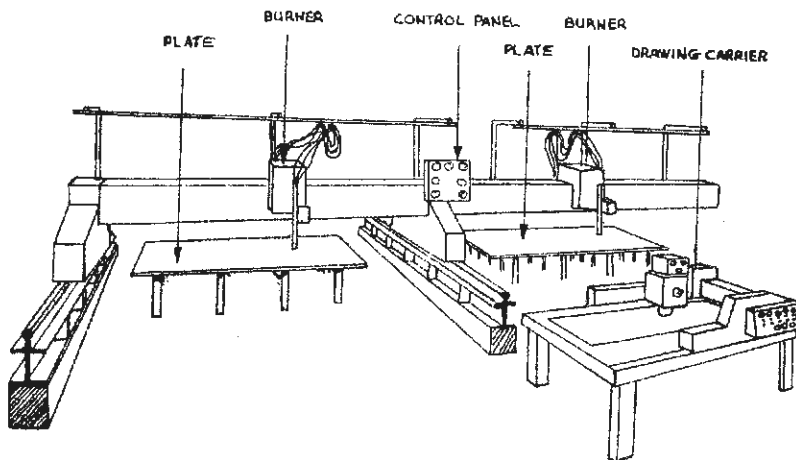
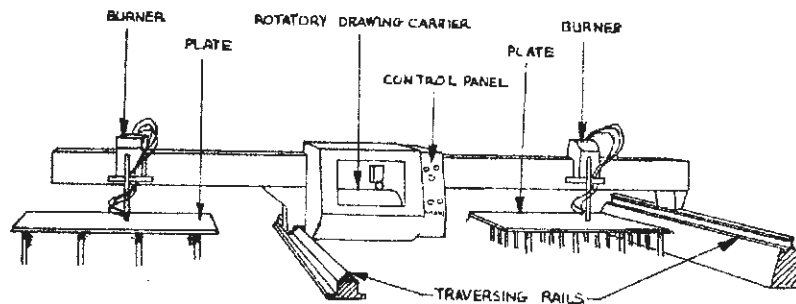
SKETCH OF CUTTING LINE ON PLATE

The cutting drawings must be prepared strictly in accordance with the instructions for the type of cutting machine for which it has been prepared. In particular the thickness of the lines of the drawing must suit the design of the sensing unit. For some machines the lines may require to be as narrow as between 0.008 and 0.010 in width for the sensing unit, and hence the machine, to operate satisfactorily when cutting on 1/10th scale.

The operating instructions must also be correctly followed as regards the use of the tracing unit which the operator guides along the cutting line to control the cutting head. For some machines the tracing unit must be made to follow the middle of the cutting line and for others to follow one edge of the line.

The sketches below illustrate the general arrangement of two types of machine. In the first type the cutting drawing is secured on a rotary table integral with the control console and in the second type on a flat table separate from the control panel. Some machines are designed for cutting a single plate and others for cutting two identical plates simultaneously using the same 1/10th scale drawing.

### PLATE CUTTING MACHINES



SHELL EXPANSIONDIAGONAL METHODa. CONSTRUCTION

In Figure 1 let  $xx$  and  $yy$  represent the top and bottom of the shell plates respectively in the body plan. Draw the line  $NN$  passing through the girth centre of each frame from  $xx$  to  $yy$ . Draw the diagonals,  $aof$ ,  $boe$ ,  $bog$ ,  $cof$ , etc.

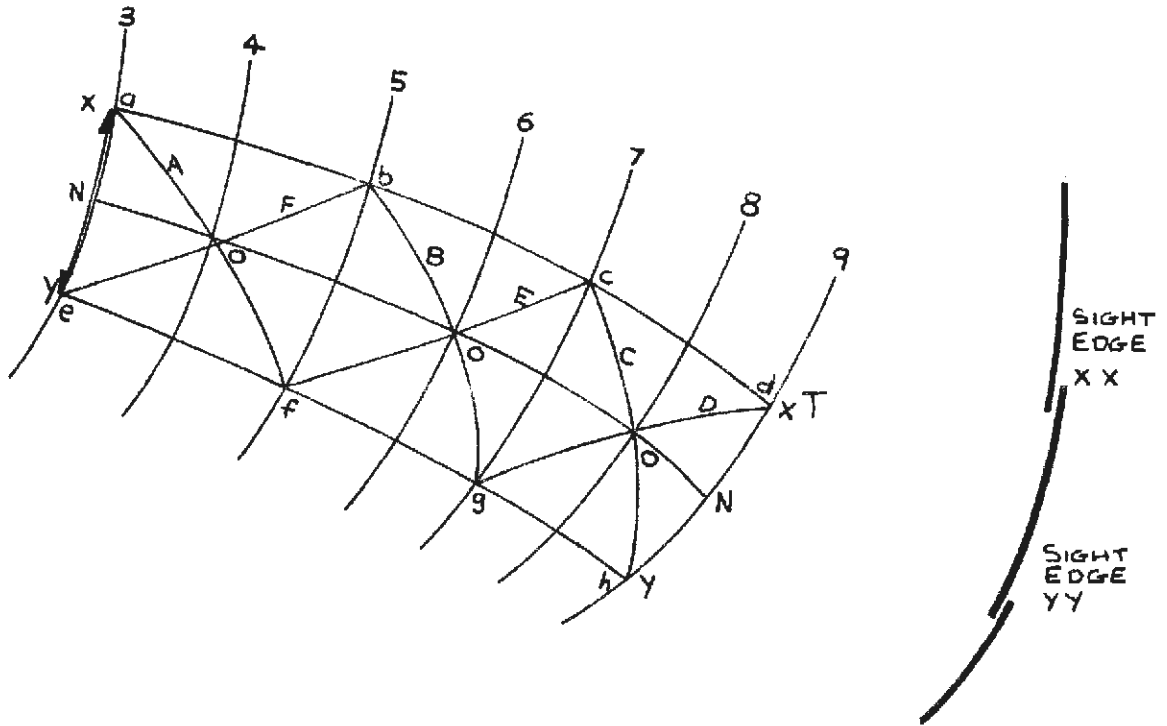


FIGURE 1

b. EXPANSION OF DIAGONALS

In Figure 2 set off 2 set off 2 frame spaces as shown and erect a perpendicular at each frame. In Figure 1 girth the diagonal "aof" and apply this to Figure 2 "ao" to one frame and "af" to the other. A line drawn through a, o and f will give the true length of the diagonal A. The remaining diagonals expanded in similar manner.

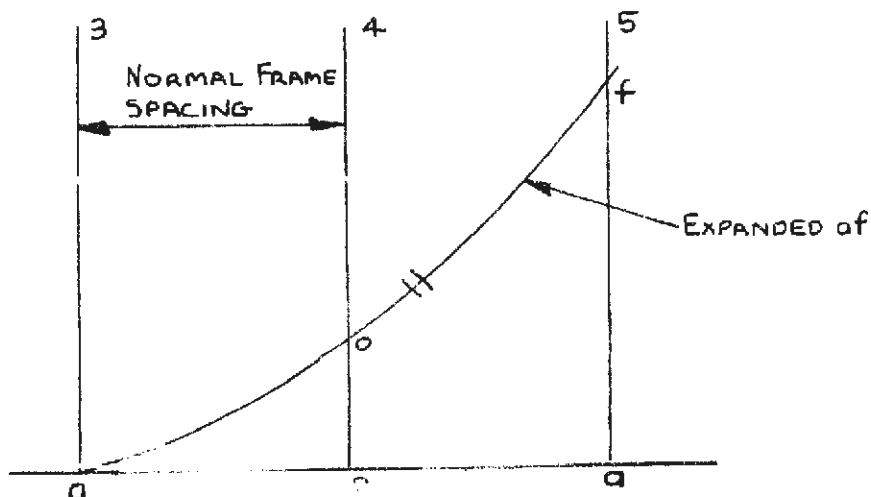


FIGURE 2

c. EXPANSION OF PLATE (SIGHT) EDGES

In Figure 3 set off the frame spacing as shown and erect perpendiculars. From Figure 1 girth the sight edge xx from a to b, a to c, a to d, and apply to their respective frames in Figure 3. A batten through these spots will give the true expansion of the top sight edge xx. The bottom sight edge yy is expanded in a similar manner.

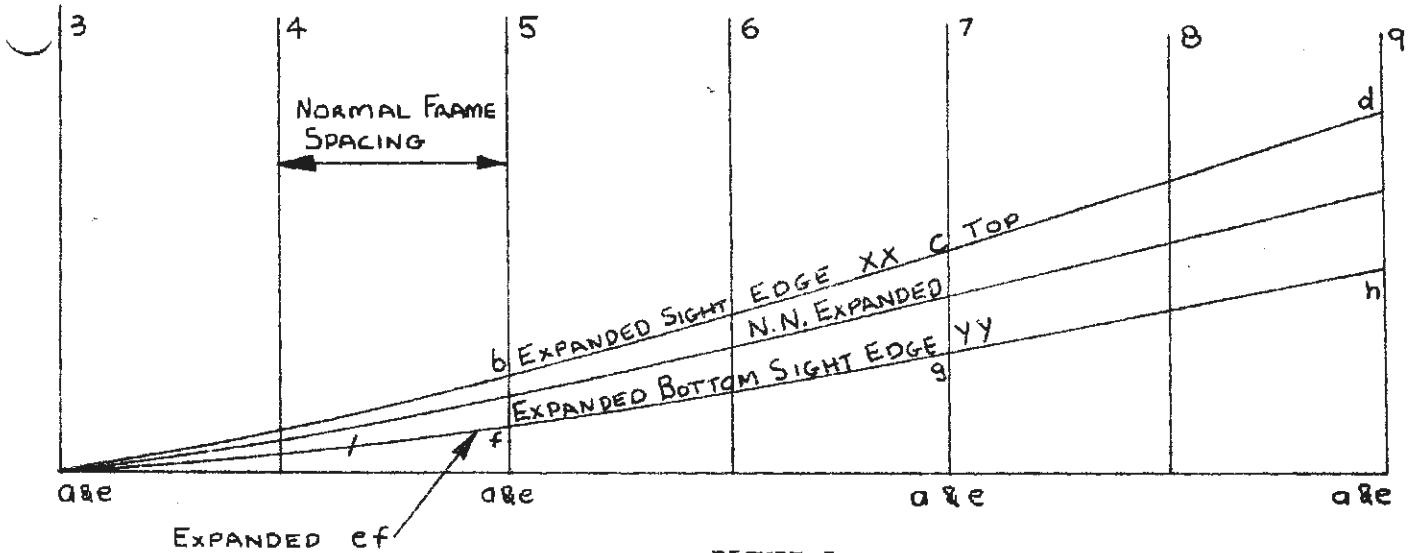


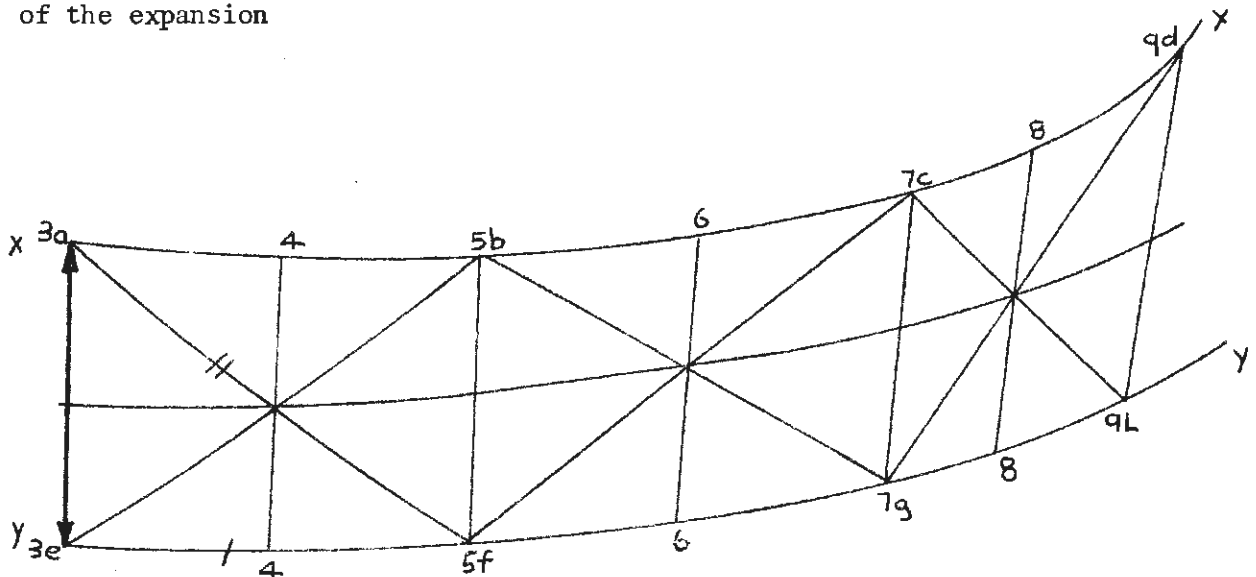
FIGURE 3

d. APPLICATION

Apply a batten to the top and bottom expanded sight edges xx and yy and mark on these battens the expanded frames. Pin one end of each batten a distance apart equal to the girth distance from x to y on frame 3. From "a" apply the expanded diagonal A until it meets frame 5 on yy. Similarly from "e" apply expanded diagonal F till it meets frame 5 on xx.

Similarly by using the expanded diagonals B, E, C and D the positions of the expanded sight edges xx and yy are found.

The expanded girth centre NN, is used as a check to test the accuracy of the expansion



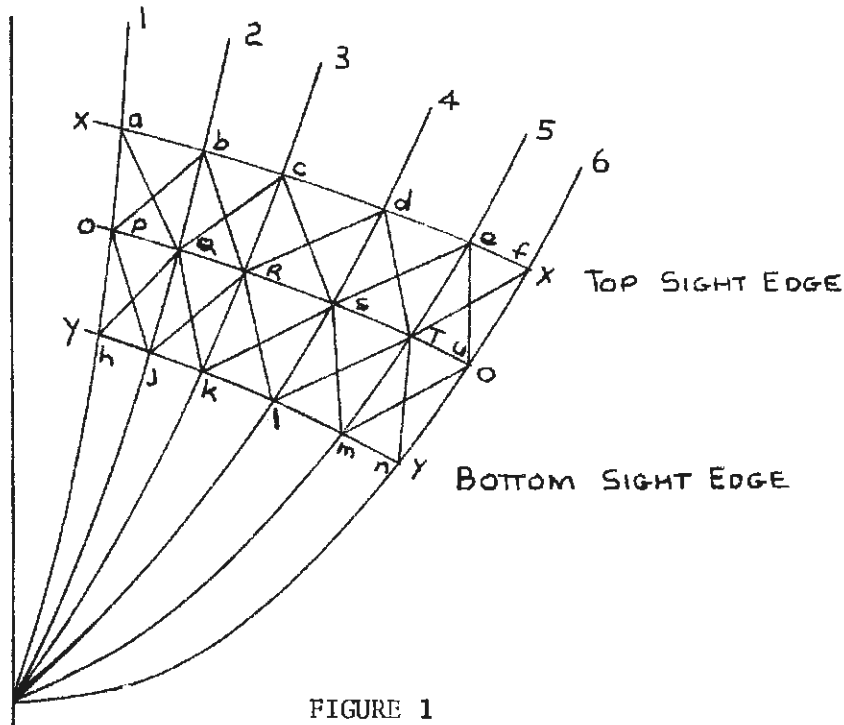
NOTE: Diagonal not necessarily straight

FIGURE 4

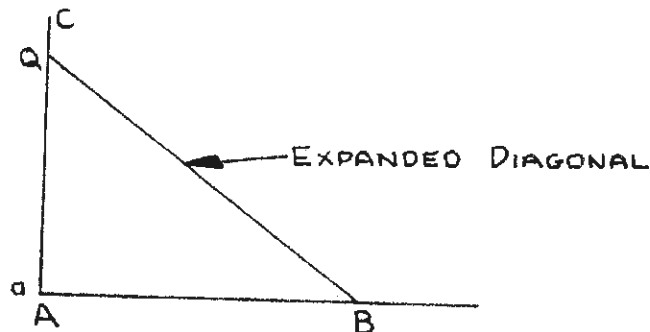
## TRIANGULATION METHOD

a. CONSTRUCTION

In Figure 1 let  $xx$  and  $yy$  represent the top sight edge and bottom sight edge respectively in the body plan. Draw the line  $00$  passing through the girth centre of each frame at  $PQRSTV$  etc. Draw the diagonals  $aQ, bPj, bR$  etc, these being straight lines.

b. EXPANSION OF DIAGONALS

In Figure 2  $AB$  represents the normal frame spacing,  $AC$  is drawn perpendicular to  $AB$ . On  $AC$  mark the diagonal  $aQ$ , joint  $Q$  to  $B$ , then this line  $QB$  is the expanded diagonal.

c. EXPANSION OF SIGHT EDGE

This is done in the same manner as shown previously in Figure 3. (Shell Expansion by Diagonal method). Pick up the expanded frame spaces.



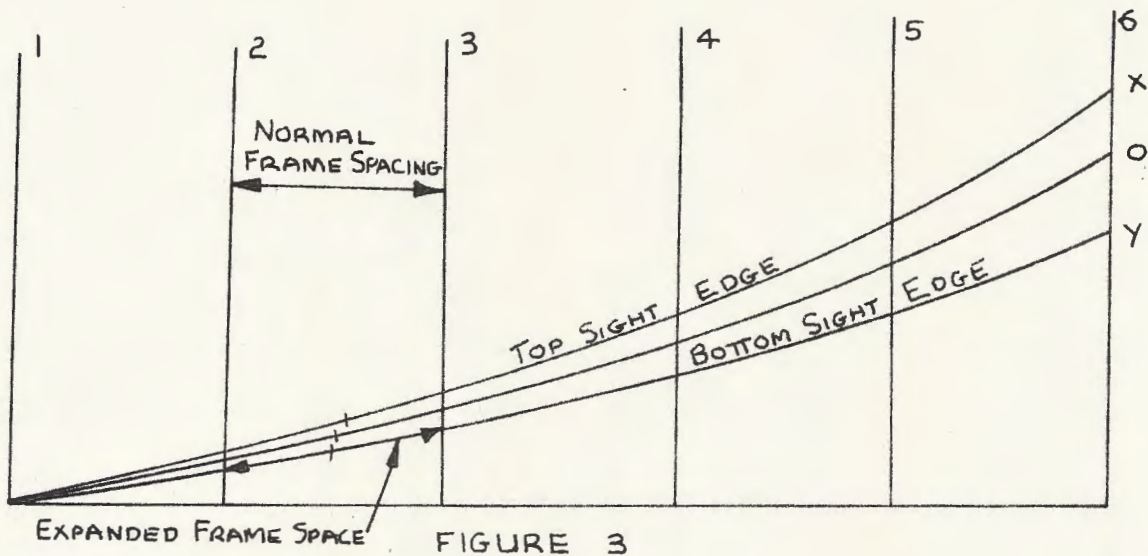


FIGURE 3

d. APPLICATION

These expanded frame spaces are marked A on the battens xx, oo and yy. Pin one end of each batten at a distance apart of the girth distance aP and Ph which will be the girth between the sight edges on frame 1. Apply from a on xx the expanded diagonal which is obtained from Figure 2 and in this case is represented by aQB (Figure 4).

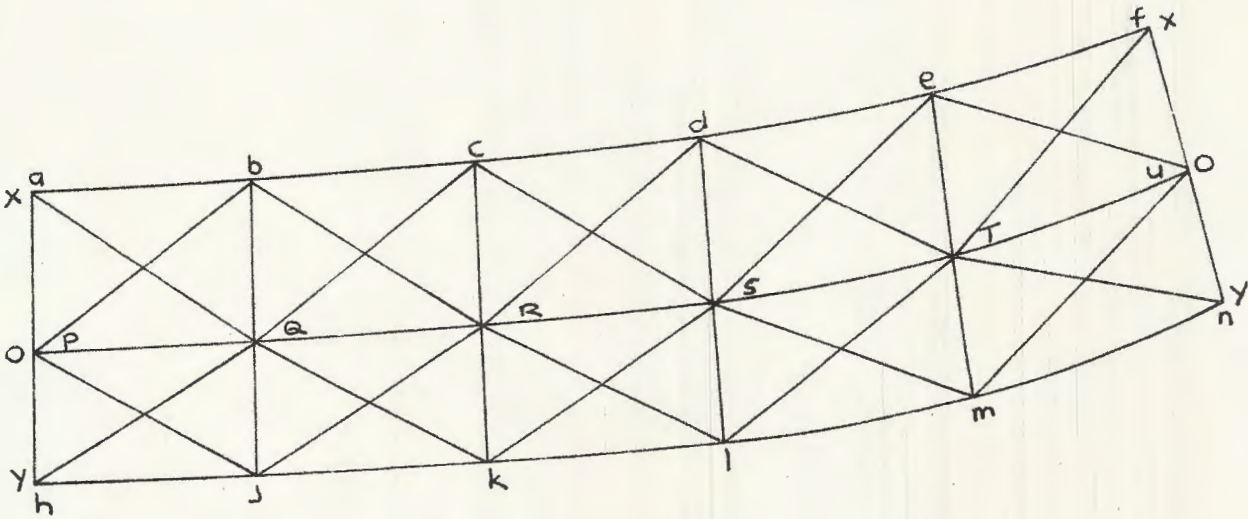


FIGURE 4

NOTE: Expansion by triangulation is more accurate than the previous method and is the method most commonly used. In general practice allowance must be made for laps and butts in the actual expansion.

## CENTRE SQUARE METHOD

a. CONSTRUCTION

In Figure 1 let  $xx$  and  $yy$  represent the top and bottom sight edges respectively in the body plan. Draw the chords  $ah$ ,  $bj$ ,  $ck$  and  $dl$  etc connecting the top and bottom sight edges.

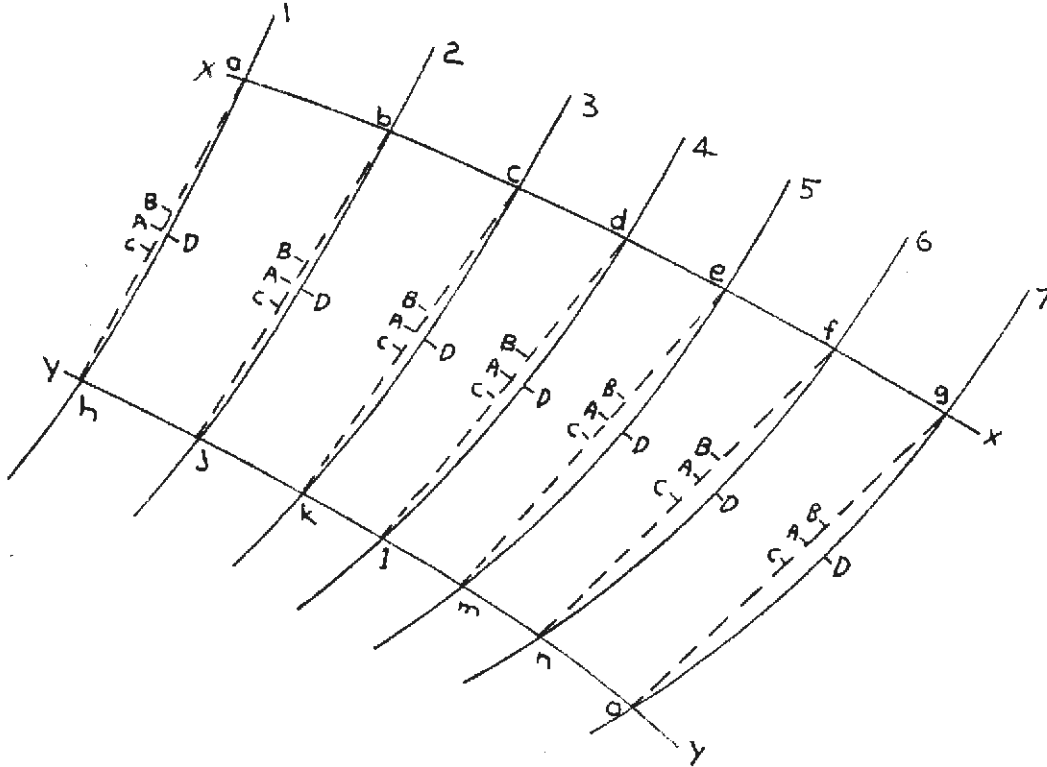


FIGURE 1

b. EXPANSION OF SIGHT EDGES

This is done in same manner as in the previous method and the expanded frames obtained.

c. SQUARING THE CENTRE SPOTS IN THE BODY PLAN

From the chord at frame 7 in Figure 1 select a spot that is about midway between the sight edges and mark the spot A. Take a square and hold it along the chord at frame 7 at the spot A, where the blade crosses the chord at frame 6, mark this spot B. Now reverse the square and hold it on the chord of frame 6 with the blade on the spot A (chord 7). At the spot where the square rests on chord 6, mark the spot C, if these straight lines of chords at each frame were parallel there would be no twist in the plate and spots B and C would be identical, but if there is a twist in the plate there will be a slight space between B and C, divide this space evenly and mark the spot A on chord 6 which becomes a new square root.

By using the edge of the square as a straight edge, set the square at spots A on chords 6 and 7 at the same time crossing the curve frame line 7 on which mark the spot D.

This spot D will be the working spot from which the actual development is done. Next hold the square on chord 6 at spot A and square to spot A (chord 6) and mark C on chord 5. Halve this distance between B and C on chord 5 and obtain the spot A. Repeat the performance of producing the spots A on chords 5 and 6 back to the curved frame line 6 thus obtaining the spot D. The spot D is thus obtained on each curved frame line in a similar manner for the length of the plate.

The expansion of the sight edges having already been obtained, the width of the plate between the sight edges must also be obtained. The plate being bent around curved frames, the frames must be girthed or measured around the curve to obtain the width between the sight edges. This is done with a batten which has the same thickness as the plate if there is very much curvature.

With D as the working spot on frame 7, girth frame 7 and mark the top and bottom sight edges on the batten. With the same batten and holding it at the spot D on frame 6, girth frame 6 and mark the top and bottom sight edges on the batten. This is repeated for each frame remembering that D is the working spot in each case.

For convenience a developing square is made as shown in Figure 2 and the girthed spots are transferred from this girth batten to the edge of the square.

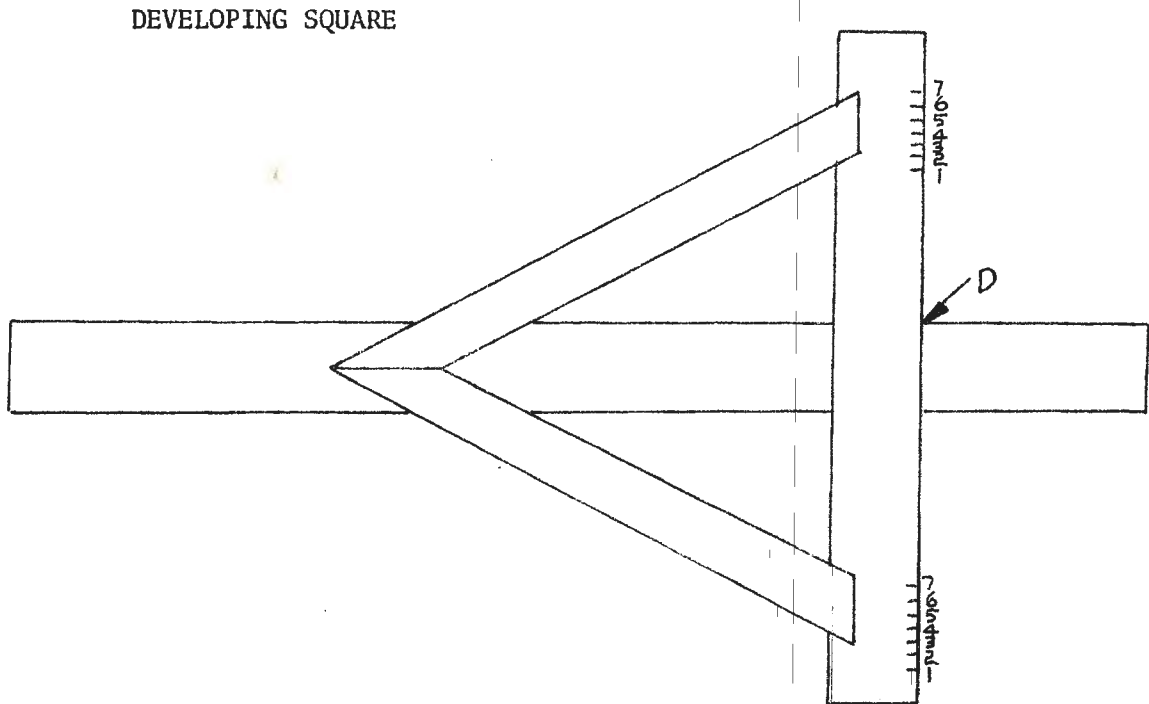


FIGURE 2

d. APPLICATION

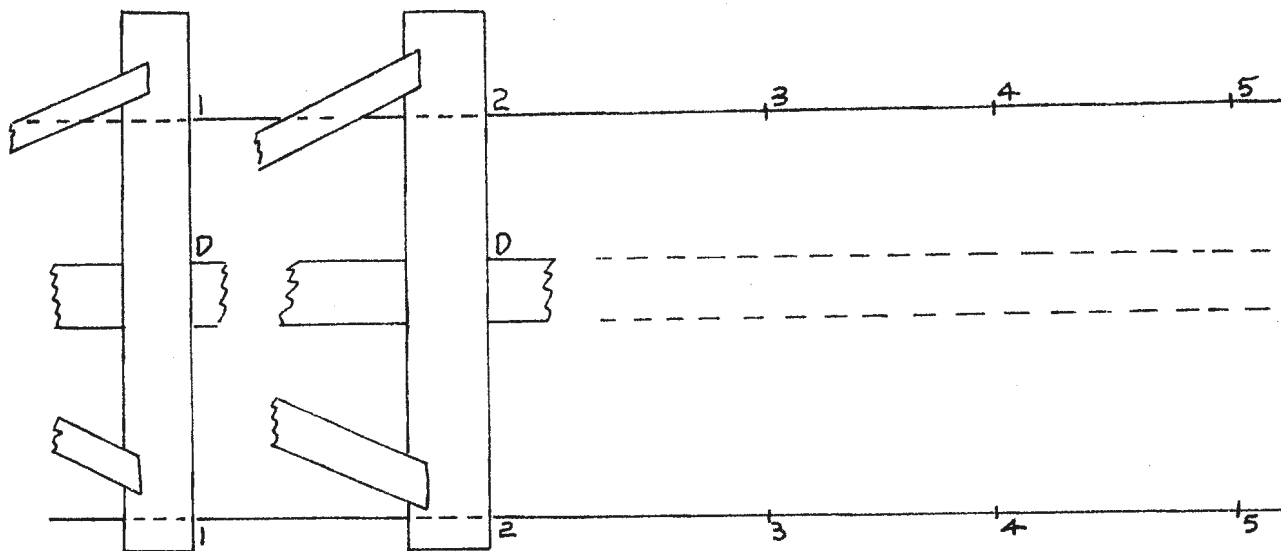
A straight line representing frame 1 is drawn and the upper and lower sight edge expansion battens placed in their approximate positions as shown in Figure 3. The developing square on which the girth spots have been placed is set on top of these battens which are fastened at frame 1 to the spread between the girth spots for this frame. Then place a nail in the floor at the working spot D on frame 1.

Hold the square against this nail and mark along the blade of this square approximately where frame 2 will cross obtaining the spot B. Move the square ahead to frame 2 on the sight edge expansion battens at the same time holding the blade of the square against the nail at frame 1.

With the square in this position mark C on frame 2, then remove the nail from frame 1 and place it midway between the spots B and C on the frame 2 for the spot D. Hold the square against this nail in order to set the edge battens properly at frame 2, now hold the developing square against this nail at frame 2 and mark along the blade at approximately where frame 3 will cross, obtaining the spot B, then move the square ahead to frame 3 on the sight edge expansion battens at the same time holding the square against this nail at frame 2, mark the spot C.

Remove the nail from frame 2 and place it midway between B and C on frame 3, for spot D. Hold the square against this nail to set the edge battens properly at frame 3. Continue this construction at each frame until the end of the development is reached.

NOTE: In all shell expansions particular attention should be given to the plate, which is to be expanded, as to whether it is an inside or an outside strake so that allowance can be made for laps.



EXPANSION OF MARGIN PLATE.

Place the level line g.o. in the Body (Fig. 2 ), lift points g, h, cl, m etc., from the centre line, and place them in the Half Breadth on their respective frames. Then girth this line for the position of the frames and place these expanded on a straight line about the midship frame, from which points, square lines indefinitely above and below. Lift the widths of the margin plate below the level line on the Body sections gD, hF, etc. and transfer them to their respective expanded frame stations below the level line.

Pass a curve through the spots which will give the lower edge of the margin plate.

The top edge may be found on a large section, or on the left floor Body, by drawing the curve of the plate and its position on the inner edge, see Fig. 1.

Then girth from g, h, i, etc., to each inner point "a", and set these girths off above the expansion line g, o, on their respective stations and draw a curve through the spots. This is the expanded top edge of the margin plate.

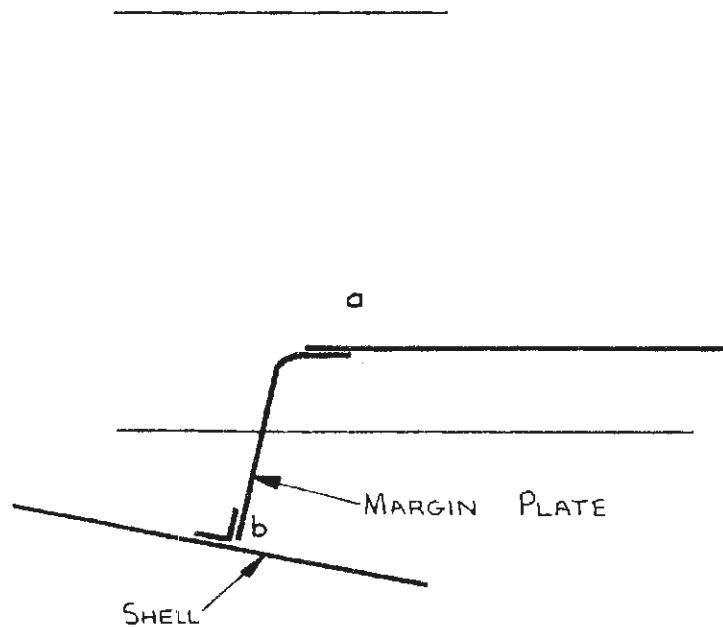
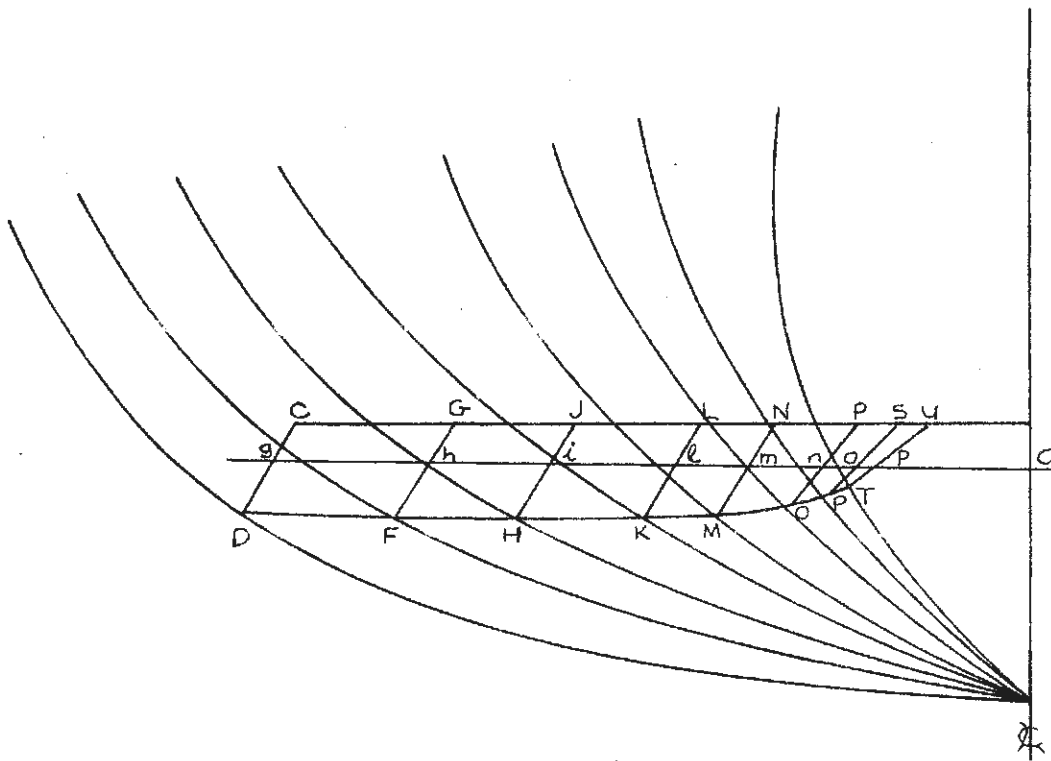
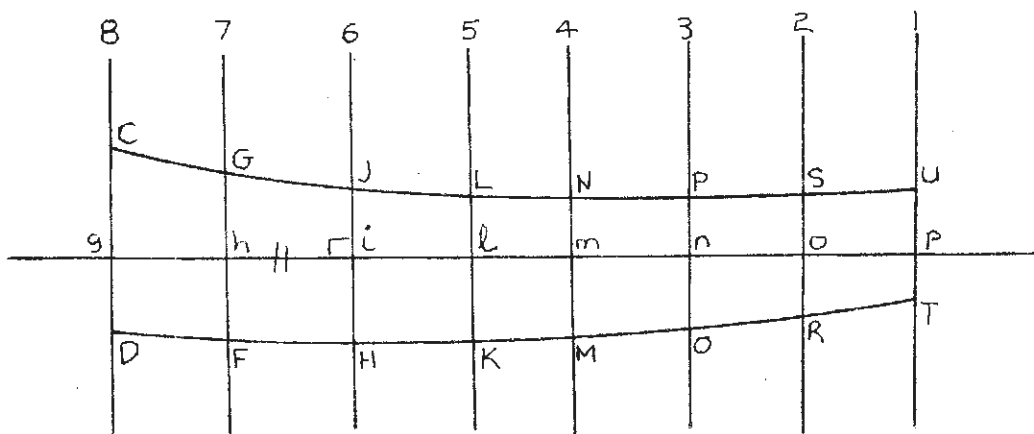
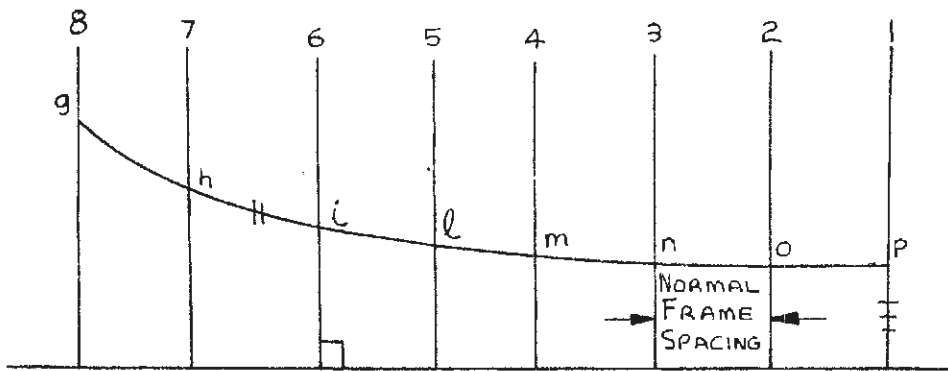


FIGURE 1



AFTER BODY (DOUBLE BOTTOM)

FIGURE 2



THE PROCEDURE ADOPTED TO ARRIVE AT, (AND EXPAND A) CURVED RAKING TRANSOM

Having already established the positions of:-

The Waterlines, (Chine) Sheer in the  $\frac{1}{2}$ Breadths Plan,  
 ..... the Sections and False Transom in the Body  
 Plan ..... the Keel, Buttocks, Sheer and Transom  
 Angle in the Profile.

It is necessary to find 1st the outboard edge of the transom  
 in the Profile and  $\frac{1}{2}$  Breadths Plan.

To do this:-

Plumb a perpendicular down from the Profile to the  $\frac{1}{2}$  Breadths  
 Plan, strike in an arc of a given radius at a tangent to this perpendicular  
 at the centre line of the  $\frac{1}{2}$  Breadths Plan.

Next measure the distances from the perpendicular to the arc,  
 along each Buttock line, then draw lines parallel too, and spaced these  
 distances from the centre line of the transom in the Profile.

(Thus giving the ends of the buttocks up the transom face) Now  
 from the Body Plan measure the heights of the top and bottom inter-  
 sections of the buttocks with the False transom (or End Elevation of it).  
 project these heights to the Profile and finish off the buttocks.

Now in the Body Plan measure off the  $\frac{1}{2}$  Breadths of a number of  
 datum points (on the out board edge of the false transom) and transfer  
 to the  $\frac{1}{2}$  Breadths Plan cutting the arc, now measure the distances from  
 the perpendicular to these points and transfer to the Profile at right  
 angles to the centre line of the transom to intersect their respective  
 heights (which have to be transferred from the Body Plan). This then  
 gives a number of points to fair in the outboard edge of the transom in  
 Profile.

Project all necessary points down to the  $\frac{1}{2}$  Breadths Plan to obtain the  
 outboard edge in this view.

Now to expand the Transom

From the points where the sheer, (chine) and waterlines intersect the  
 edge of the transom in the  $\frac{1}{2}$  Breadths Plan scribe an arc of the correct  
 radius, to the centre line, and from the respective points in the Profile,  
 square lines from the centre line of the transom out board.

Girth around the waterline arc's in the  $\frac{1}{2}$  Breadths Plan (obtaining  
 their lengths and position of the buttocks) transfer these lengths to their  
 respective positions in the Profile, measured from the centre line of the transom.  
 The height of the buttocks can be now squared across to their respective  
 positions and the expanded  $\frac{1}{2}$  Breadth of the transom drawn in.

If the Plank thickness has not already been removed, it must be done so  
 now in the approved manner.

The bevels to allow the planking to fit must be obtained also,  
 remembering that this shape (Expanded Transom) is the after face.



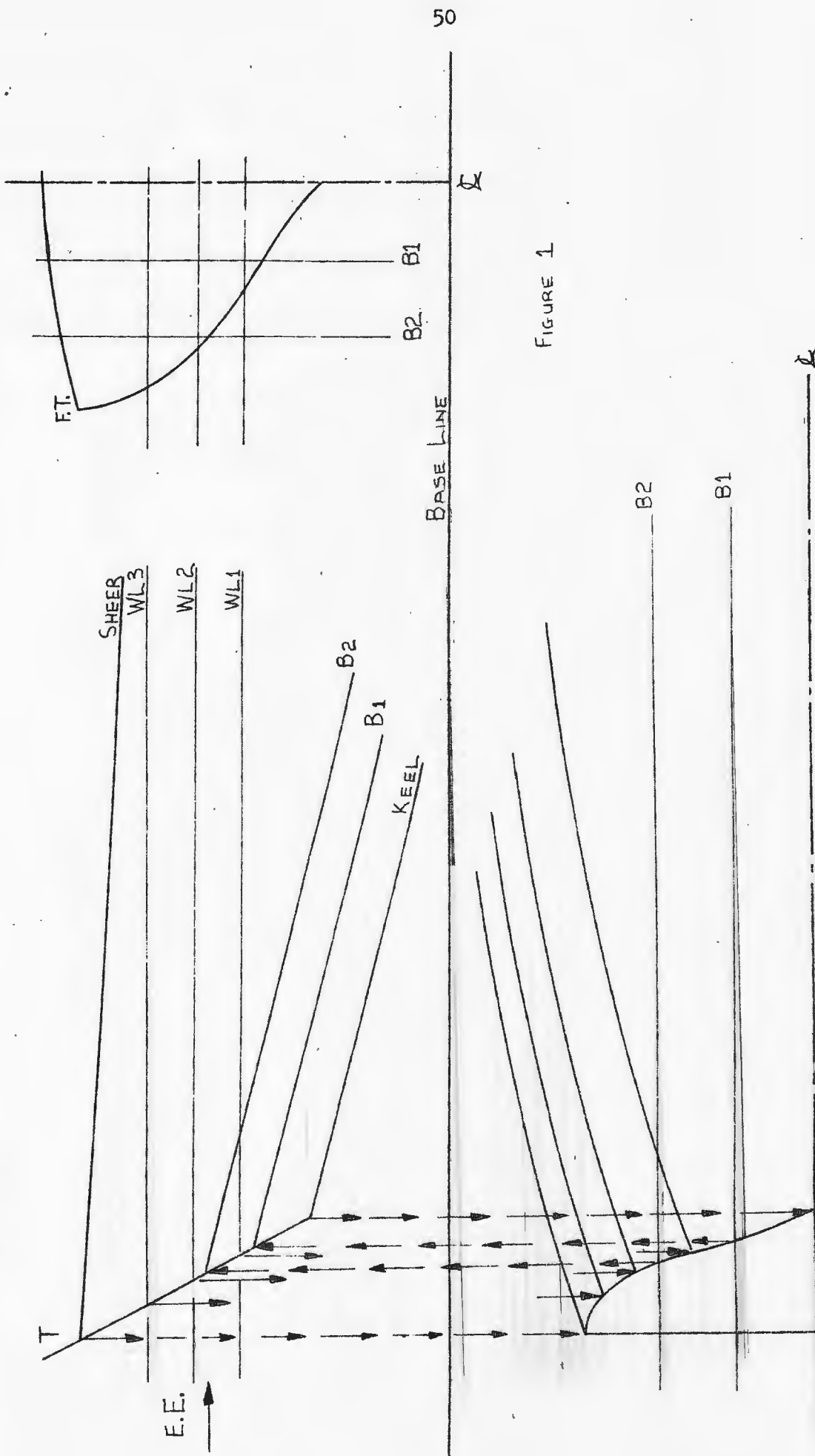


FIGURE 1

NORMAL LINES PLAN SHOWING FALSE TRANSOM VIEWED E.E.



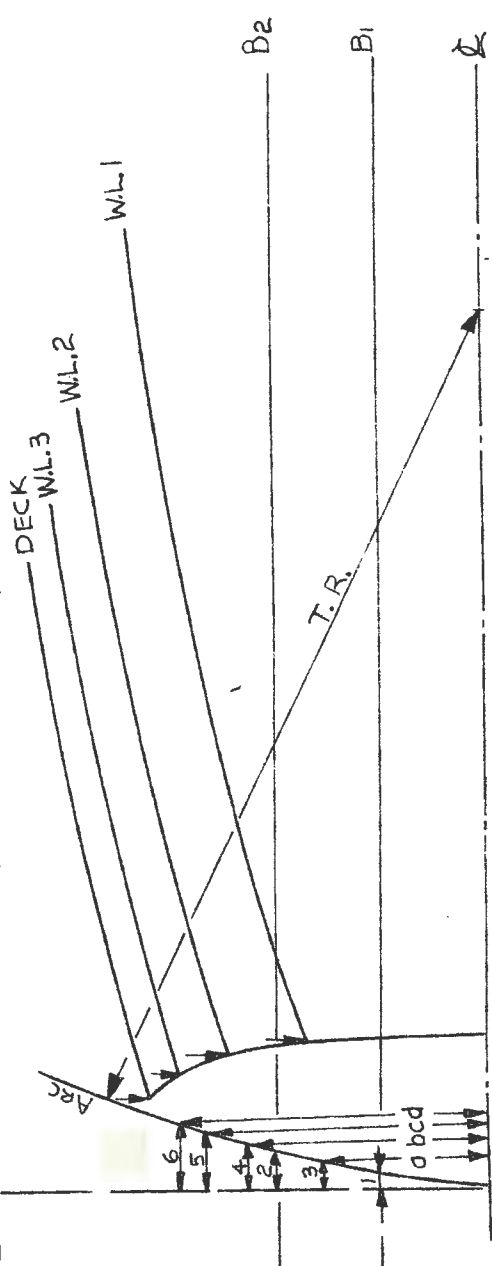
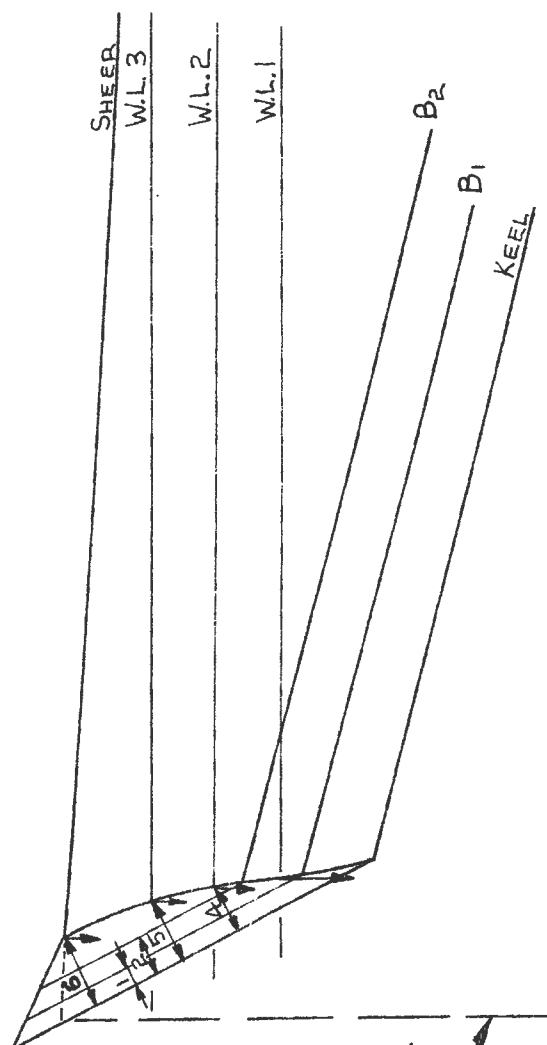
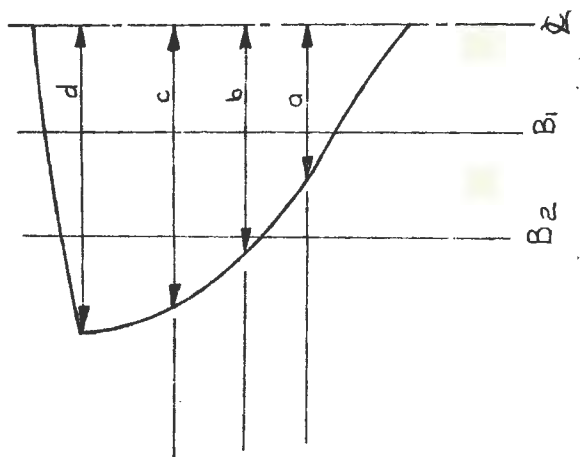


FIGURE 2

PERPENDICULAR

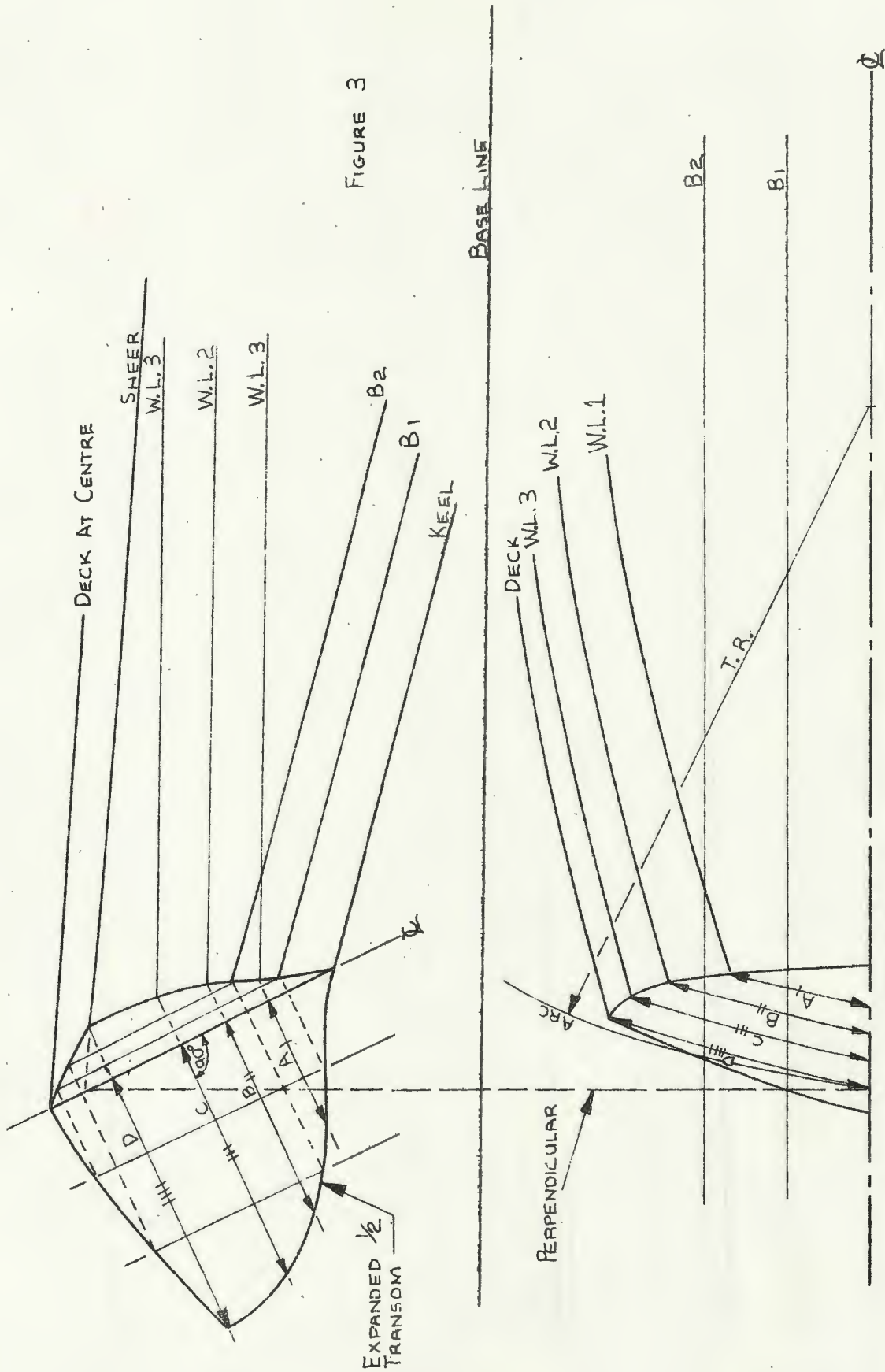


FIGURE 3

LINES SHOWING TRUE SHAPE OF TRANSOM.  
 LENGTHS ABCD BEING GIRTHED IN THE 1/2 BREADTH  
 PLAN AND TRANSFERRED TO THE PROFILE.