Understanding Ships Draughts

by David White

PART I
INTRODUCTION

Even those who are fully conversant with twentieth century ship plans usually find eighteenth century draughts difficult to read. Anyone who is unfamiliar with a modern ship drawing may therefore be freely forgiven if he finds an eighteenth century one totally bewildering. Somewhere between these two we would expect to find the average model maker not completely baffled but probably confused by the multitude of lines that appear on the old drawings. This series will endeavour to help such a person interpret the maze :hat confronts him, without rending him with science. To cover the subject fully would require every page of Model Shipwright for several years to come - which is obviously out of the question and not really necessary. However it is possible to cover the main aspects, and the least that the series should do is to help the reader distinguish between the lines needed to build a model and those that are purely constructional from a drawing point of view. Hopefully it will go further and give an added interest through understanding.

First of all, then - what is a ship's draught? Its twentieth century counterpart is called a ship's plan and the man who draws it, a draughtsman. Paradoxically, in the eighteenth century the word draughtsman was not used and the man who created the draught was known as an artist!

Secondly - what does a draught consist of? Essentially it is a drawing showing a particular aspect or aspects of a whole ship. Drawings of part of a ship, no matter how elaborate, were simply referred to as sketches. In the early years of the century one multi-

aspect drawing normally sufficed; by the end of the century a three- decker might have had as many as eleven. At this stage it will be sufficient to enumerate the various types, followed later by a more detailed description.

1. Sheer Draught .

In modern terms a lines plan combined with a part external profile and usually a small amount of internal construction. Although generally speaking 'sheer draught' has been superseded by 'lines plan' it may still be found from time to time even today. Indeed it is rumoured that the expression is still in use by that very secretive and conservative body, the Royal Corps of Naval Constructors.

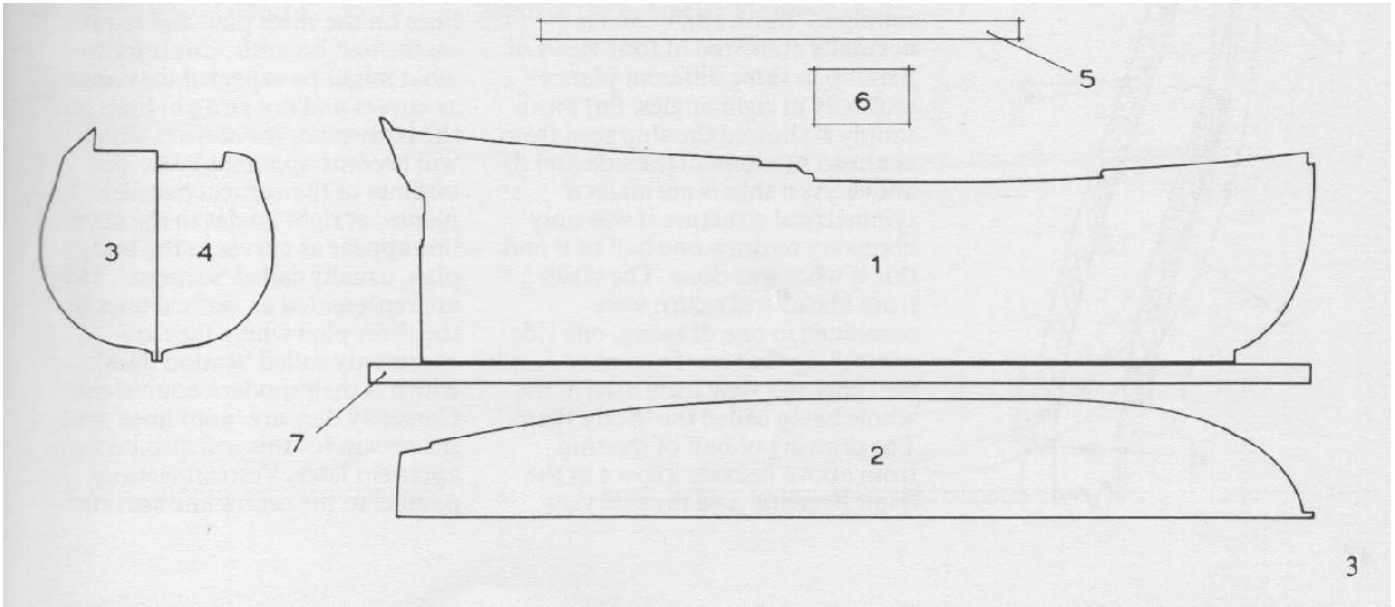


Fig. I
The conventional Sheer Draught in outline.
1: Sheer plan
2: Half breadth
3: Body plan - after body
4: Body plan - fore body
5: Title
6: Dimensions
7: Scale.

2. Profile of Inboard Works

Draught of Inboard Works or Draught Profile Known nowadays as a profile general arrangement, it was occasionally combined with the sheer draught.

3. Disposition of Frame

A drawing unique to wooden ships, it has no modern equivalent.

4. Plan of the Xxxx Deck

The twentieth century equivalent is 'general arrangement of the xxxx deck'.

5. Outboard Plank Expanded

The direct ancestor of shell expansion.

6. Inboard Works

(or Plank) Expanded Now the inner shell expansion.

Finally - where can these draughts be found? The world's largest collection of eighteenth century draughts is the Admiralty Collection in the National Maritime Museum at Greenwich. In addition to containing the draughts of almost every class of warship built in this country during this period the collection has many draughts of captured ships and merchant ships purchased for Admiralty service. The former are predominantly French, as might be expected, but Spanish, Dutch, Danish and American ships are there in some number and there is even a Russian frigate. The Greenwich museum also has around 200 draughts comprising the Hilhouse Collection. These are largely, but not entirely, of naval and merchant ships built at Bristol. Smaller but none the less valuable collections at Greenwich which contain draughts of the period are those of Charnock and Croad.

Outside the National Maritime Museum the largest collection of eighteenth century draughts is almost certainly the Mulgrave Collection at Leeds. The National Museum of Wales and the Buckler's Hard Museum are amongst those having small collections whilst further draughts of British ships also exist in the Danish and Swedish archives. Photocopies of the last two collections are held at the National Maritime Museum.

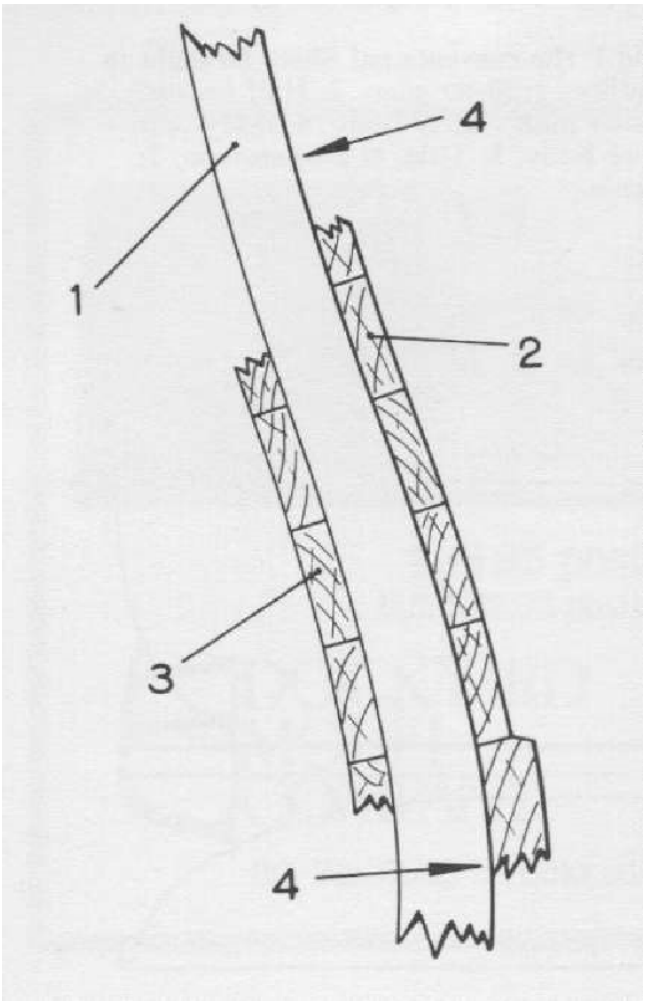
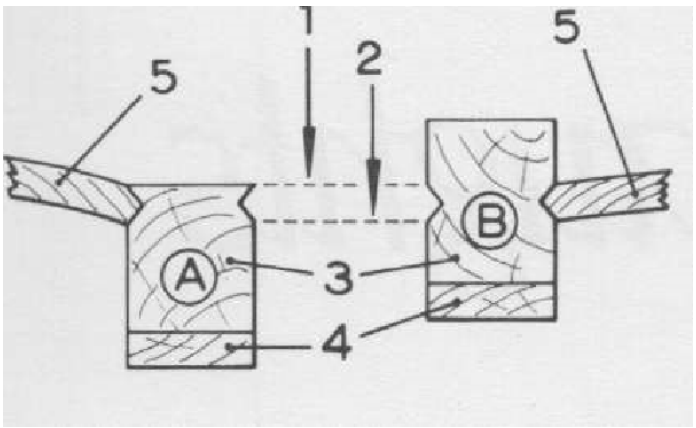


Fig.2

Part section through the side of the ship
1: Frame or bend
2: Outer planking
3: Inner planking
4: Moulding line

Fig.3

Sections through the keels of
A - a warship and
B - a merchant ship
1: Upper rabbet line
2: Lower rabbet line
3: Keel, 4: False keel
5: Garboard strake.



THE DRAUGHTS 1.

Sheer Draught

When there was only one multi- aspect drawing it was known simply as 'the draught' and it normally consisted of four views of the ship in three different planes mutually at right angles. Put more simply is showed the ship seen from a) ahead b) astern c) the side and d) above. As a ship is normally a symmetrical structure it was only necessary to draw one half of it and this is what was done. The views from ahead and astern were combined in one drawing, one side portraying the view from ahead and the other the view from astern, the whole being called the 'Body Plan'. The drawing of half of the ship from above became known as the 'Half Breadth' and the side view, which obviously could not be halved, was known as the 'Sheer Plan' or 'Sheer Draught'. A modern draughtsman, other than a ships' draughtsman, would call the body plan and sheer plan 'elevations' and the half breadth a 'plan'.

As more draughts were added:: the simple initial draught it became necessary to distinguish them and n became the practice to refer to the old draught as the sheer draught although strictly speaking the expression refers to only one part c:' it. From a very early date a convention regarding the positioning of the three aspects was established and it is still in use today, not only in Britain, but internationally. This can be seen in Fig 1 which represents a conventional sheer draught in outline only. In the top left hand corner is the body plan, the left hand half representing the view from astern and the right hand half the view from ahead. To the right of this is the true sheer plan showing the ship as seen from the starboard side, that is with its bow to the right, and below it is the half breadth facing the same way.

Outline views give no idea of the actual shape of a ship and to overcome this deficiency the hull is sectioned by a series of parallel planes and the outlines of these are incorporated in the appropriate view. The outlines of the horizontal planes are called 'waterlines' as they are usually parallel to the ship's waterline when it is floating on an even keel. They appear as straight lines on the sheer plan and curves on the half breadth. Contrary to what might be expected they appear as curves and not straight lines on the body plan, for reasons which will become apparent later. The outlines of the vertical parallel planes, at right angles to the centre line appear as curves in the body plan, usually called 'sections'. They are represented as vertical lines on the sheer plan where they are commonly called 'station lines', which is their modern equivalent. Correctly they are 'joint lines' and the reason for this will also become apparent later. Vertical sections parallel to the centre line are not usually shown on eighteenth century draughts - they were used, but only as construction lines to aid the fairing of the form at the extremities. Known as 'bow lines' in the fore body and 'buttock lines' in the after body they appear on today's plans as curves on the sheer and straight lines on the half breadth, being usually known simply as buttock lines.

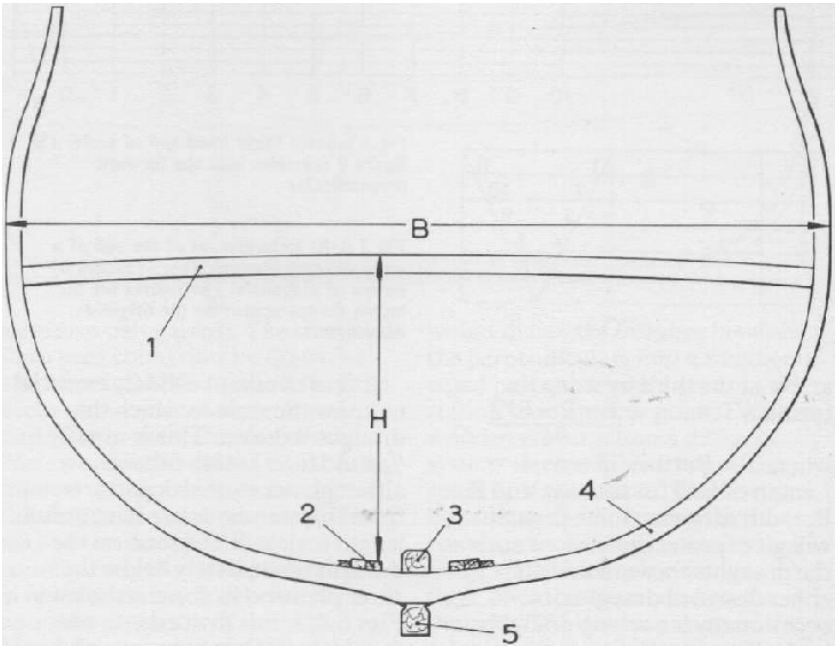


Fig.5

Section at the Dead Flat or Midships Bend.
1: Lower deck beam,
2 : Limber strakes,
3: Keelson,
4: Midships bend,
5: Keel,
B: Breadth moulded,
H: Depth in hold

Before starting on a detailed explanation of the sheer draught , there are a few points that should be bourne in mind. First of all, there is almost always an exception to every rule and although the names a and the methods described in this series are those in general use, inevitably an exception will occur fir m time to time. Secondly it should be remembered that the lines of the ship which show the form of the hull are drawn to the moulded dimensions. This means dimensions to the outside of the frame. which is the same as the inside of the outer planking (Fig 2).

Where the outer planking meets the keel stem or stern post these items are rabbeted or rebated to take the planking, so that here the moulded form is bounded by the forward rabbet line of the stern post, the after rabbet line of the stem and the upper rabbet line of the keel (Fig 3).

The basic dimensions quoted on draught are:-

A) Length on the gun deck.

This is the length from the forward edge of the rabbet of the stern post to the after edge of the rabbet of the stem at the height of the gun deck (Fig 4). The deck used to establish this dimension was the lowest continuous deck, usually but not always called the gun deck by seamen. However the shipwright's term 'lower deck' will be used throughout this series in order to avoid ambiguity.

B) Breadth moulded. The greatest breadth to the outside of the frames. This occurs at the midship bend or frame and despite its name it is seldom, if ever, at the mid-length of the ship (Fig 5).

C) Depth in hold. The distance from the top of the limber strakes to the upper side of the lower deck beam amidships. This determines the depth of the hull when the tween deck heights and the deck planking are added to it

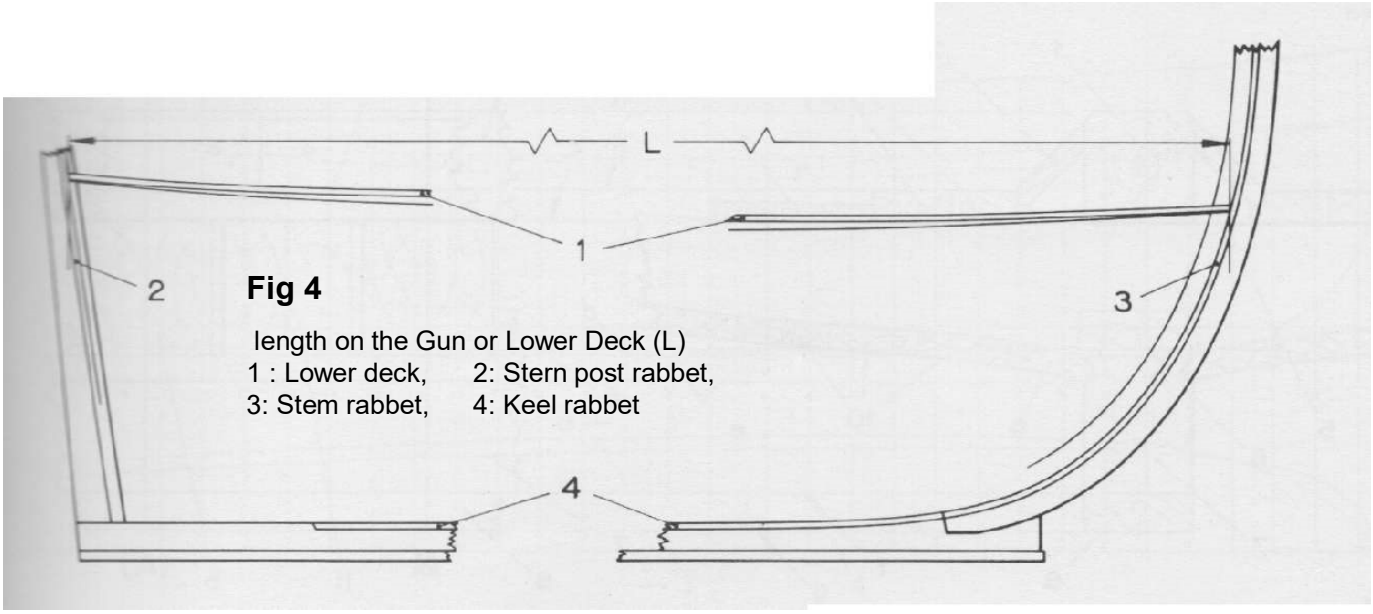


Fig 4

length on the Gun or Lower Deck (L)
1 : Lower deck, 2: Stern post rabbet,
3: Stem rabbet, 4: Keel rabbet

(Fig 5).

Other dimensions to be found on the sheer draught are 'Length of Keel for Tonnage', 'Breadth Extreme' and 'Burthen in Tons'. The first two are derived or calculated figures and are used to arrive at the third by using the formula

T = (L x B x B/2)/94

where T = Burthen in tons, L = Length of keel for tonnage and B = Breadth extreme. Some draughts will give further dimensions such as the draughts forward and aft - either designed draughts, or occasionally launching draughts, or both. These require no further comment as they are self explanatory, beyond saying that in this instance the word 'draught' means the depth of water drawn by the ship or in other words the depth of water from the waterline to the bottom of the keel.

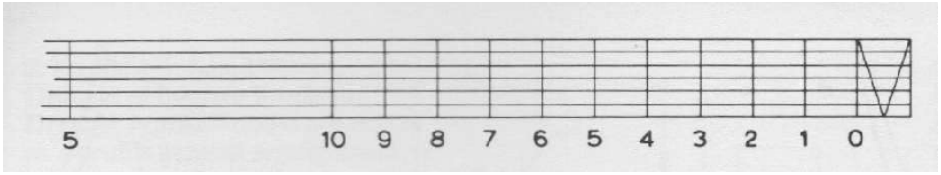


Fig.7 (left) Enlargement of the end of a scale showing measurement of inches by means of diagonals. The figures for the inches do not appear on the original drawings.

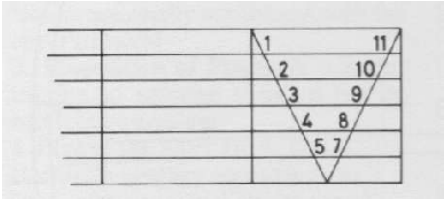


Fig.6 (above) Right hand end of scale. The figure 0 coincides with the forward perpendicular.

It is of course absolutely essential to know the scale to which the draught is drawn. This is usually 1/4in to 1ft or l/48th full size although occasional departures from this standard do occur. A full length scale will be found on the draught immediately below the sheer plan and its form is shown in Figs 6 & 7. It is divided into one foot intervals but by means of diagonals in the end sections it is possible to measure inches as well.

Finally, although perhaps not essential knowledge for a study of these early draughts, it is useful to remember that in the eighteenth century as well as in the twentieth, virtually no ship design has ever been completely original. Designs are evolved by taking the characteristics of a previous ship, similar to the one required, and modifying them. It may simply be a case of lengthening or shortening the original, leaving the other dimensions the same; or similarly

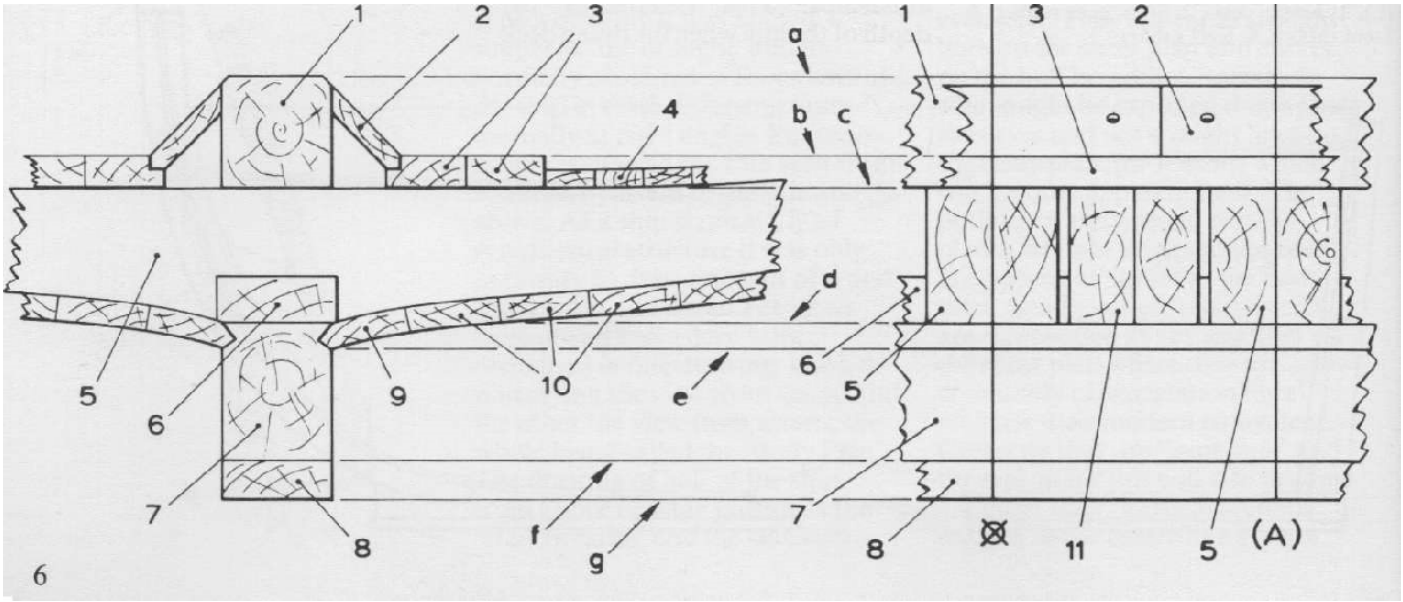


Fig.8
Section of the keel and part of the sheer plan amidships.
1: Keelson,
2: Limber board.
3: Limber strakes,
4: Ceiling,
5: Floor,
6: Rising wood,
7: Keel,
8: False keel,
9: Garboard strake,
10: Plank of bottom,
11: Filling frame,
a: Upper side of keelson,
b: Upper side of limber strakes,
c: Cutting down line,
d: Upper rabbet line of keel,
e: Lower rabbet line of keel,
f: Lower side of keel,
g: Lower side of false keel

altering beam or depth; or altering two or all three of these basic

dimensions. Alternatively overall dimensions may be retained and the form of the basic ship modified to give a greater volume and consequently greater cargo or fuel capacity; or to give a finer form in the quest for greater speed or fuel economy. The permutations are virtually infinite.

Assuming that the basic dimensions had been decided upon, the first stage in laying out the draught was to establish a datum line, and the upper rabbet line of the keel was used for this purpose. This actually coincided with the top of the keel in a warship but was usually at about mid-height in a merchant ship (Fig 3). From this line perpendiculars were set up at a scale distance apart corresponding to the length of the lower deck, together with a further one representing the dead flat or midships bend. The latter (the correct terminology for a complete double frame is bend, although frame is commonly used in this context particularly by modern observers) was normally placed just forward of mid-length, the actual position depending upon the type of vessel and/or the designer's choice. It was marked by either a circle with a cross or a circle with a plus inside or by a more elaborate variation of these two basic symbols.

The next line to be drawn in was the 'cutting down line' which represented the upper side of the floor timbers, followed by the upper side of the limber strakes and the keelson (Fig 8). It should be noted that the upper side of the keelson was not essential to the construction of the ship's lines but upper side of the limber strakes was. From this line amidships the depth of hold was set up to establish the upper side of the lower deck beam (Fig 5). By adding the desired amount of sheer to this height fore and aft the line of the lower deck could now be drawn in, and the points were this line intersected the fore and aft perpendiculars enabled the stem and stern post rabbets to be constructed (Fig9).

(In the early part of the century the lowest section of the stem was an arc of a circle but towards the end of it elliptical

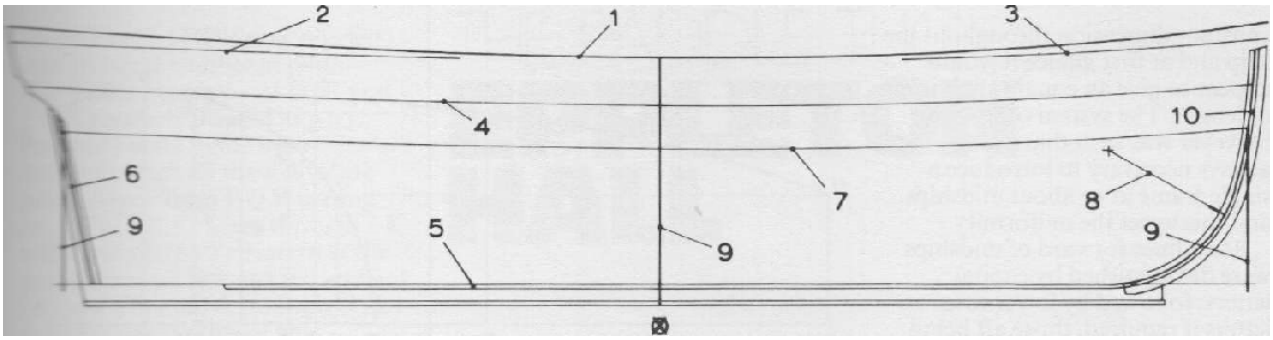


Fig 9

Outline of the sheer plan of a two decked ship
1: Sheer line, 2: Quarter deck, 1 ; forecastle. 4: Upper deck, 5: Rabbet of the keel, 6: Rabbet of stern post,
7: Lower deck, 8: Radius of the rabbet of stem, 9: Perpendiculars. 10: Rabbet of stem

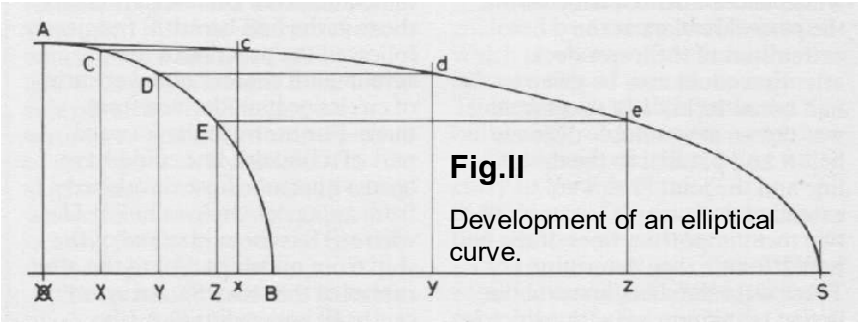


Fig.II

Development of an elliptical curve.

and designer's eye' curves were also being used). The stem and stern post could now be drawn in and after establishing the line of the decks above the lower deck and outlining in the stern, the 'sheer line', which is the upper limit of the frames, was drawn in to complete the outline of the sheer plan. (The rake of the stern post and consequently the stern post rabbet in naval vessels was dependent upon the geometry of the helm. Merchantmen as a whole had simpler steering gear not affecting the rake of the stern post which in consequence tended to follow custom or the designer's whim).

Modern draughting technique would divide the distance between the perpendiculars into a number of equal parts and would set up station lines at these points. With wooden construction a different system was used, based upon the spacing of the frames. These were bolted together in pairs with the common face being known as the 'joint' or 'joint line' and it was these lines that were used on the draught. The distance apart of the joint lines was called the 'room and space' and will be dealt with in more detail under the heading of 'Disposition of Frame'. It was a constant

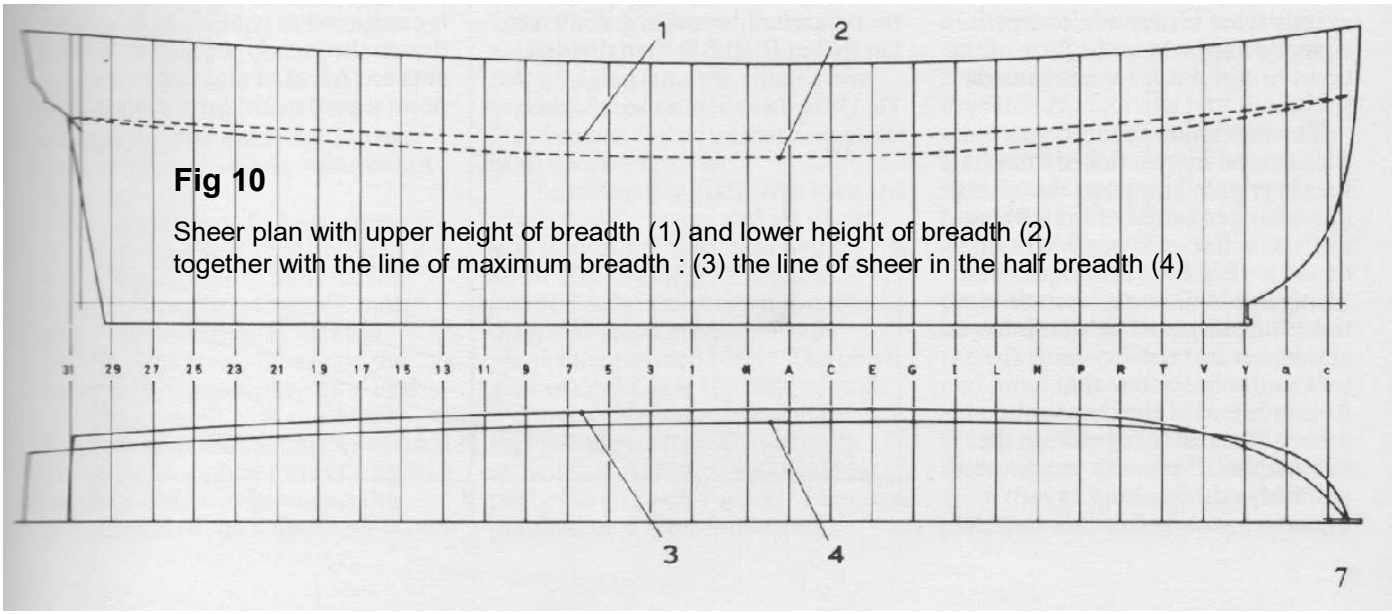


Fig 10

Sheer plan with upper height of breadth (1) and lower height of breadth (2) together with the line of maximum breadth : (3) the line of sheer in the half breadth (4)

dimension throughout the ship and at first glance it would appear to give an equal subdivision of length. The system of framing however was such that it was always necessary to introduce a single frame at or about midships and this upset the uniformity.

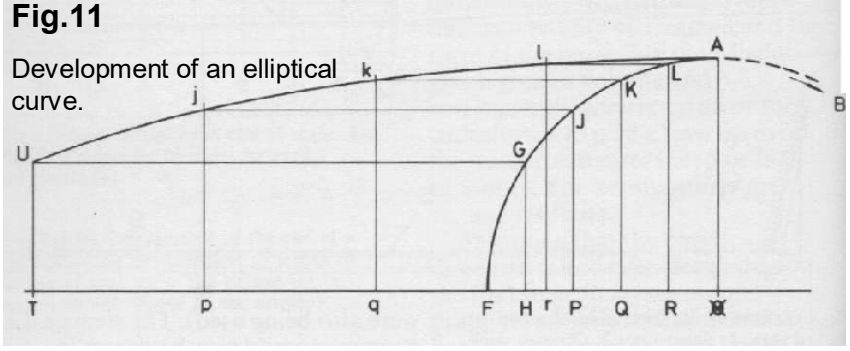
Joint lines forward of midships were distinguished by capital letters, followed by lower case letters if required, those aft being identified by numbers and because of their close proximity to one another it was usual to draw alternate ones only. The markings varied slightly but around midships the commonest combination was 7 5 3 1 @ A C E G The appearance of joint line marks in brackets indicated that the bend in question was of the same form as the midship bend or in other words that a certain amount of parallel middle body occurred.

This would appear as 7 5 3 (1)@ (A) C E G or possibly as -7 5 3 1 @ (A) A C E G

Having drawn in the positions of the required joint lines, none of which necessarily coincided with the perpendiculars at the extremities of the lower deck, attention could now be given to the half breadth (Fig 10). A centre line was drawn at a suitable distance below and parallel to the rabbet line and the joint lines were extended downwards to cut it. The two most important lines of the half breadth were then determined. These were the sheer line and the line of maximum breadth, which is exactly what it says it is, except right forward where the flare of the bows brings the sheer line outside it.

Fig.11

Development of an elliptical curve.



The maximum breadth was represented by two ticked lines on the sheer plan known as the 'rising line of upper height of breadth' and the 'rising line of lower height of breadth' (Fig 10). (The expression 'rising line' will occur from time to time, it is simply a line that is lowest amidships and rises towards the bow and stern or one that rises from one end of

the ship to the other.) The distance between the two heights of breadth was greatest amidships diminishing to zero at the extremities and in this area the side of the ship was flat and vertical. Vessels with no flat vertical sides obviously had only one height of breadth line and were seldom found in British construction but the practice was very common on the Continent, particularly in France.

The deck and sheer lines were normally drawn in by using a batten through three established points namely the heights amidships and fore and aft; but these and other curves, particularly those in the half breadth, frequently followed the practice of the seventeenth century and were arcs of circles or lines derived from them. For example the forward part of a breadth line could have been a quarter ellipse developed from a quarter circle as in Fig 11, where @S is the centre line of the ship from midships (@) to the after rabbet of the stem (S). An arc centre @ and radius @ A (the midships half breadth) is drawn to cut @S at B. @B is then divided into an equal number of lengths - in this example four - at X Y Z and perpendiculars to the centre line are erected to intersect the arc AB at C D and E. @S is similarly divided into the same number of equal parts at x y z and further perpendiculars to the centre line are erected at these points. Lines drawn parallel to the centre line from C D and E cut these perpendiculars at c d e respectively and a fair curve through A c d e and S produces a quarter ellipse.

The after part of the half breadth could be derived from the arc of a circle as in Fig 12. @T represents the after part of the centre line, T being the forward rabbet of the stern post and @ A is once again half of the midships breadth. A perpendicular TU is erected to the desired half breadth aft and arc BA is continued to cut @T at F. A line drawn through U parallel to T@ cuts arc AF at G and from this point a perpendicular is dropped to cut F@ at H. H@ is now divided into an equal number of parts - four in this example - at PQR and similarly divided at p q r. Perpendiculars to the centre line are drawn through all these dividing points, those from PQR cutting AF at J K L. Lines through J K and L parallel to T@ intersect the perpendiculars through p q and r at j k l . - d a fair curve through U j k l A completes the line of half breadth.

Sometimes the designer would wish to use the arc of a very large circle, beyond the scope of his drawing instruments - rising lines were frequently arcs of circles, and they can be constructed as in Fig 13. which represents the forward half of a rising line. If A and B are the heights of the rising line amidships and forward respectively then the rectangle A@BC is completed by drawing horizontal and vertical lines through these two points. A line is drawn from B perpendicular to the diagonal AB to cut AC produced at D. @B, AD and BC are now divided into equal parts (again four in this example) at X Y : and PQR respectively. Xx, Yy, Zz and AP, AQ, AR are joined and a true circular arc is obtained by running a fair curve from A to B through the intersections p, q and r an the drawing. The use of mathematically derived curves of this nature, although in almost universal use at the beginning of the century had virtually died out by the end of it as far as the Royal Navy was concerned. Merchant designers, lacking the sophistication and technical resources of their Navy Board contemporaries continued to use them until well into the nineteenth century.

Having drawn the basic lines on the sheer and half breadth plans it was now possible to start on the body plan and the first and most important thing to do was the outline, which was of course the same as the midships section and will be dealt with in Part II,

together with the various ways used through the eighteenth century to produce the body plan and the actual lines of the ship.

Having established the basic lines on the sheer and half breadth plans it was then the turn of the midships section. This determined the ship's form and the most important part of it was that which lay below the waterline, or, for practical purposes, below the lower height of breadth line. In the eighteenth century the midships section was built up from arcs of circles, known as sweeps, and could be categorised by the number of sweeps used below the lower height of breadth - either one, two or three. The most primitive sections were made up, not from curves, but from two or three straight lines (fig 1), and although found in a few basic craft like lighters or punts they are only of interest in

this context because they lead to the introduction of single sweep sections and the use of the term 'floor' for the flat part of a ship's bottom. It can be seen from fig 2 that the centre of the floor sweep, in a single sweep section, was

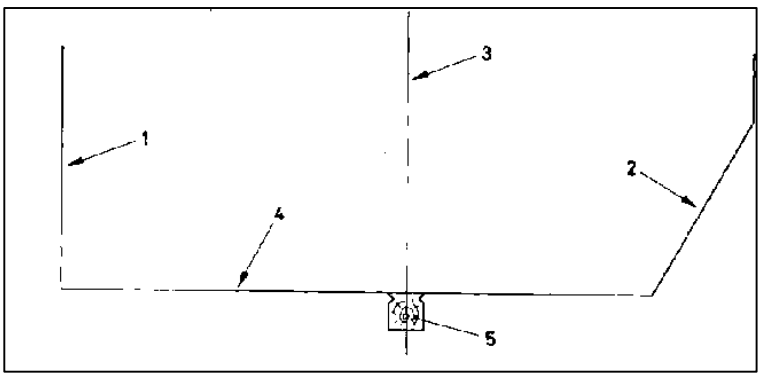


Figure 1

Straight line sections.
1. Larboard side 2. lines;
2. Starboard side-3 lines;
3. Middle line;
4. Floor;
5. Keel.

vertically above the outboard end of the flat floor (floor head) and in the horizontal plane of the lower height of

breadth - its radius being the vertical height between the floor and this plane. In the half breadth (fig 3) this centre is shown at X and by keeping a constant radius of floor sweeps for all stations a 'line of centres of floor sweeps' could be drawn equidistant inboard from the height of breadth. This was known as the 'narrowing line of floors' as it represented not only the line of the centres of the sweeps but also the floor heads directly beneath them. In a similar manner a 'rising line of floors' could be drawn on the sheer plan at a distance equal to the radius of the floor sweep below the lower height of breadth line (fig 4).A flat-bottomed vessel under sail makes a great deal of leeway with the wind anywhere except dead aft, and as a vessel built in this manner would also have a curved keel, which would exaggerate this tendency, it would also be extremely difficult to steer. In order therefore to increase the sailing qualities of this type of hull a deeper straight keel was added and the hull was faired into it by means of an auxiliary curve known as a 'rise of floor sweep' or more simply as the 'rise of floor'. This was usually put in by eye using a batten and would have been of the same form throughout the length of the vessel.

The height of the floor above the rabbet line became known as the 'deadrise' (fig 5).

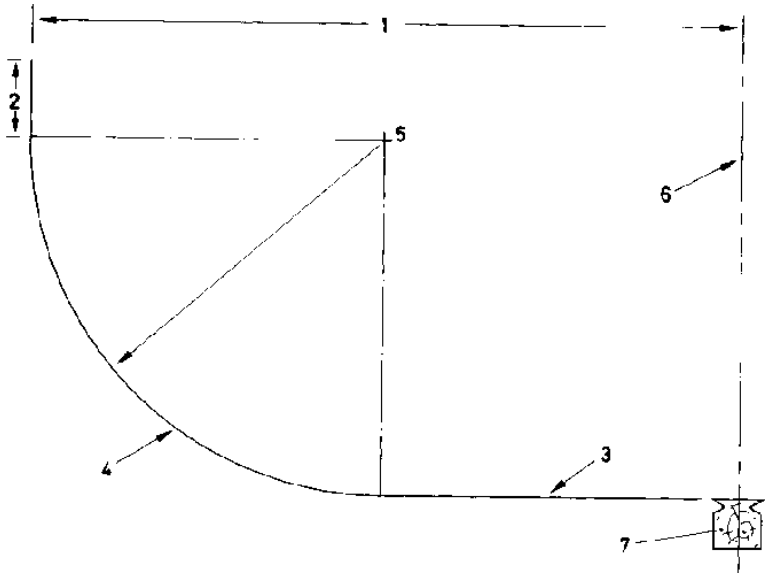


Fig 2

1. Maximum breadth;
2. Height of breadth;
3. Floor;
4. Floor sweep;
5. Centre of floor sweep;
6. Middle line-
7. Keel.

This method of deriving the midships section was used mainly by the smaller builders - only two templates or moulds, used in conjunction with a line of maximum breadth, a line of floors and a sheer line, enabled all the frames of a vessel to be laid off without the need of a more complicated body plan or offsets, and a skilled mould maker to interpret them. It was known as 'whole moulding' and although not used for naval vessels it was used throughout the eighteenth century and well into the nineteenth century in the construction of large pulling boats for warships, where a large carrying capacity, rather than seaworthiness and sailing qualities, was the primary consideration. Its other main use in Britain was for barges and lighters where similar characteristics were required, but it was quite popular on the Continent of Europe, particularly in the shallow waters off the Dutch coast where its shallow draught was a great advantage and where its leewardly qualities were largely overcome by the use of leeboards. The main drawback to whole moulded hulls was their fullness at the extremities and so for sea-going ships it was soon overtaken by the better method of employing two sweeps of different radii (fig 6). In the basic form of the two-sweep section the sweeps met on a common 45° diagonal AC (fig 6) from the intersection A of the vertical through the maximum breadth B and the horizontal through the rabbet line R, cutting the middle line at C. A vertical through D, the floor head, cut AC at F and established the centre of the floor sweep DH. A horizontal through B cut AC at G, the centre of what became known as the 'lower breadth sweep' - BH. Having established this midships section the

Figure 3 Whole moulding – half breadth.
1. Line of maximum breadth; 2. Narrowing line of floor (line of floor head); X. Centre of midships floor sweep.

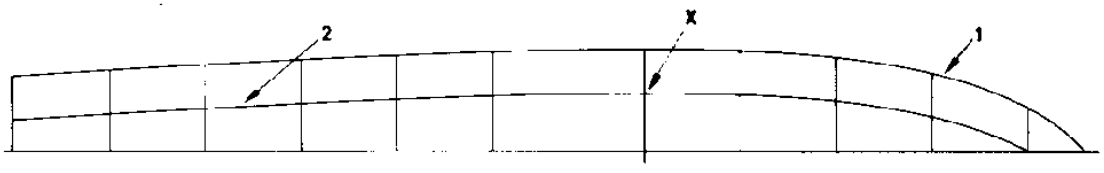
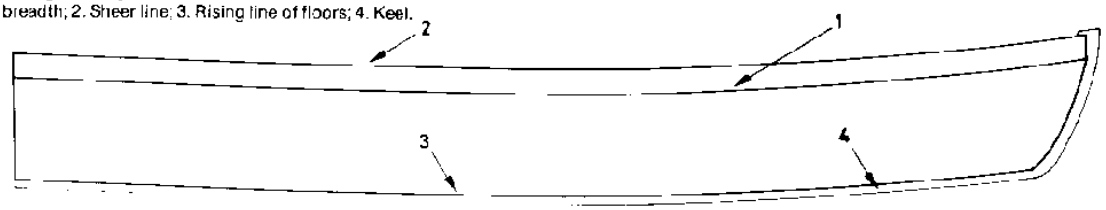


Figure 4 Whole moulding – sheer plan.
1. Rising height of breadth; 2. Sheer line; 3. Rising line of floors; 4. Keel.



designer now had four variables at his command (the two sweep radii, the maximum breadth and the line of floors) and by varying these factors fore and aft was able to introduce better hull forms. However, just as in whole moulding, the lower height of breadth was dependent on the maximum breadth and so there still remained a drawback to this method. That was that by sticking to the 45° diagonal a rather low height of breadth, and consequently a shallow hull, resulted. By the middle of the century the centre of the lower breadth sweep tended to move to another diagonal a few inches above and parallel to the first one (ac in fig 7). The lower breadth sweep met this line in h and the gap /zH was filled by means of a straight line tangential to both

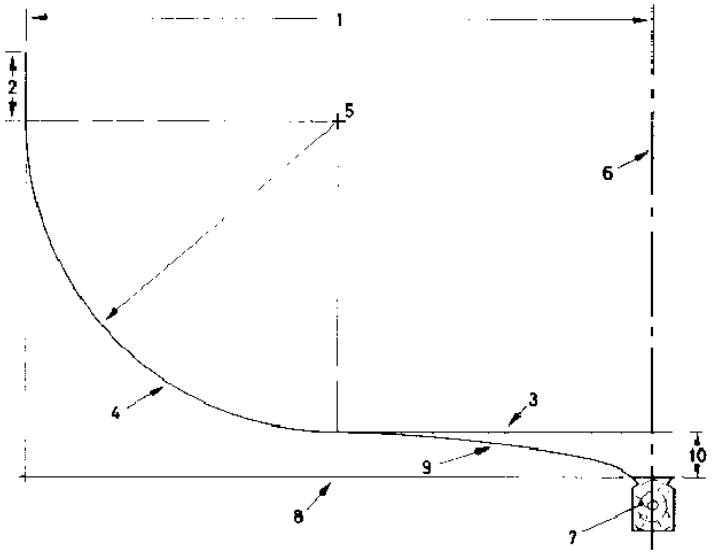


Figure 5

Single sweep section with deadrise.
1. Maximum breadth;
2. Rise of breadth;
3. Floor;
4. Floor sweep;
5. Centre of floor sweep;
6. Middle line;
7. Keel;
8. Base (rabbet) line;
9. Rise of floor;
10. Deadrise.

sweeps. This of course produced a flat on the hull which was unacceptable for more than a few inches, and as the centre of the floor sweep was also starting to move away from the diagonal (producing an even larger gap) a further sweep became necessary to fill it and the three sweep midships section had evolved. It should be noted that a three sweep section was nothing new at this stage as the two sweep midships section, when developed fore and aft, usually became a three sweep section. It was the three sweep midships section that was new* With this section the centre of the floor sweep remained above the floor head but now its radius was determined by the designer rather than by the 45° diagonal, which was abandoned. The lower height of breadth was raised and the centre of the lower breadth sweep was similarly determined by the designer. Having drawn in these two sweeps they were then joined with a fair curve by means of a third large radius 'reconciling sweep' (fig 8)

Multiple sweep sections tended to produce relatively narrower floors than the single sweep sections and consequently although the concave rise of floor, tangential to the floor, continued to be used, its curvature became sharper and so there was a growing tendency to introduce a rise of floor tangential to the lower floor sweep (fig 9).

It will be seen later that this happened of necessity with sections in the fore and after bodies as they got finer, even when it did not occur in the midships section. Where the deadrise was not materially changed a straight line rise of

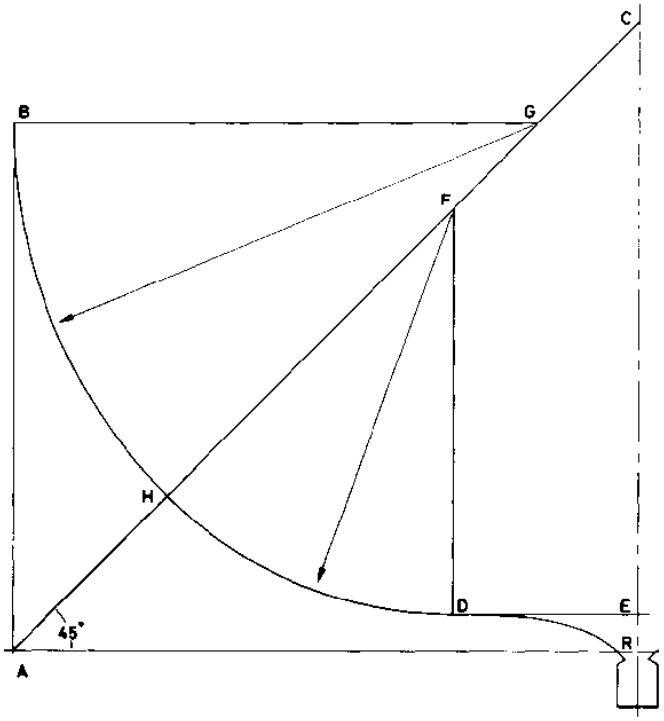


Figure 6

Two sweep section.
BH- lower breadth sweep;
G-centre of lower breadth sweep;
HD-floor sweep;
F-centre of floor sweep;
DE- floor;
DR - rise of floor;
AC - 45° diagonal.

floor was sometimes used but with the tendency for the deadrise to increase, in the effort to improve efficiency to windward, a concave line was preferred to keep the tangential point closer to the floor head. (The ultimate in straight line deadrise was probably reached by the Symonds' 'peg top' designs of the mid-nineteenth century and the ultimate in concave deadrise can be seen in twentieth century racing yachts.)

It still remained to establish the topsides, above the maximum breadth. In the case of the single sweep sections of small radius the maximum breadth was continued up to the sheer line to give a wall sided body. Larger radius

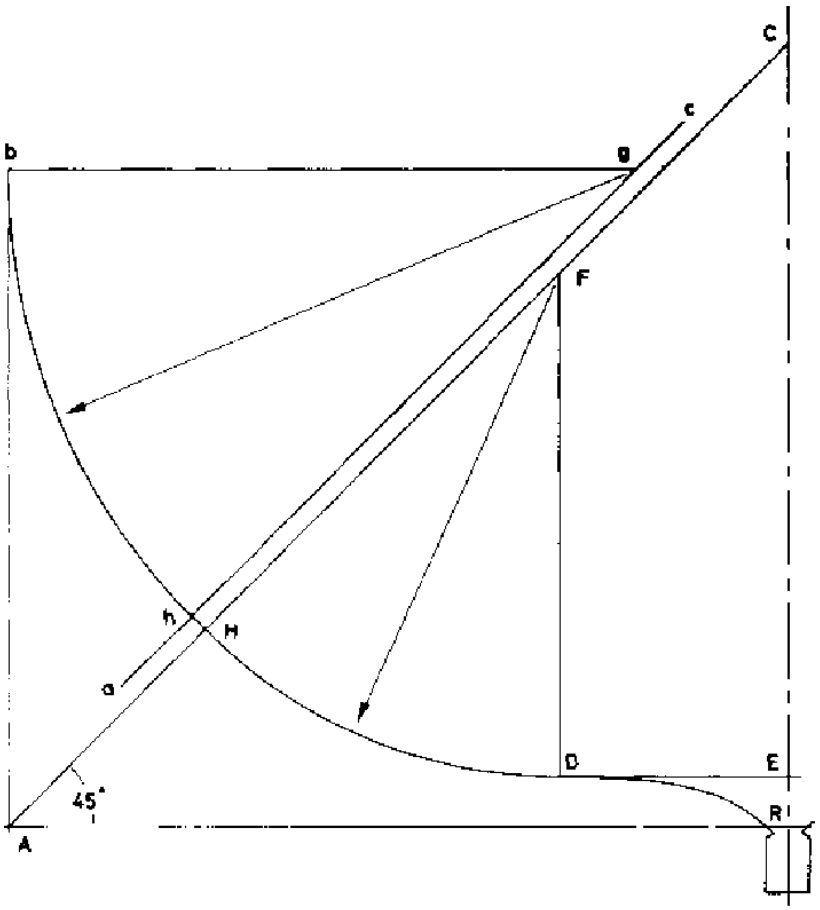


Figure 7

Modified two sweep section.
bh- lower breadth sweep;
g - centre of lower breadth sweep;
HD - floor sweep;
F- centre of floor sweep;
DE - floor;
DR - rise of floor;
AC - 45° diagonal; ac - second diagonal.

sections frequently simplified matters by making the sheer line coincide with the line of maximum breadth. However in order to make a reasonably shaped hull a comparatively steep rising line of floors was needed which by this method produced an exaggerated sheer line. Consequently many whole moulded craft, and warships boats in particular, had a sheer line coincident with the maximum breadth amidships and cut below it towards the ends (fig

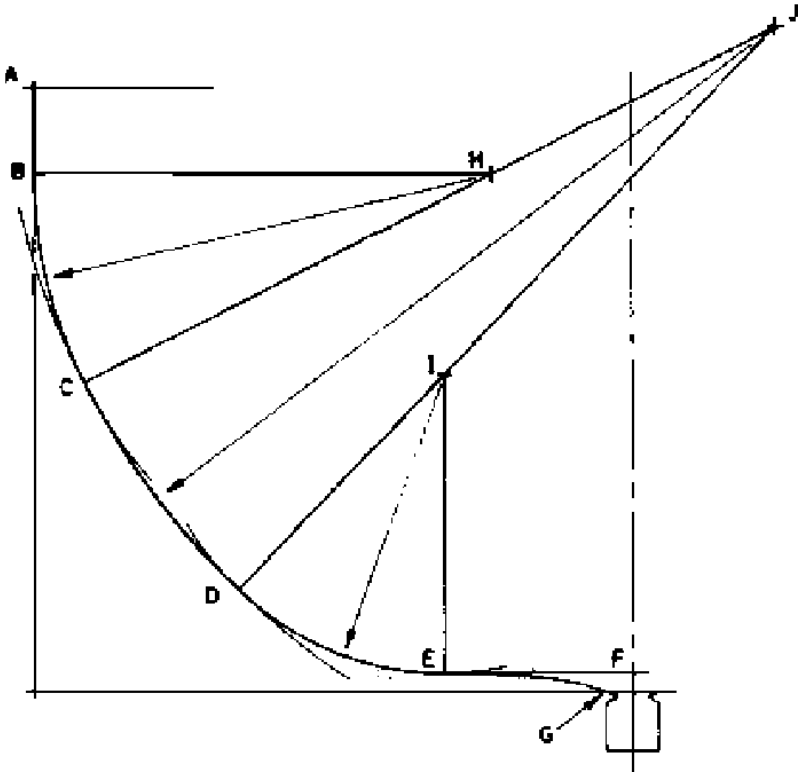


Figure 8

Three sweep section.
A - upper height of breadth;
B - lower height of breadth;
BC - lower breadth sweep;
CD - reconciling sweep;
DE - floor sweep;
EF - floor;
EG - rise of floor
G - rabbet line;
H - centre of lower breadth sweep;
I - centre of floor sweep;
J - centre of reconciling sweep

10). Multiple sweep sections usually had a small tumblehome in merchant ships but in warships a two part reverse curve was used (fig 11). The lower part was called the upper breadth sweep and had its centre at F in the same horizontal plane as the upper height of breadth C. The upper part, the 'top timber sweep' had its centre at E, either in the same horizontal plane as the sheer line A - which brought the side vertical at the deck edge - or more usually just above it giving a slight tumble home. Having established the midships section the next stage was to develop it into the body plan by drawing sections corresponding to the stations already marked out on the sheer plan and half breadth. First of all the longitudinal lines already drawn on the sheer plan and half breadth were marked out on the body plan. These were the sheer line, the upper and lower heights of breadth and the line of floors, and fig 12 shows how it was done for station 7 in the after body, all the other stations in both the fore and after bodies being treated in

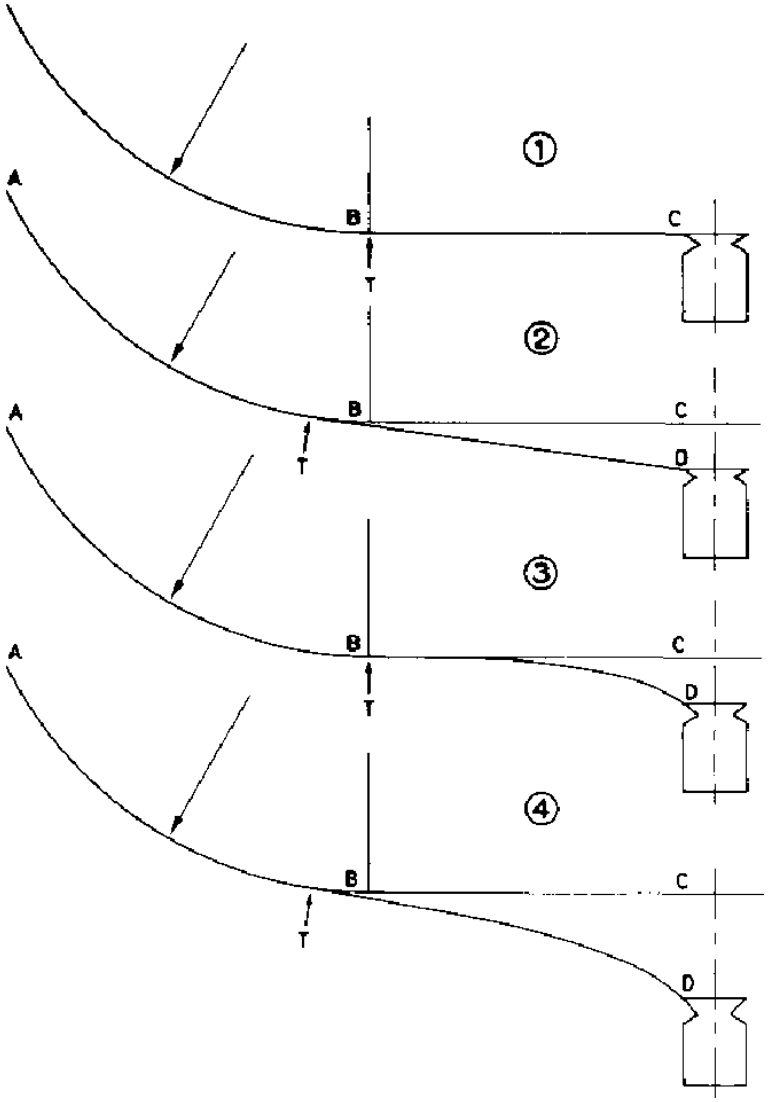


Figure 9

Variations on rise of floor.
1. No rise of floor;
2. Straight line tangential to floor sweep;
3. Curve tangential to floor;
4. Curve tangential to floor sweep;
AB - floor sweep;
BC - floor;
BD - rise of floor;
T - tangent point.

exactly the same way. From the sheer plan the heights of the longitudinal lines above the rabbet line at station 7 were measured and a horizontal pencil line was drawn at each height - AB, CD, EF and GH at the height of floor, lower height of breadth, upper height of breadth and sheer lines respectively. Similarly from the half breadth the horizontal positions of these lines at station 7 were found and marked by vertical pencil lines - IJ, KL, and MN at the breadth of floor, maximum breadth and sheer lines. The intersection of AB with IJ at O gave the position of the floor head and BO represented the floor. The intersections of CD with KL at P and EF with KL at Q gave the positions of the lower and upper heights of breadth and the maximum breadth was marked in by joining P and Q. The position of the sheer line was given by the intersection of GH with MN at R. It was now possible for the centre of the floor sweep to be marked in on OI at S, for the centre of the lower breadth sweep on DP at T and for the centre of the upper breadth sweep at U on FQ. Normal practice was to ink in the lines OS and PT but not QU, U being simply marked with a +. This was to avoid the confusion of horizontal lines which would have otherwise resulted when all the sections had been drawn in. The sweep centres and radii having now been fixed the sweeps were drawn in and the sections completed, the process being repeated for each station in turn. Fig 13 shows a few of these sections completed and with equivalent points in them joined with fair curves to give the sheer line, the upper and lower height of breadth lines, the floor line, the line of centres of the lower breadth sweeps and the line of centres of the floor sweeps. The line of centres of the lower breadth sweeps was purely a fairing line to ensure that the change of radius of the sweeps fore and aft was smooth. It was usually a ticked line in the body plan and was of course coincident with the lower height of breadth line in the sheer plan. It did not appear in the half breadth although it

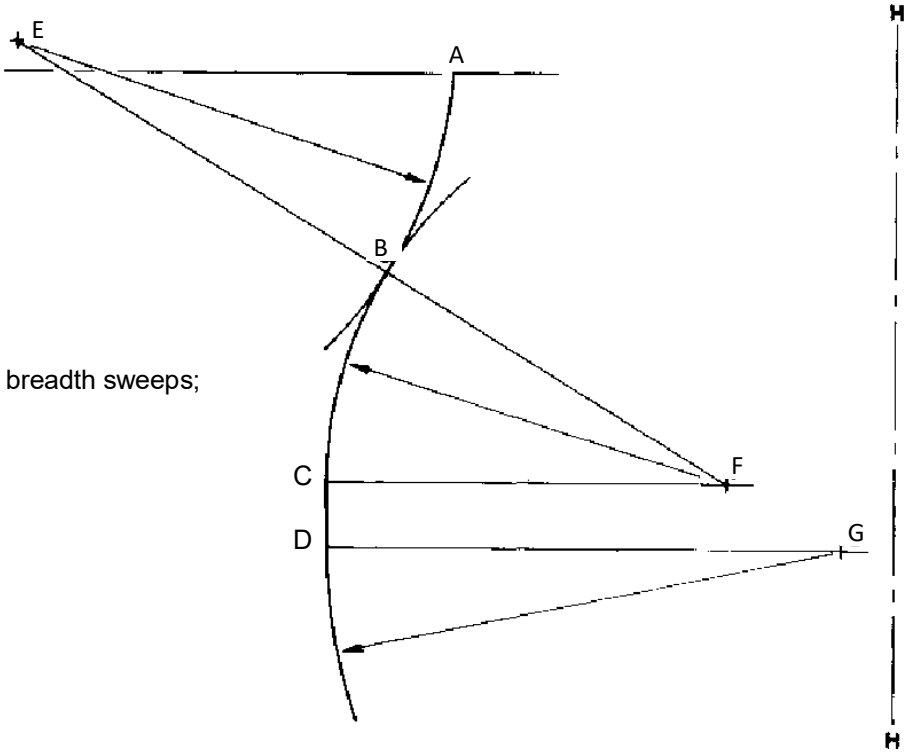


Figure 11

Construction of topsides.
A - sheer line;
B - intersection of top timber and upper breadth sweeps;
C - upper height of breadth;
D - lower height of breadth;
E - centre of top timber sweep;
F - centre of upper breadth sweep;
G - centre of lower breadth sweep;
HH - middle line;
AB - top timber sweep;
BC - upper breadth sweep.

would have been used as a construction line. No fairing line was required for the centres of the upper breadth sweeps as, with very few exceptions, these were of constant radius throughout the length of the ship - as were the top timber sweeps - and were therefore equidistant from an already fair line, the upper height of breadth.

The floor sweeps also being of a constant radius, the line of their centres was consequently equidistant vertically from the line of floors and although shown ticked on the body plan it did not appear on the sheer plan. It would have been of no practical use there and would have only added confusion in an area which in the finished draught contained the rising lines of the upper and lower heights of breadth, the upper and lower lines of the wales and probably deck lines on both the middle line and the ship's side as well. It was of course coincident with the narrowing line of floors on the half breadth. Although the three sweep section proved satisfactory amidships it tended to produce too fine a hull at the turn of the bilge towards the extremities, so that by the middle of the century the floor sweeps in the forward quarter and the aftermost third of the hull were being ignored, the body sections coming outside them. The ever conservative Navy Board turned a blind eye to this and continued to clutter its draughts with a forest of floor lines and their associated vertical sweep radii even though almost half of them were of no use

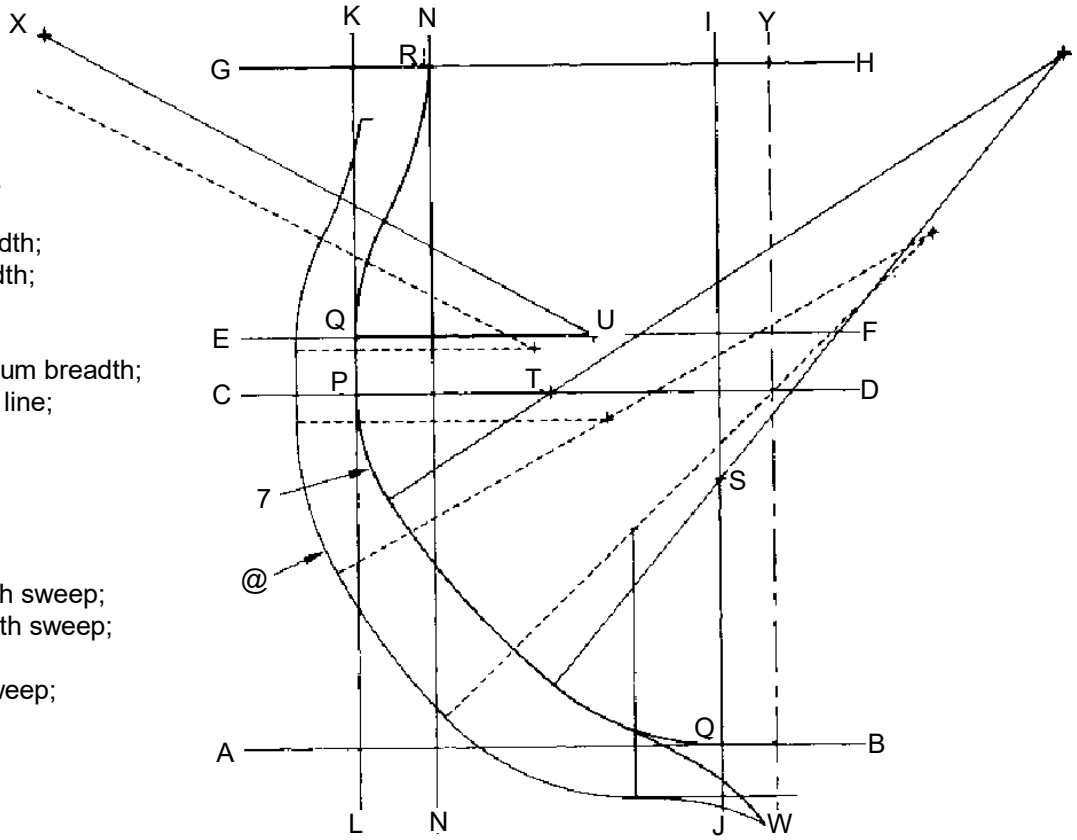


Figure 12

Construction of section 7.
AB - height of floor;
CD - height of lower breadth;
EF- height of upper breadth;
GH- height of sheer line;
IJ - half breadth of floor;
KL-half breadth of maximum breadth;
MN-half breadth of sheer line;
O - floor head;
P- line of lower breadth;
Q - line of upper breadth;
R - line qf sheer;
S - centre of floor sweep;
T - centre of lower breadth sweep;
U - centre of upper breadth sweep;
VW-middle line;
X- centre of top timber sweep;
7 - section 7;
@ - midships section.

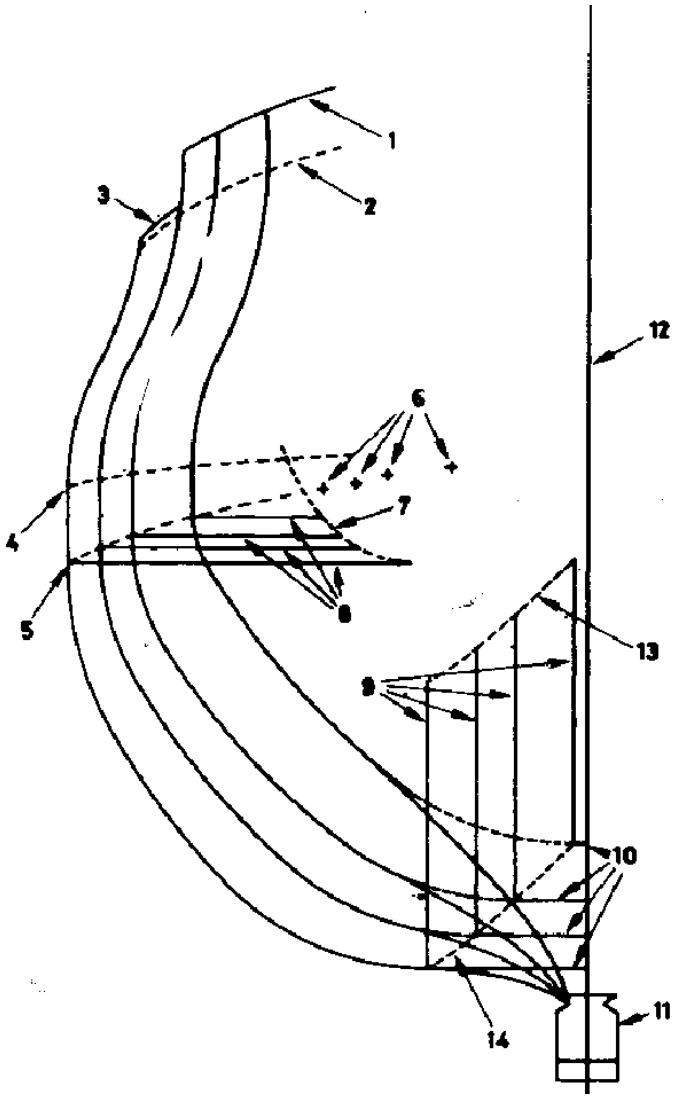


Figure 13

Part of after body plan.
Rough tree rail (quarterdeck rail);
2. Sheer line;
3. Plansheer in waist;
4. Rising line of upper breadth;
5. Rising line of lower breadth;
6. Centres of upper breadth sweeps;
7. Line of centres of lower breadth sweeps;
8. Radii of lower breadth sweeps;
9. Radii of floor sweeps;
10. Floors;
11. Keel;
12. Middle line;
13. Line of centres of floor sweeps;
14. Rising (and narrowing) line of floors

whatsoever. Fig 14 is part of the body plan of a 36-gun frigate of 1757 and demonstrates quite clearly that the last floor sweep used going aft was at station 7 and going forward it was at station G. The floors and associated sweep radii were however drawn in as far as stations 17 and N respectively In 1764 Sir Thomas Slade, one of the Surveyors of the Navy and probably best remembered as the designer of Nelson's Victory, introduced a new method of developing body sections which used a novel concept of floor sweeps, the other sweeps remaining as before. Although the centre of the midships section floor sweep remained above the floor head in this new system, exactly as it had done previously, as the body sections progressed fore and aft the lengths of the floor sweep radii increased and their centres moved towards, and eventually across, the middle line. The line of centres now

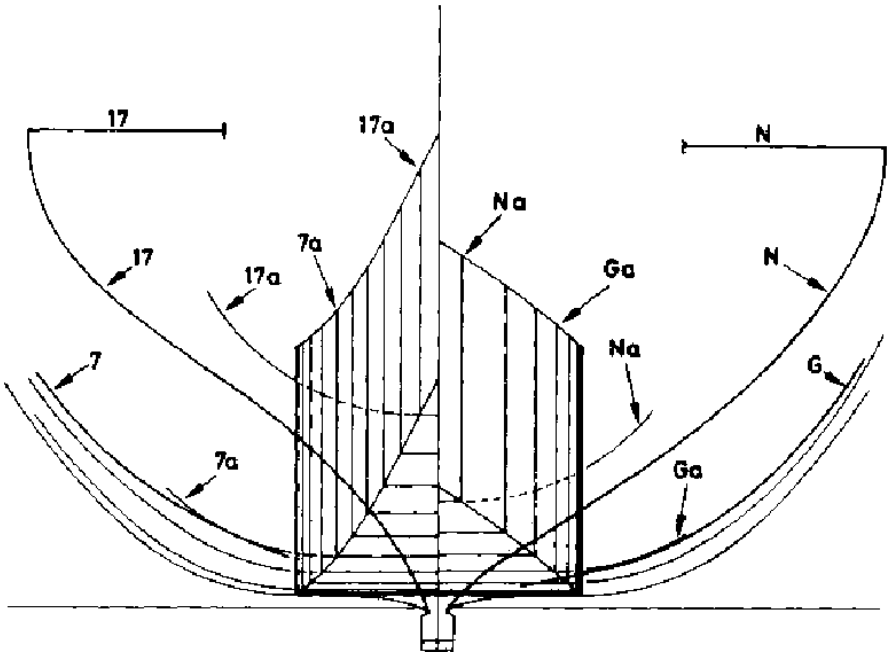


Figure 14

Part body plan of 36-gun frigate of 1757.
7. Part of section 7;
7a. Floor sweep and radius, section 7;
17. Part of section and lower breadth sweep radius, section 7;
17a. Floor sweep and radius, section 17;
G. Part of section G;
Ga. Floor sweep and radius, section G;
N. Part of section and lower breadth sweep radius, section N; Na. Floor sweep and radius, section N.

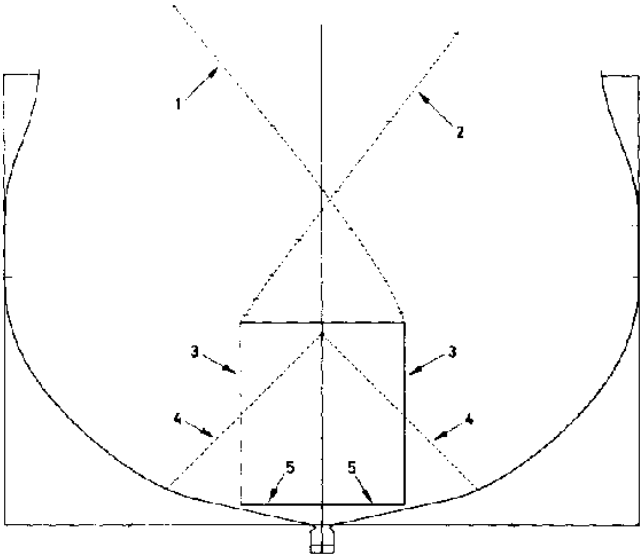


Figure 15
Midship section based on floor harpin.
1. Rising line of centres of floor sweeps - fore body;
2. Rising line of centres of floor sweeps - after body;
3. Radius of midship floor sweep;
4. Floor harpin;
5. Floor.

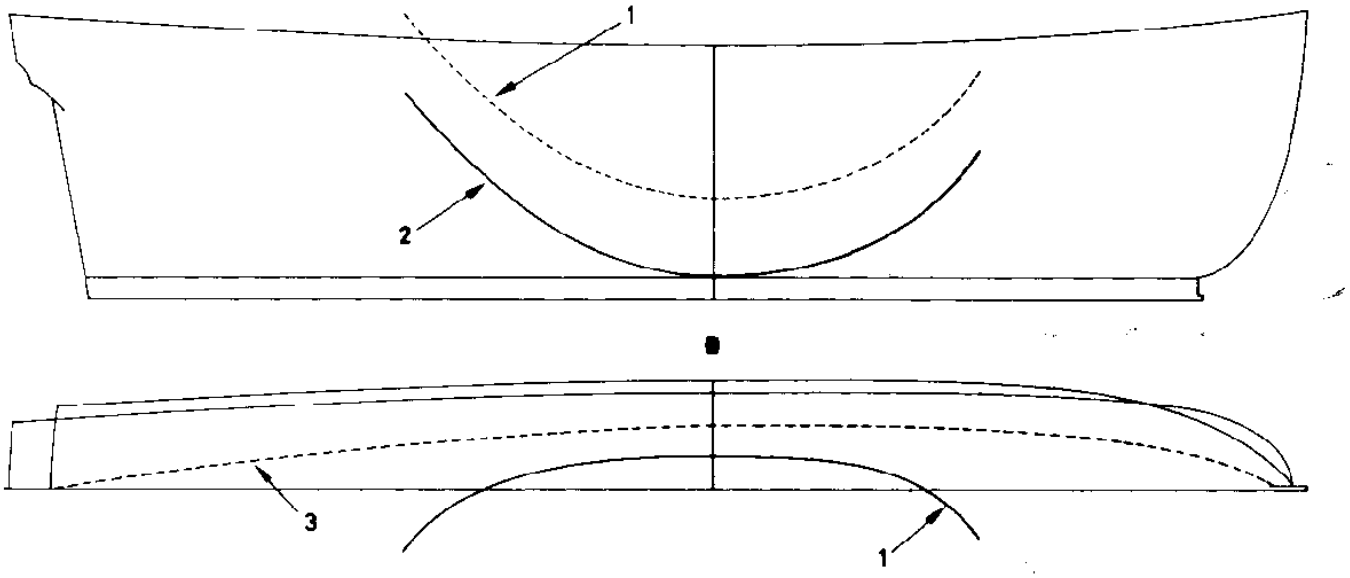


Figure 16

Sheer plan and half breadth based on floor harpin.
1.True position of line of centres of floor sweeps;
2. Conventional position of line of centres of floor sweeps;
3. Floor harpin.

appeared on the body plan as a ticked line (fig 15) and on the half breadth as a full line (fig 16). The sheer plan was treated slightly differently. As already mentioned, in the old system the line of centres was not drawn in on the sheer plan as it was not needed there - the rising line of floors, of exactly the same form and lower down, being used instead. The new system adopted the same idea and placed the line of centres of the floor sweeps lower down than its actual position, in a clear area tangential to the rabbet line amidships.

As the centres were no longer above the floor heads the sweeps did not come in tangential to them and so a new base line had to be established. This was a 'floor harpin' and was simply a diagonal at 45° to the base line from a point between a half and two thirds of its half length from the middle line. Conventionally it appealed on both the body plan and the half breadth as a ticked red line but was omitted from the sheer plan. Jhe radii of the sweeps were then taken from the appropriate centres to the floor harpin and not to the floor head as before, except for those of the midships section where these two lines were equal in length.

The waterlines are the only major lines on the sheer draught which remain to be described and these will be dealt with in Part 3 together with the many auxiliary and construction lines which may, or may not, be found there. (Part 3 will be published in Model Shipwright 50. Editor)

The joint lines in the body plan in-dicated the shape of the ship divided into sections by vertical planes at right angles to the middle line plane. Draught waterlines show the shape of the ship divided by horizontal planes parallel to the ships actual waterline. In modern vessels the designed waterline is norm-ally parallel to the keel or base line and so the waterlines are mutually at right angles to the sections and to the middle line plane. However eighteenth century

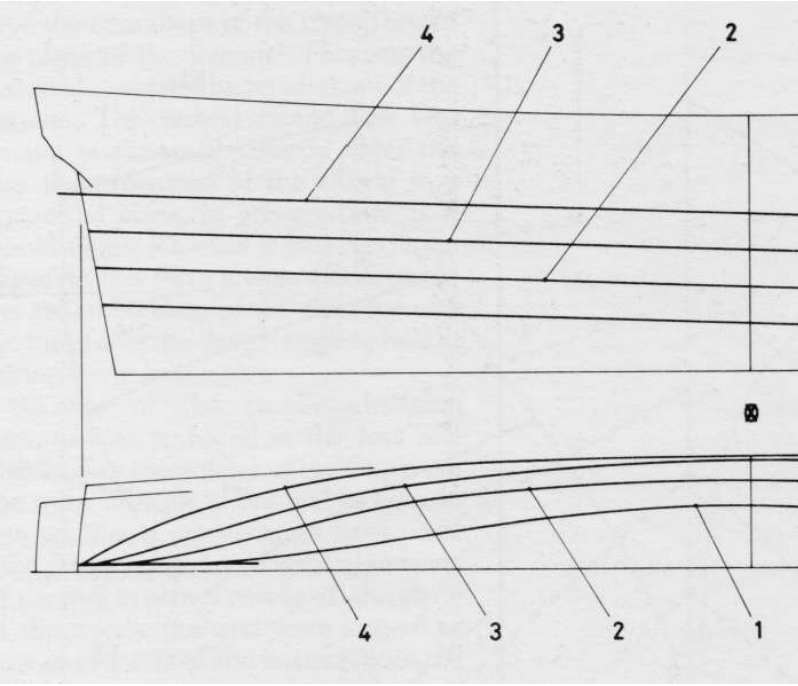


Figure 1
Appearance of waterlines in the sheer plan
1-3 waterlines 1-3
4 designed waterline

sailing ships were designed to have a trim by the stern, as this had been found by experience to improve their sailing qualities. The design waterlines there-fore were not at right angles to the joint line (fig 1). They appeared as straight lines in the sheer plan and as curves in the half breadth, and although they might be expected to be straight lines in the body plan it will be seen from fig 2 that they were actually curves. It was conven-tional to draw the waterlines in green ink. Unfortunately the copper salts used to produce the green colour have a tendency, over a long period of time, to migrate into the paper, resulting in a thick fuzzy line which black and white reproduction seems to emphasize.

Examination of the body plan reveals a number of diagonal lines which have yet to be defined. The first group com-prises the lines of the floor heads and the first, second and third futtock heads. (The floor and futtock heads are the up-per ends of the various timbers compris-ing the frame bends, and will be dealt with in more detail when the 'Disposi-tion of Frames' draught is described.)

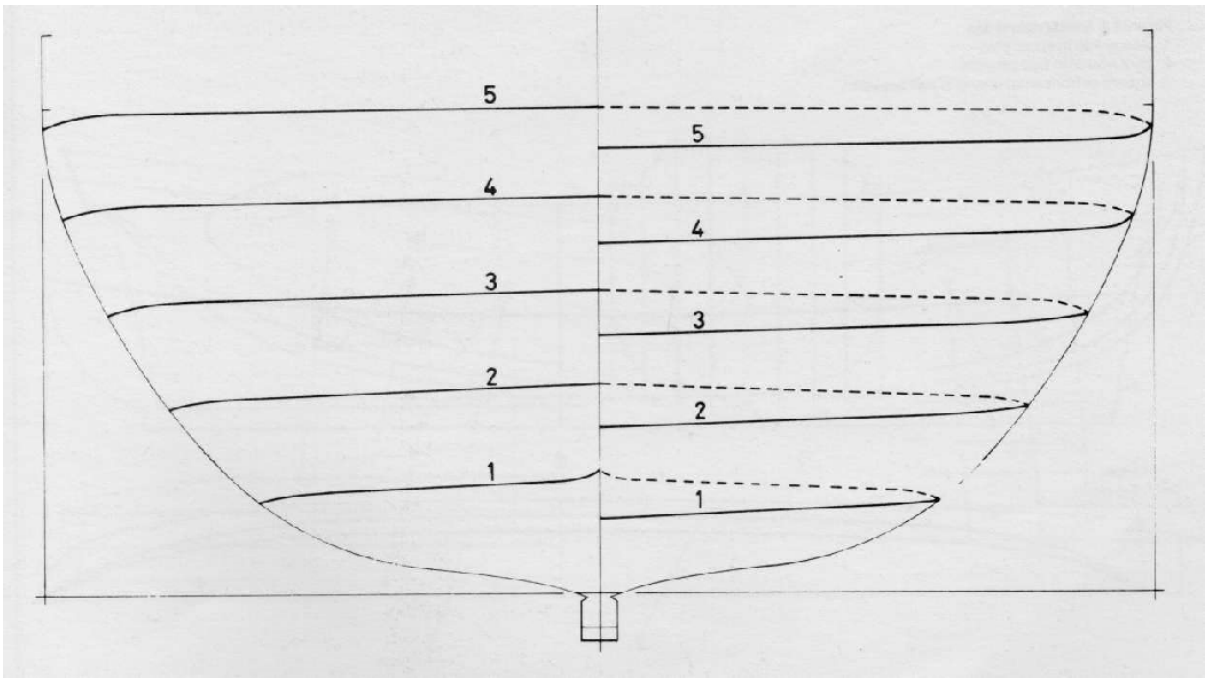


Figure 2

Appearance of waterlines in body plan. Ticked lines inforebody re peat the waterlines in the afterbody. They do not appear in the original draughts.
1-4 waterlines 1-4
5 designed waterline

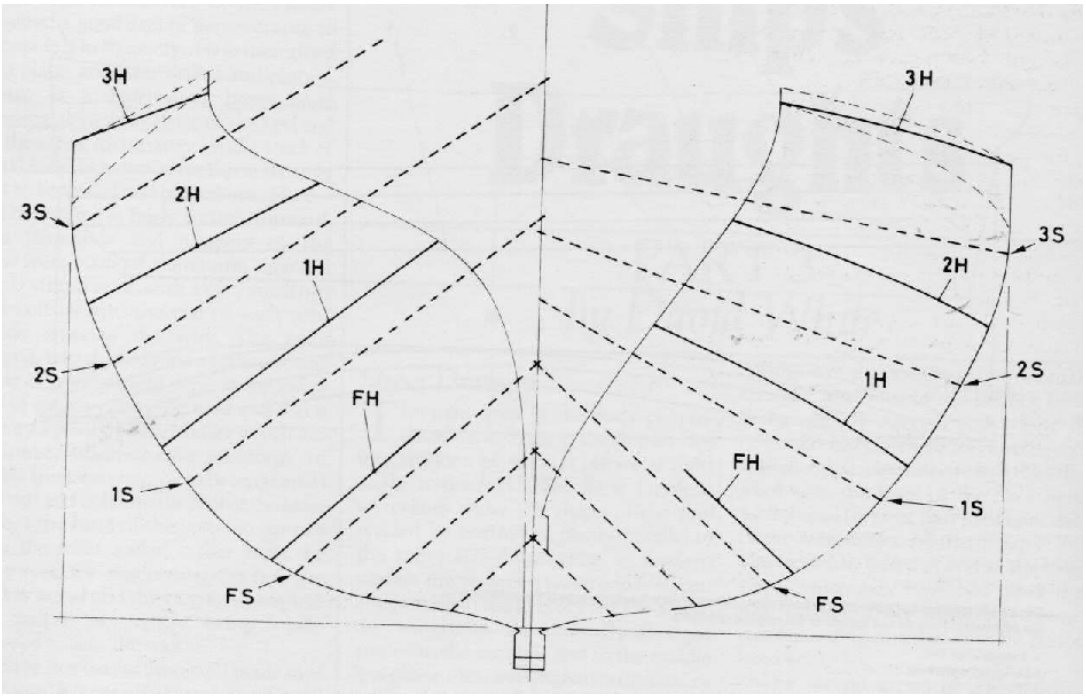


Figure 3

Diagonal lines in the body plan

FH floor head
1H 1st futtock head
2H 2nd futtock head
3H 3rd futtock head

FS floor sirmark
1S 1st futtock sirmark
2S 2nd futtock sirmark
3S 3rd futtock sirmark

The lines of the floor heads were usually straight, the lines of the futtock heads being slightly curved, and whilst the latter did not continue forward beyond the foremost joint line or abaft the after-most one, the lines of the floor heads terminated three or four joint lines short of the extremities. All this group of lines was normally inked in and in the larger ships which may have had more than four futtocks there would have been a corresponding number of extra futtock head lines.

The second group of diagonal lines which may appear on the body plan, usually in pencil, served a twofold purpose. In addition to being construc-tion lines used to help in 'fairing' the ship's lines they also marked the posi-tions of the ribands and harpins. These were square sectioned longitudinal timbers used to hold the frame bends and filling frames together, before the planking was put on, when they were removed. In the middle body of the ship where they could easily be either sprung or steamed to shape they were called ribands, but at the extremities where the curvature of the hull was more pro-nounced they were shaped to fit and were known as harpins. They usually ran two or three feet below the floor and futtock heads and their intersections with the joint lines, known as sirmarks, were used as reference points for the bevelling of the frame bends. The sirmarks were named after floor or fut-tock upon which they were inscribed , becoming floor sirmark, first futtock sir- mark etc (fig 3).

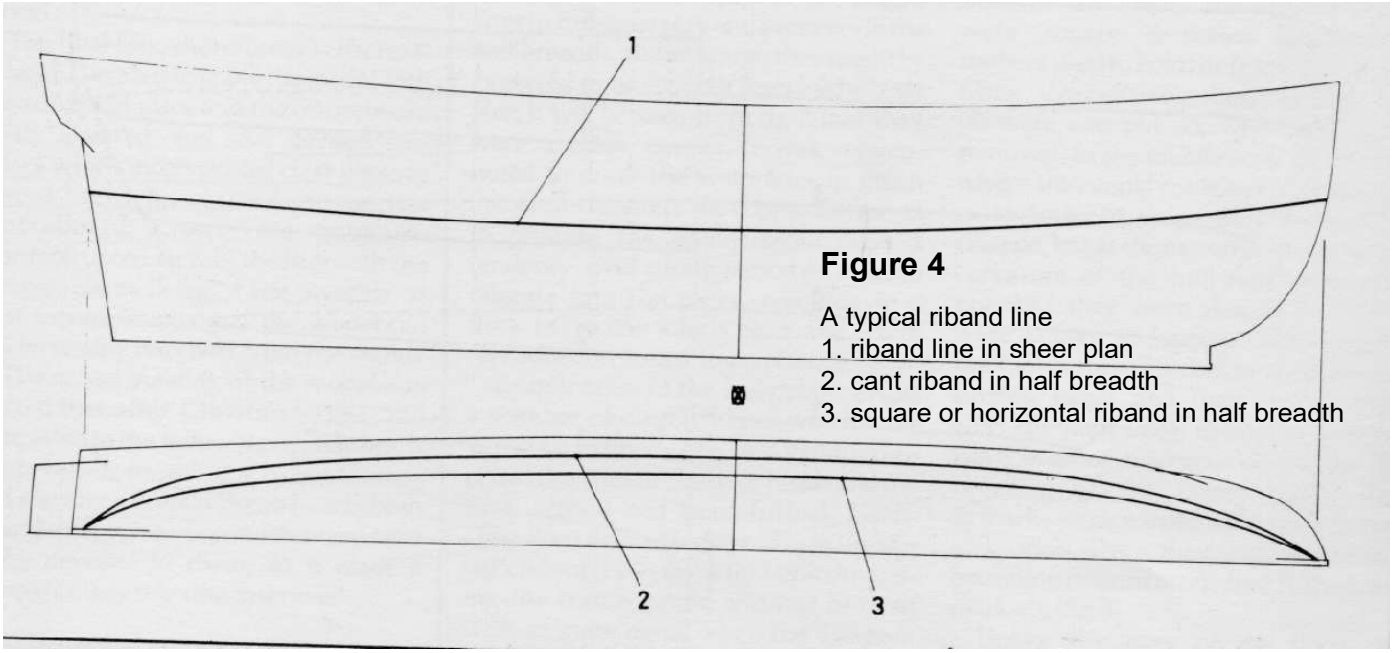


Figure 4

A typical riband line
1. riband line in sheer plan
2. cant riband in half breadth
3. square or horizontal riband in half breadth

Unlike the lines of the floor and futtocks heads the riband lines were drawn in, again usually in pencil, on the sheer and half breadth plans (fig 4). There was just one line for each riband line on the sheer plan, but on the half breadth they were drawn in two ways, Firstly there was the cant riband, which gave the true shape of the riband line in the plane of the diagonal. This was the line used to obtain the actual shape of the harpins. The second riband line was known as a square or horizontal riband and was the projection of the riband in a horizontal plane, in other words as it

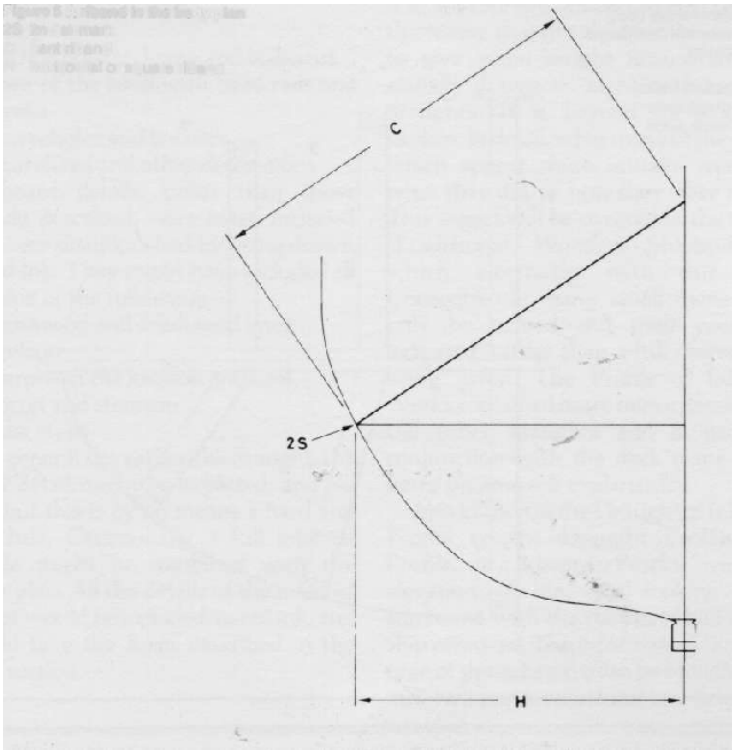


Figure 5

A riband in the body plan
2S 2nd sirmark
C cant riband
H horizontal or square riband

would appear if looked at from vertically above. In this form it was of little use in the actual building of the ship but was very useful at the design stage to help in fairing the lines (fig 5). Because of the rapidly changing curvature to be found in the fore and after bodies these parts of the ship were the most difficult to fair and to help do this additional construction lines were used. They represented vertical sections of the hull in planes parallel to the plane of the middle line and were known as bow lines forward and buttock lines aft. They appeared as vertical straight lines in the body plan, straight lines parallel to the middle line in the half breadth and curves in the sheer plan. As pure

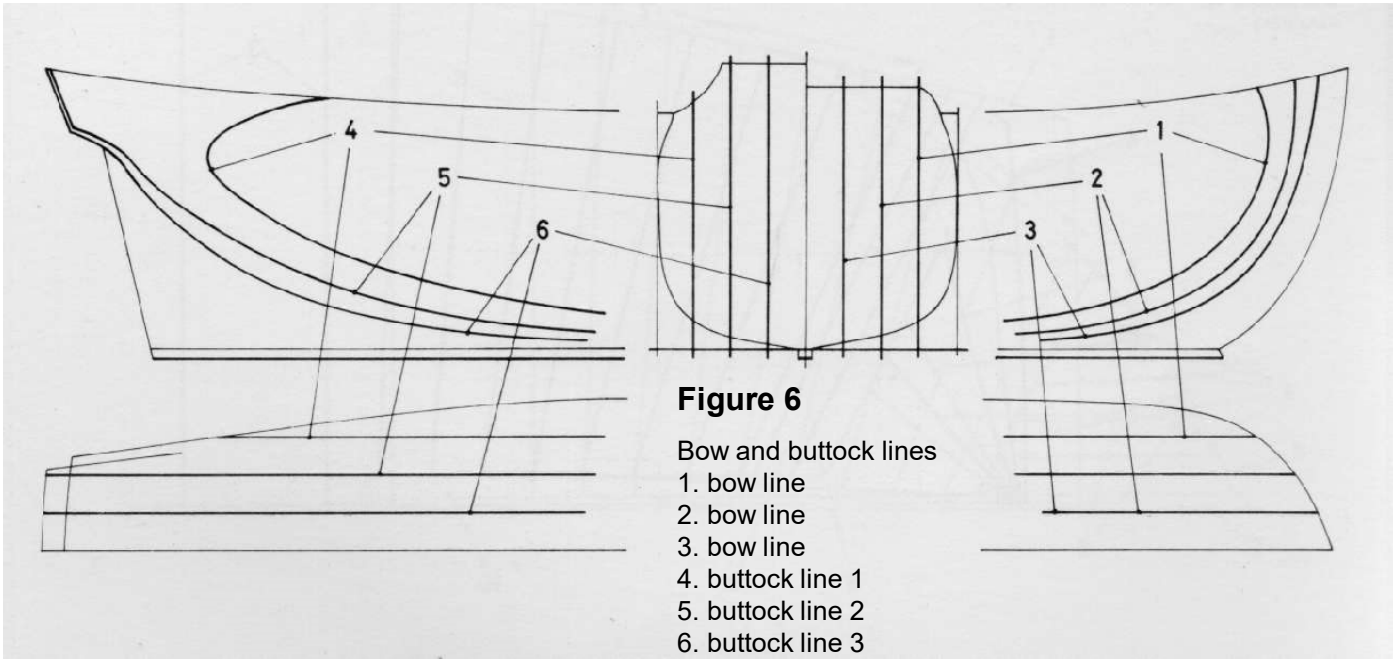


Figure 6

Bow and buttock lines
1. bow line
2. bow line
3. bow line
4. buttock line 1
5. buttock line 2
6. buttock line 3

construction lines they were usually drawn in pencil and are rarely to be found in the surviving sheer draughts (fig 6).

The half breadth usually contained a set of inked in lines which did not appear in the sheer or body plans. These were the joint lines of the cant frames. In the fore and after bodies of the ship the curvature of the hull became such that to use frame bends prependicular to the middle line meant cutting away a lot of wood to waste, which in turn involved a lot of unnecessary labour. To reduce these two items to a minimum, cant frames were used, which as far as possible were perpendicular to the ship's side rather than to the middle line (fig 7). The joint lines of these cant frames appeared on the half breadth as shown in figs 8 and 9. The aftermost cant frames were called fashion pieces and they were joined together transversely by a series of timbers known as transoms. These were also occasionally marked in on the half breadth (fig 8). At the forward end of the ship the gap between the foremost cant frame and the stem was filled in by timbers known as hawse pieces, which were in effect half frames parallel, or almost parallel, to the middle line of the ship. These too were usually inked in on the draught and appeared as in fig 9. Cant frames,

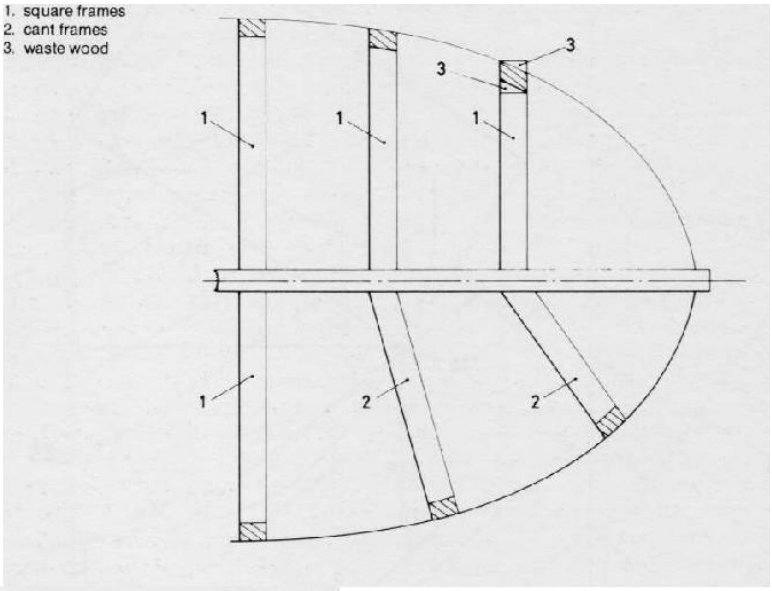


Figure 7

Fore end with all square frames (top); square and cant frames (bottom)

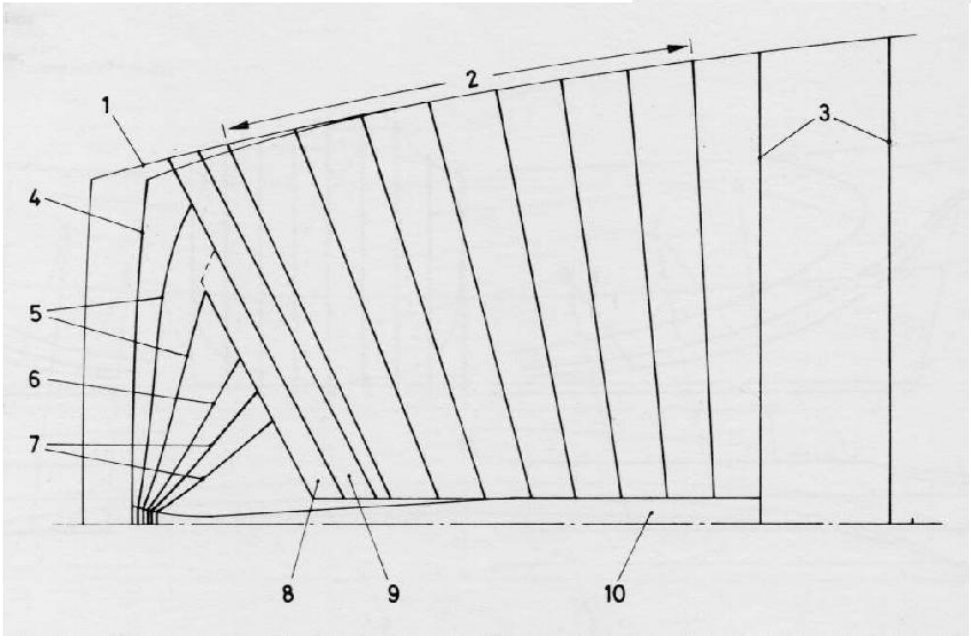


Figure 8

After body half breadth
1. maximum breadth
2. cant frame joint lines
3. square frame joint lines
4. wing transom
5. upper filling transoms
6. deck transom
7. lower filling transoms
8. after fashion piece
9. forward fashion piece
10. dead wood
(Note 4-7 are the upper, after edges of the transoms.)

hawse pieces and transoms will be dealt with in more detail under the heading of 'Disposition of Frames7.

As mentioned in part one of this series it was usual for the sheer plan to have quite a lot of detail on it in addition to the hull lines of the ship. Outboard details would normally have included some or all of the following and would be inked in with black ink:

Rudder with pintles and braces
Quarter pieces and galleries
Channels with details of chains and
lower deadeyes
Timberheads
Rough tree rails
Steering wheel and stantions
Capstans
Quarterdeck breastwork Gangway steps Fenders Chesstrees
Gunports
Forecastle breast rail Belfry
Anchor bolster, lining and billboard Knee of the head with head rails and cheeks
Hawseholes and bolsters
Figurehead and other decorations Inboard details, other than those already described, were often included and were distinguished by being drawn in red ink. They might have included all or some of the following:
Deadwood and deadwood knee Keelson
Scarphs in the keelson and keel Apron and stemson Mast steps

In general the earlier the draught, the more detail might be expected, and vice versa, but this is by no means a hard and fast rule. Occasionally a full internal profile might be combined with the sheer plan. All the details of the internal

layout would be included, in red ink, and would take the form described in the next section.

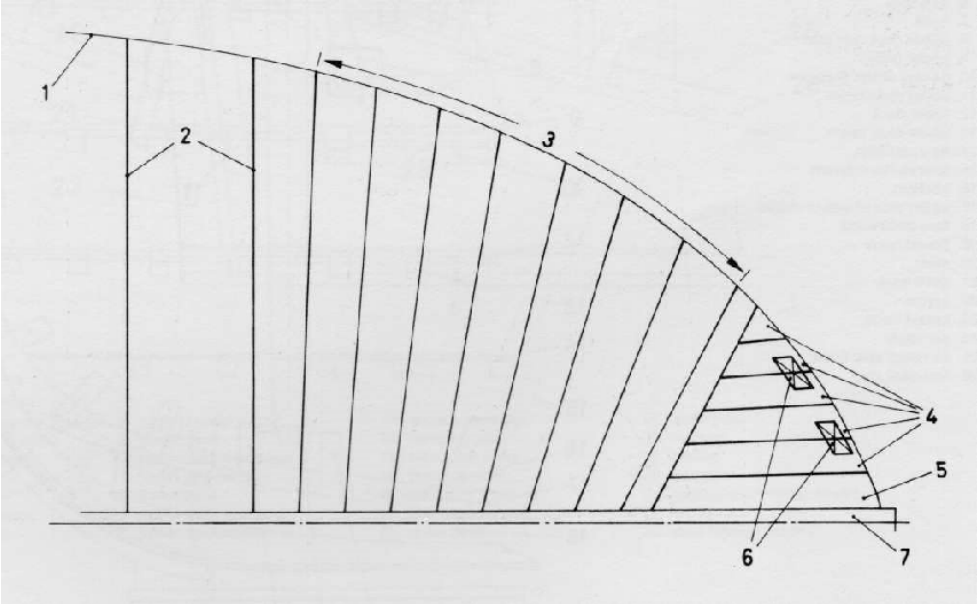


Figure 9

Fore body half breadth
1. maximum breadth
2. square frame joint lines
3. cant frame joint lines
4. hawsepieces
5. bollard timbers
6. position of hawse holes
7. stem

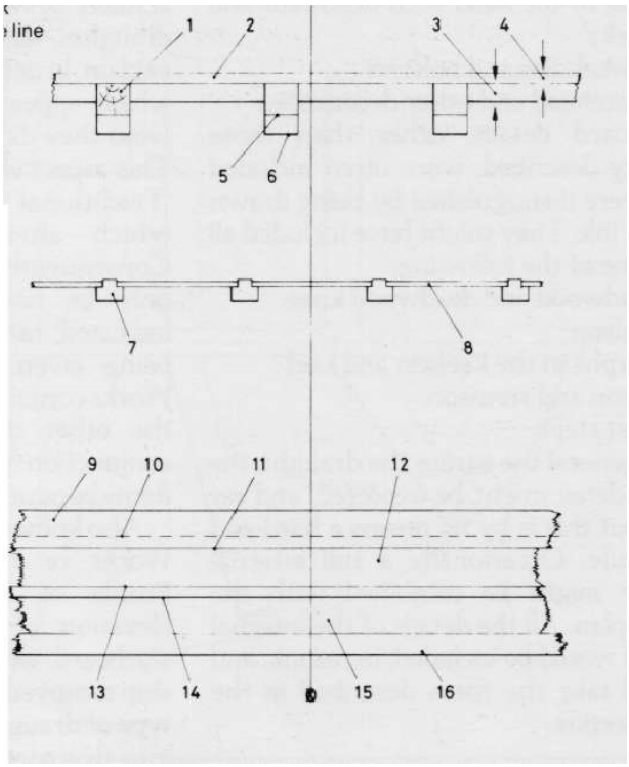


Figure 10

Part profile amidships from lower deck downwards
1. lower deck beam
2. lower deck plank on middle line
3. round up of lower deck
4. thickness of lower deck plan!
5. lower side of beam on middle
6. lower side of beam at side
7. orlop beam (no round up)
8. orlop plank
9. keelson
10. upper side of limber strake
11. cutting down line
12. rising wood
13. upper rabbet line
14. lower rabbet line
15. keel
16. false keel

Profile of inboard works

It is appropriate at this stage to remind the reader that the object of this series is to give some insight into what was actually drawn on eighteenth century draughts. It is beyond its scope to explain, in detail, what many of the items which appear there actually were, or what they did, or how they were made. This aspect will be covered in the series Traditional Wooden Shipbuilding' which alternates with this one. Consequently many small items may only be named and their positions indicated, rather than a full description being given. The Profile of Inboard Works contained more minor detail than the other draughts and if used in conjunction with the deck plans most items became self explanatory.

Also known as the Draught of Inboard Works or the Draught Profile, the Profile of Inboard Works was an elevation of the ship, looking from starboard, with the starboard half of the ship removed. The information that this type of draught gave can be broadly split into two parts; structural and details of the internal layout and fittings. Some of it may also appear on the sheer plan to a greater or lesser extent.

Structural

The most important thing that the profile showed was probably the position of the decks. Three lines ran the length of each deck and they delineated the upper and lower sides of the deck planking at the middle line, and the lower side of the deck planking at the ship's side (fig 10). This of course means that it was possible to establish the thickness of the planking, and also the *round up* or camber of the deck. The sizes and positioning of the deck beams and deck transoms were also shown, as were the deck hooks and crutches (see deck plans).

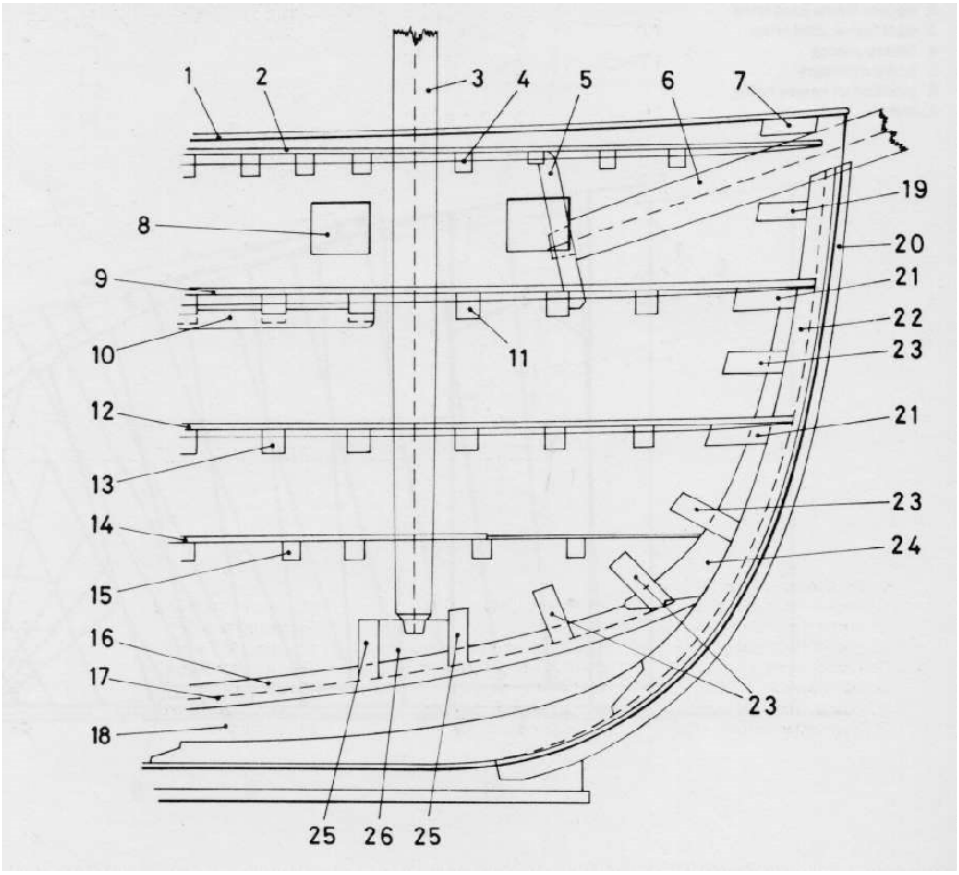


Figure 11

Fore end profile

1. forecastle plansheer
2. forecastle deck
3. foremast
4. forecastle beam
5. bowsprit step
6. bowsprit
7. hook
8. upper deck gun port
9. upper deck
10. carling under fireplace
11. upper deck beam
12. lower deck
13. lower deck beam
14. fore platform
15. fore platform beam
16. keelson
17. upper side of limber strake
18. fore deadwood
19. breast hook
20. stem
21. deck hook
22. apron
23. breast hook
24. Stemson
25. Foremast step hookl
26. Foremast step

The forward end of the profile usually indicated the make-up of the stem, apron and stemson assembly; frequently showing the seraphs used both in its construction and in its attachment to the forward deadwood, keel and keelson (fig 11). The upper surface of the latter was drawn in together with the cutting down line, so that the keelson was clearly defined. In between these two a ticked line indicated the upper surface of the limber strakes (fig 10). At the after end be found the stern post and inner post, together with the stern post knee if there was one (fig 12): Other structural details would include the deadwood knee and sometimes the make up of the -•eaawood and possibly the positions of the bolts holding it together. The position of the transoms were indicated and some profiles also showed the position of the after fashion piece.

The masts steps were drawn astride the keelson and the heels of the masts shown fitting into them. Towards the end of the eighteenth century mizzen masts were often stepped on the lower deck and, where appropriate, this was indicated on the draught; together with the mast step carling and one or two supporting pillars.

Details of the internal layout of the ship and the fittings that were shown on the profile will be dealt with in part 4 of the series (in Model Shipwight 52).q

Profile of Inboard Works contd

Part 3 of this series (Model Shipwright 50) gave an indication of some of the structural items shown in the profile of inboard works - namely the decks, the bow and the stern. In addition to these items the profile frequently showed, in ticked lines, the positions of the riders and deck standards where these existed. These can be seen in Fig 1 which is part of the middle body profile of the same ship as Figs 11 and 12 in Part 3 - a 38- gun frigate of 1794.

A part section is shown in Fig 2 in order to indicate more clearly the posi-tions of these items. It is included solely for this reason and is not part of the profile draught.

Figs 3, 4 and 5 again show the profile of a 38-gun frigate, but this time most of the hull is omitted for the sake of clarity. The internal details, which were left out of the previous figures, are put in in full. These include, in the after body (Fig 3), the rudder, tiller and steering wheel, the after magazine and the various ladderways and other deck

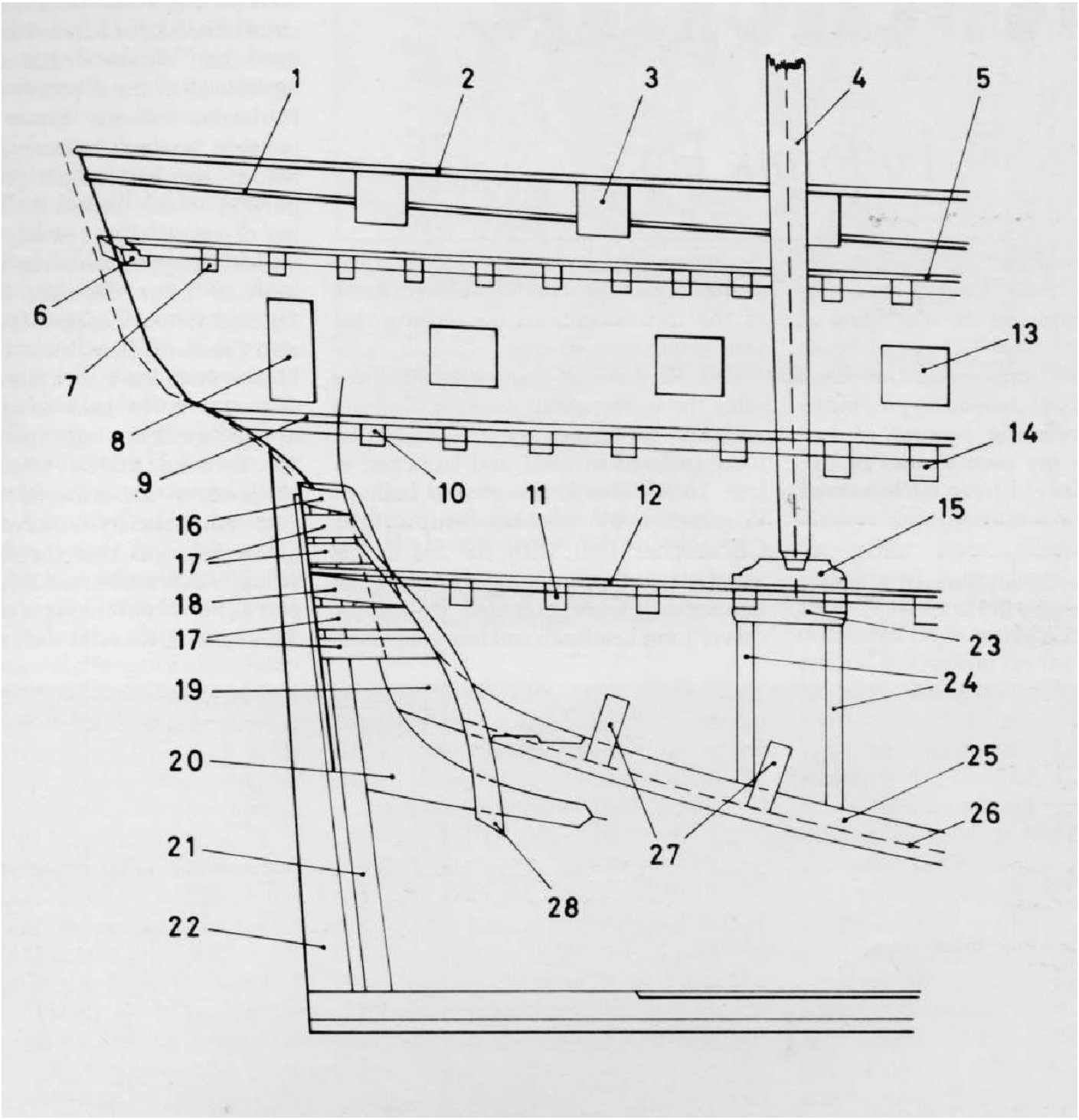


Figure 12

After end profile

1. quarterdeck plansheer
2. rough tree rail
3. quarterdeck gun port
4. mizzen mast
5. quarterdeck
6. quarterdeck transom
7. quarterdeck beam
8. quarterdeck plansheer
9. rough tree rail
10. quarterdeck gun port
11. mizzen mast
12. quarterdeck
13. quarterdeck transom
14. quarterdeck beam
15. mizzen mast step
16. wing transom
17. filling transoms
18. deck transom
19. stern post knee
20. deadwood knee
21. inner post
22. stern post
23. carling
24. pillars
25. keelson
26. upperside of limber strake
27. crutches
28. after fashion piece

openings, as well as the after store¬rooms, the capstan and the mizzen top¬sail sheet bitts.

Fig 4 (the middle body) also shows deck openings, the pumps, well, shot lockers and orlop deck. The ship's bel¬fry, galley stove and riding bitts are among the items drawn in the fore body (Fig 5) which also indicates the positions of the fore magazine and filling room.

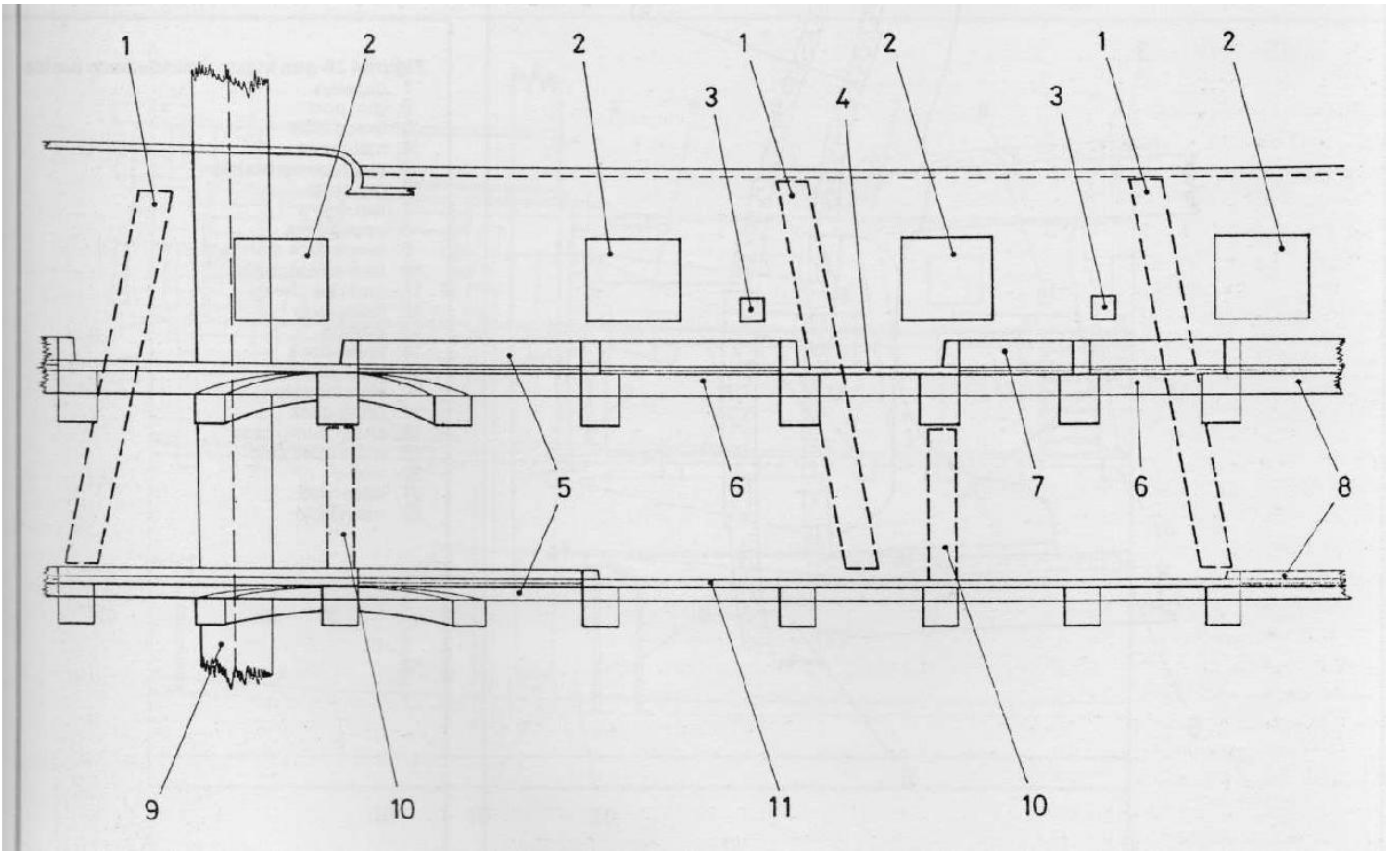


Figure 1

38 gun frigate - part profile in waist
1. top rider
2. upper deck gun ports
3. oar ports
4. upper deck
5. main hatchway
6. ladderway
7. grating

A frigate has been chosen to illustrate the profile because basically it has every- thing that a two decker has, even if proportionately they differ. By adding an extra gun deck it virtually has all that a three-decker has. There are of course some differences. The most obvious one, albeit the least significant one structurally, is that the frigate has no lower deck ports It should perhaps be explained at this point that the lowest complete deck in a two-decker is called the gun deck; the one above it being the upper deck. (The orlop deck, although lower than the gun deck, is not a complete deck). In a three- decker the lowest complete deck is also usually called the gun deck, but can oc-casionally be found referred to as the lower gun deck. Above that is the middle deck and above the middle deck is the upper deck. A number of romantically-minded historians have attempted to perpetuate the myth that when the classic' frigate evolved in the middle of the eighteenth century, largely by the omission of guns from the lowest deck, the conservative seamen continued to call this deck the gun deck, despite the fact that it had no guns. They probably did initially but there seems to be little evidence to sup-port a continued use of the name, other than wishful thinking. On the draughts it is always marked lower deck, and as this series is about draughts, then lower deck will be the name used.

A further noticeable difference is that the frigate used as an example has a round bow. All the eighteenth century two-and three-deckers had a beakhead, as did a handful of the early frigates of the middle of the century. This and other differences are shown in the sketch profile of a two-decker 74-gun ship in Fig 6.

At the stern the larger ships were significantly different in that they had more than the single tier of lights of the frigate. A two-decker had two tiers of lights, or one tier of lights and a gllery; a three-decker a three tier combination

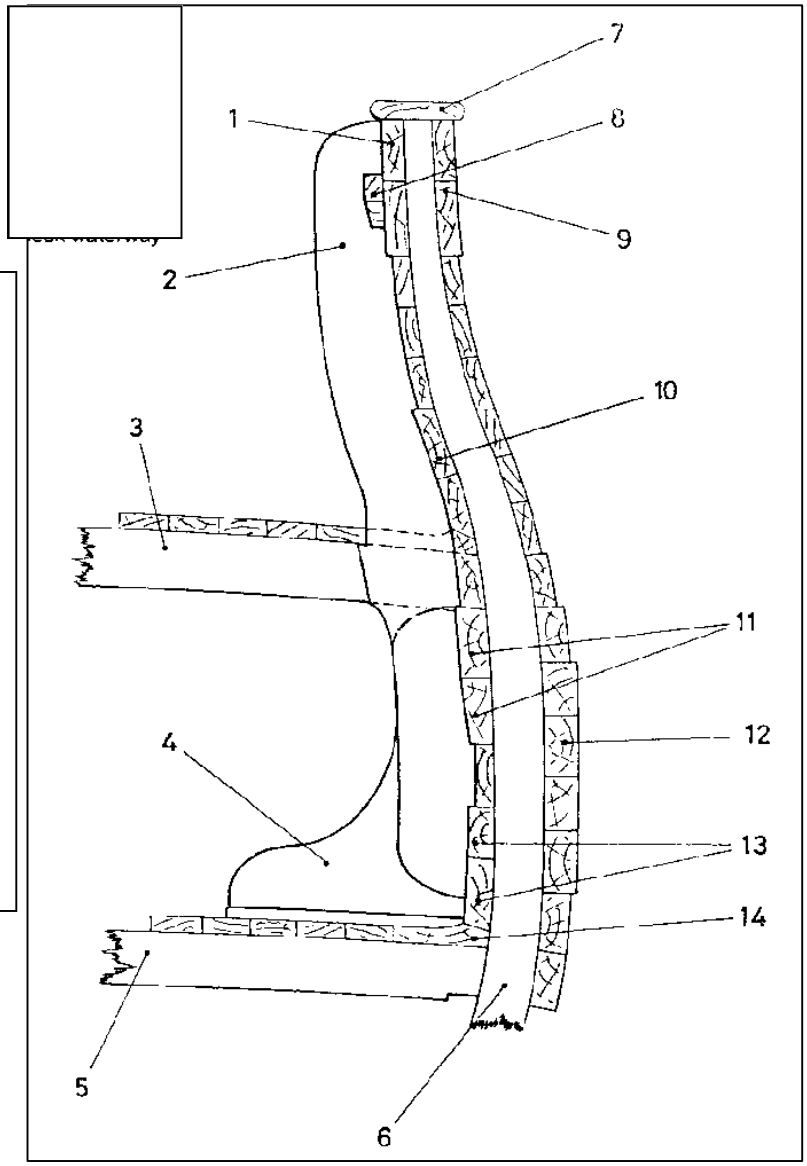


Figure 2 Section of the ships side in the waist

1. string
2. top rider
3. upper deck beam
4. lower deck standards
5. lower deck beam
6. frame
7. gunwale
8. skid beam clamp
9. sheer strakes
10. upper deck spirketting
11. upper deck clamps
12. wale
13. lower deck spirketting
14. lower deck waterway

of lights and/or galleries. In addition the larger ships had a poop deck which British frigates never had although they were to be found in some Continental ones. As always there were exceptions to every rule. One of the major ones was to be found in the 44-gun two- deckers built towards the end of the century, which had only one tier of lights.

Internally the main difference, apart from layout, between the frigate and the larger ships is that the latter had a fore jeer capstan; the frigates did not. Otherwise the components are vir-tually the same, although they may appear in different places and on differ-ent decks, depending on type or indivi-dual design. For example the riding bitts and the lower barrel of the main capstan must always be on the same deck and in the case of two and three decked ships this was usually the gun deck. Apart from a few very early ships, frigates worked their cables on the upper deck and so in their case these items were to be found there.

At the other end of the scale the fri-gate profile may be used to illustrate the smaller vessels of the navy, the post ships and sloops. Reduce the number of gun ports on the upper deck and the result is virtually a 24-or 20-gun ship. A further reduction in the number of ports, and the deletion of the forecastle, gives representation of a quarter decked sloop. Remove the quarter deck and dia- gramatically the result is a flush decked sloop. (Fig 7)

Deck plans

In the twentieth century the terni draught is seldom if ever used, the word plan having taken its place. For example a 'sheer draught' is known nowadays as a 'sheer plan'. However, in the eight-eenth century the word plan was used in its true sense; in that a plan is a view of an object as seen from above, and from no other angle. Consequently to an eighteenth century shipbuilder a ship's plans meant only the plans of the decks and nothing else.

The outline of a deck plan is the moulded line of the ship at the upper side of the deck beams. In other Words it is the outline of the outer faces of the frames at that height. Inside it appears another line and this represents the inner face of the frames. Between these lines the gunports are indicated and although fore and aft these give an accurate position of the ports, in the athwartships direction they were not necessarily correct. As already mentioned the two deck outlines showed the shape of the deck at the height of the upper side of the deck beams. The lower port sills would have been nearly three feet above this and consequently unless the side of the hull was vertical at this point

Figure 3

38-gun frigate - after body profile

1. quarterdeck
2. carronade port
3. gun port
4. companion
5. bitts
6. mizzenmast
7. steering wheel
8. gratings
9. capstan
10. quarter gallery doorway
11. upper deck
12. gun ports
13. cabin bulkheads
14. oar ports
15. tiller
16. lower deck
17. scuttle
18. mizzen mast step
19. ladderway
20. grating
21. rudder
22. carling
23. crutches -
24. pillars
25. after magazine *
26. light room
27. after platform
28. fish room
29. spirit room

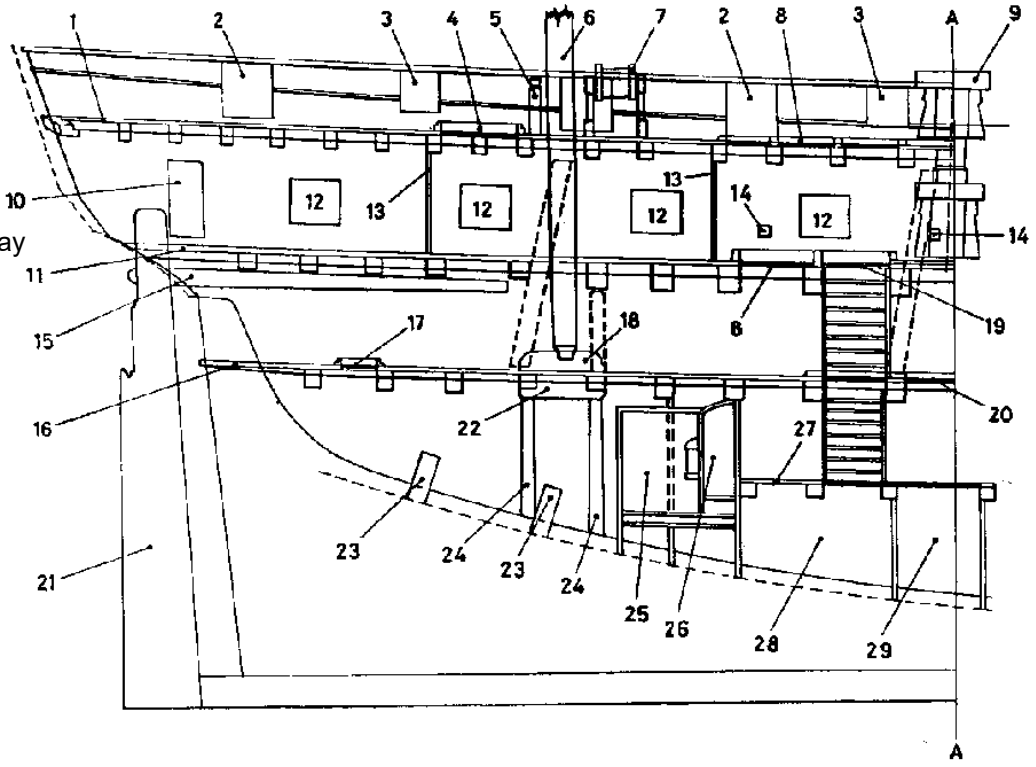
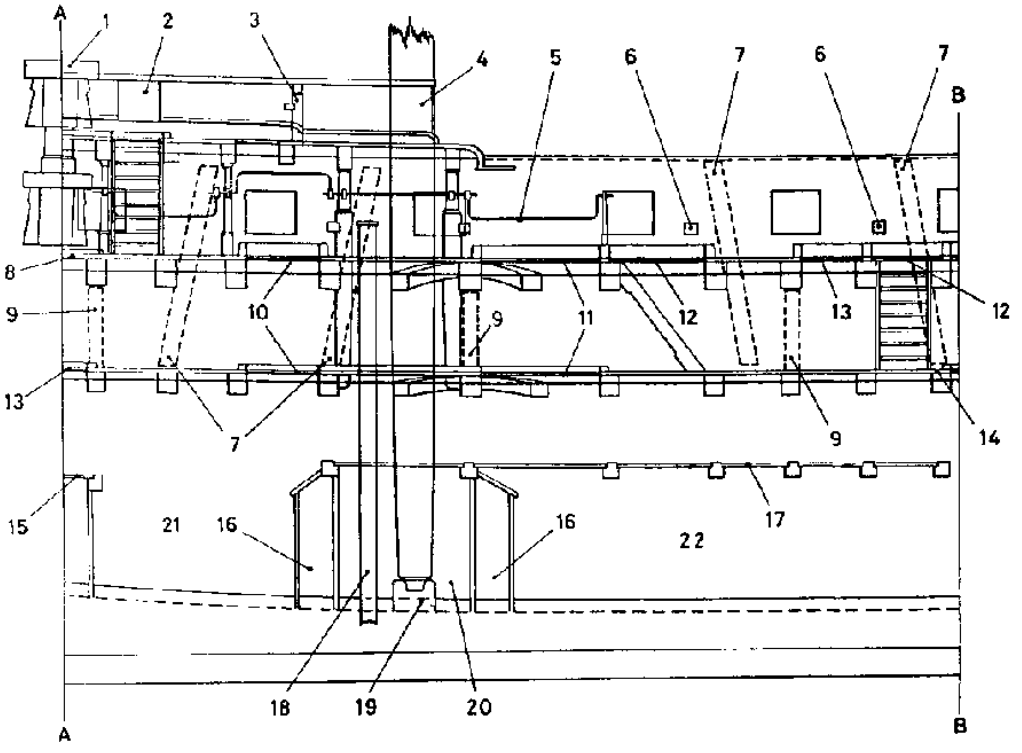


Figure 4 38-gun frigate - middle body profile

1. capstan
2. gun port
3. brace bitts
4. mainmast
5. chain pump brakes
6. oar ports
7. top riders
8. upper deck
9. lower deck standard
10. mizzen hatchway
11. main hatchway
12. ladderway
13. Grating
14. lower deck
15. after platform
16. shot lockers
17. orlop deck
18. chain pump case
19. main mast step
20. well
21. after hold
22. main hold



the line of the port sills would not coincide with the outlines, it was not usual to show any deck planking on the plans although occasionally they do occur in pencil, probably as a result of the builder trying to arrange the shift of the butts. What did show however was the positioning of the deck beams. In the early part of the century it was quite common the beam knees, both hanging and lodging, to be indicated, but the practice of including these gradually died out. Hatchways, coamings, ladderways, companionways and deck scuttles were normally indicated, together with the mast partners. Tween deck bulkheads were also included and the enclosed spaces which they made were usually named; ranging from the grand sounding *great cabin* to the intriguing but somewhat insignificant *lady's hole*. Offiers' cabins were indicated by the rank or title of the occupant; First Lieutenant, Lieutenant of Marines, Boatswain, etc, and conformed rigidly to a pattern laid down by the Navy Board.

Plans were drawn of all decks, down to and including the orlops and plat-forms. In the latter case these often indicated not only what was on them, but particularly towards the end of the century, quite a lot of what was below. This would include such compartments as magazines, filling rooms and stores, together with their attendant light rooms, passages, doors and sometimes fittings, such as racks, lockers and drawers. On the original plans every-thing below the deck was distinguished by being drawn in green ink; but as this reproduces as black in rrtodern photoprints it is often difficult to establish whether or not an item is above or below the deck. However if the plan is read in conjunction with the rele-vant profile it should become clear.

Fig 8 is a typical plan of a complete deck, in this case a gun deck. Fig 9 shows a non-continuous deck, a forecastle and a quarterdeck with an open waist bet-ween them. It also shows the fixed gangway at the forward end of the quarterdeck and temporary gangway joining the fixed one to the forecastle.

The next article in the series, in Model Shipwright 54, will deal with the Disposition of Frame.

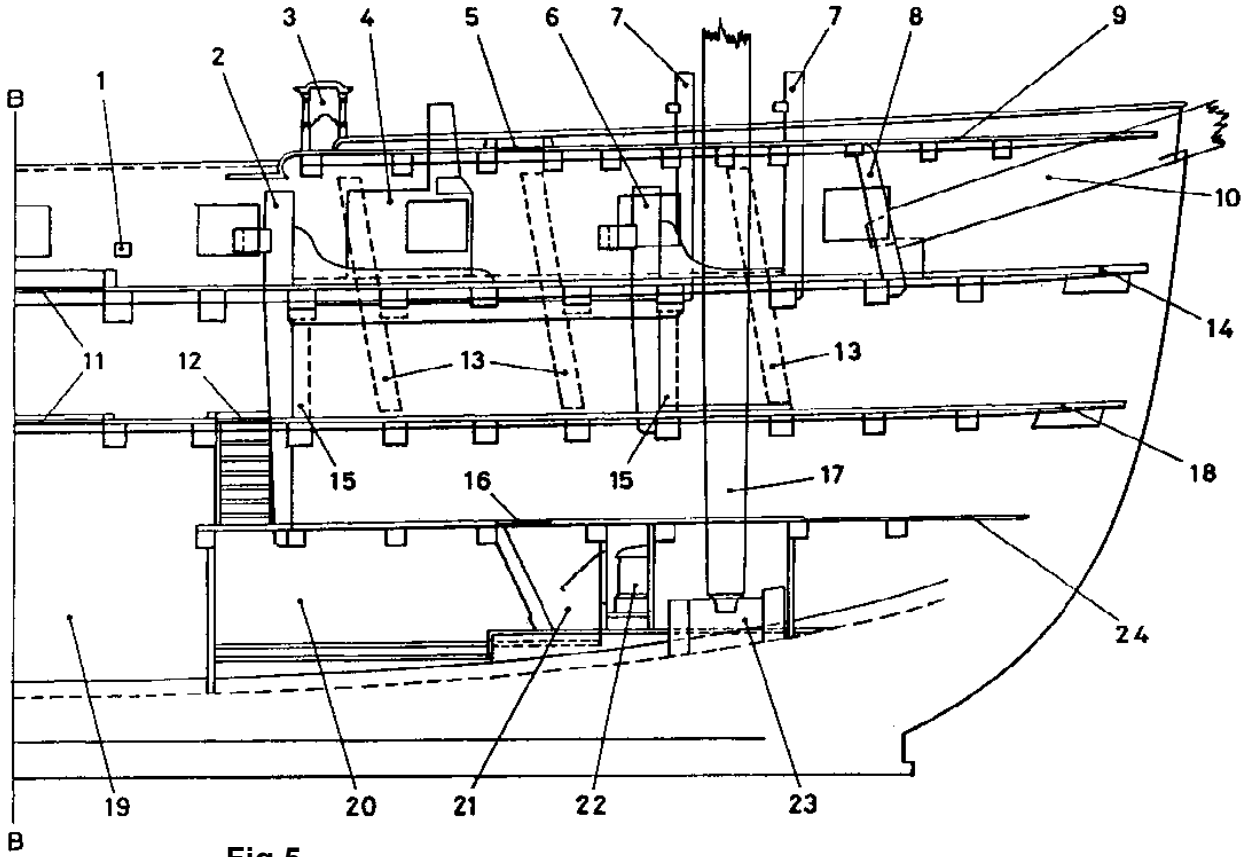


Fig 5

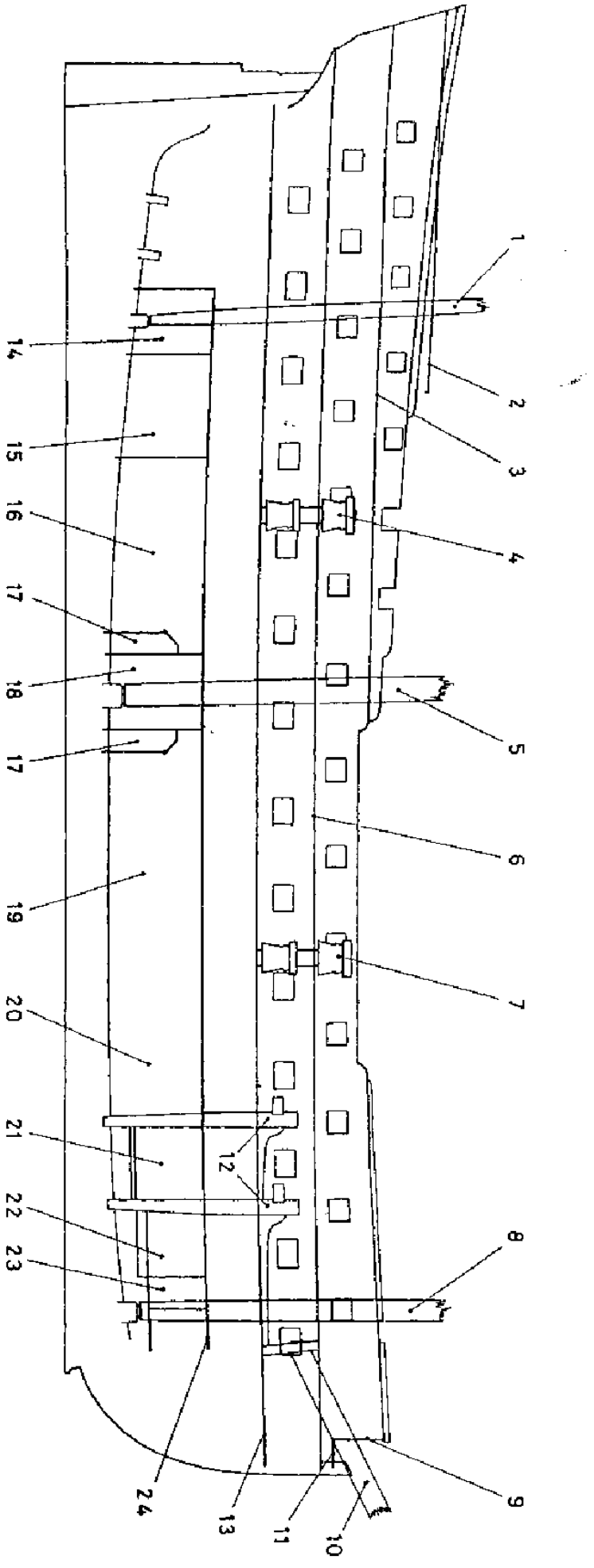
38-gun frigate
- for body profile

1. oar port
2. after riding bitts
3. belfry
4. galley stove
5. scuttle
6. fore riding bitts
7. bitts
8. bowsprit step
9. forecastle deck
10. bowsprit
11. fore hatchway
12. ladderway
13. top riders
14. upper deck
15. lower deck standards
16. scuttle to filling room
17. foremast
18. lower deck
19. fore hold
20. fore magazine
21. filling room
22. light room
23. fore mast step
24. fore platform

Figure 6

Sketch profile of a two decked 74 gun ship

1. mizzenmast
2. poop
3. quarterdeck
4. after capstan
5. mainmast
6. upper deck
7. fore jeer capstan
8. foremast
9. beakhead bulkhead
10. bowsprit
11. beakhead
12. riding bitts
13. gun deck
14. after magazine
15. fish and spirit room:
16. after hold
17. shot lockers
18. well
19. main hold
20. fore hold
21. fore magazine
22. filling room
23. light room
24. orlop deck



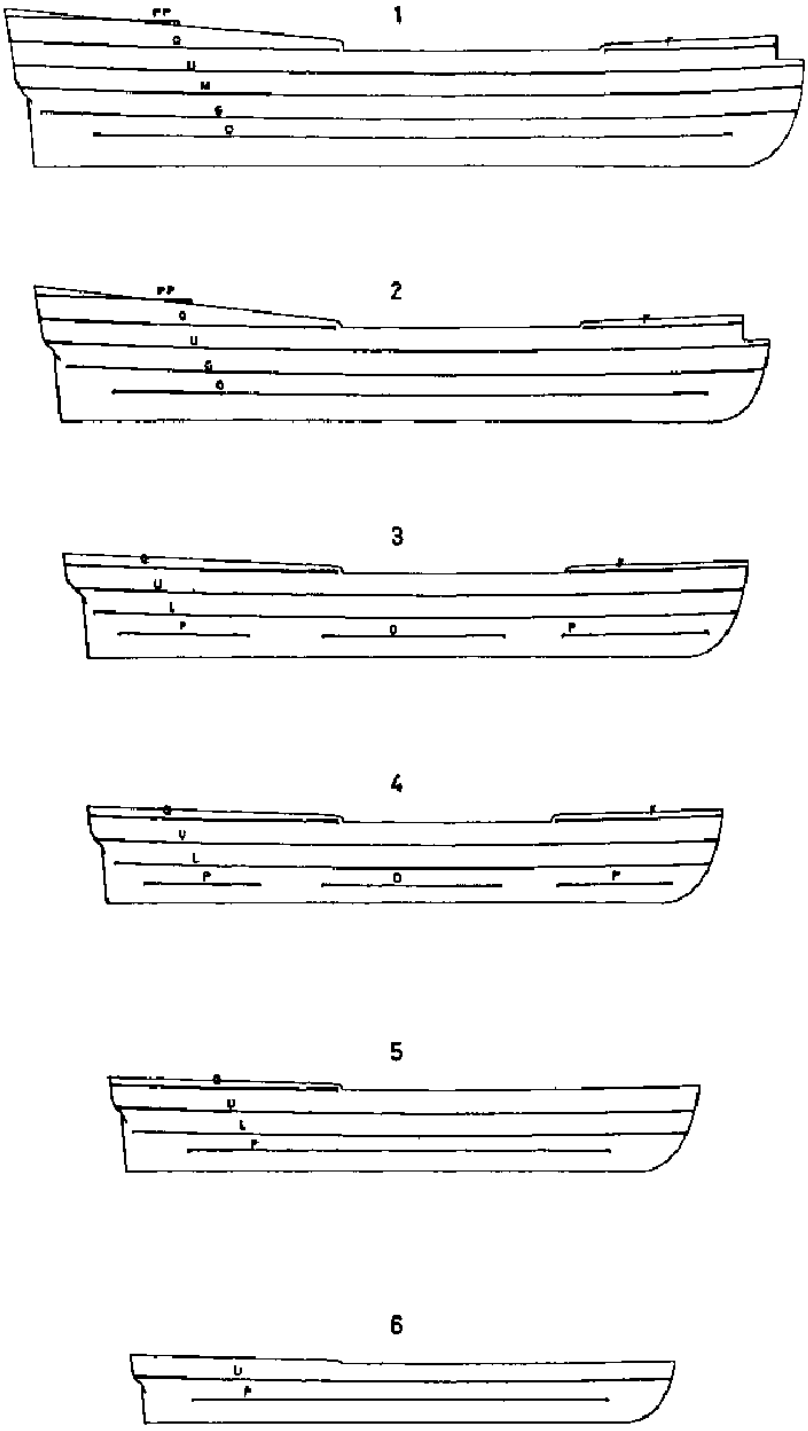


Figure 7

Arrangement of decks

1. three decker
2. two decker
3. frigate
4. post ship
5. quarterdecked ship
6. flush decked sloop

PP	poop
Q	quarter deck
F	forecastle
U	upper deck
M	middle deck
G	gun deck
O	orlop deck
P	platform

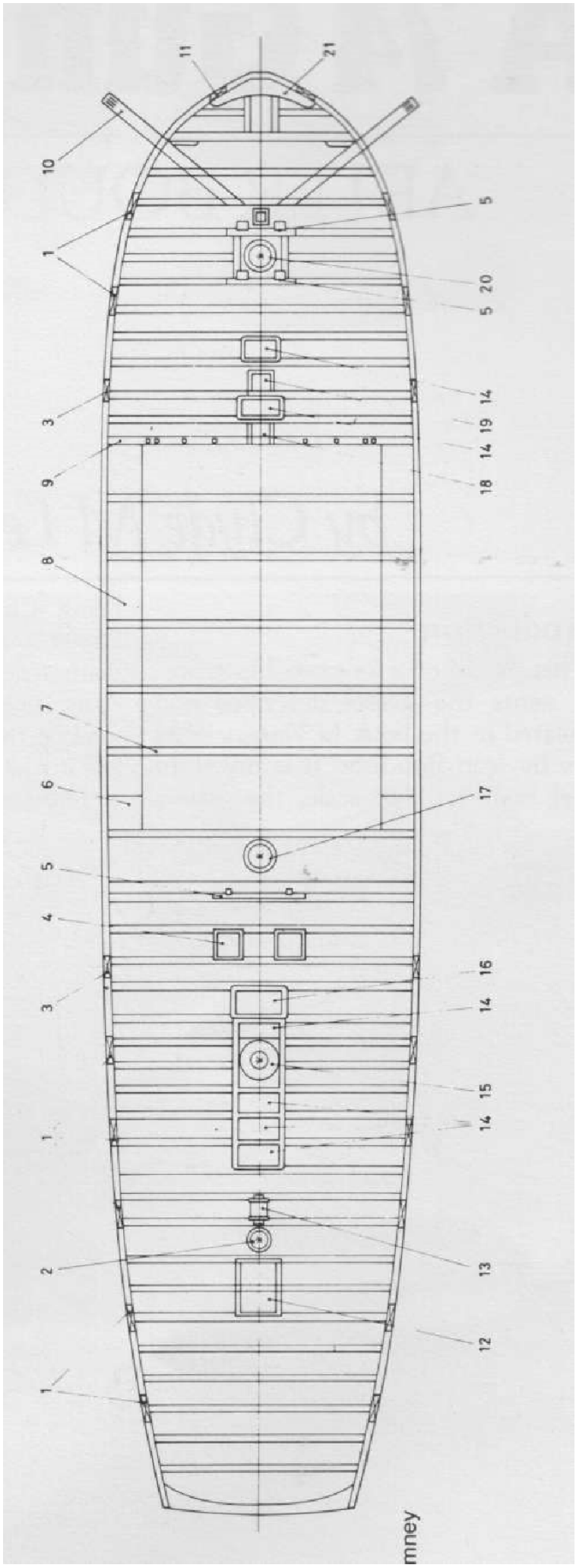


Figure 9

A non-continuous deck
the quarter deck and forecastle
of a 36 gun frigate c.1800

1. carronade ports
2. mizzen mast
3. gun ports
4. top tackle scuttle
5. bitts
6. fixed part of gangway
7. skid beam
8. temporary gangway
9. breast beam
10. cathead
11. chase port
12. companion
13. steering wheel
14. gratings
15. capstan
16. ladderway
17. mainmast
18. belfry
19. scuttle for galley stove chimney
20. foremast
21. deck hook

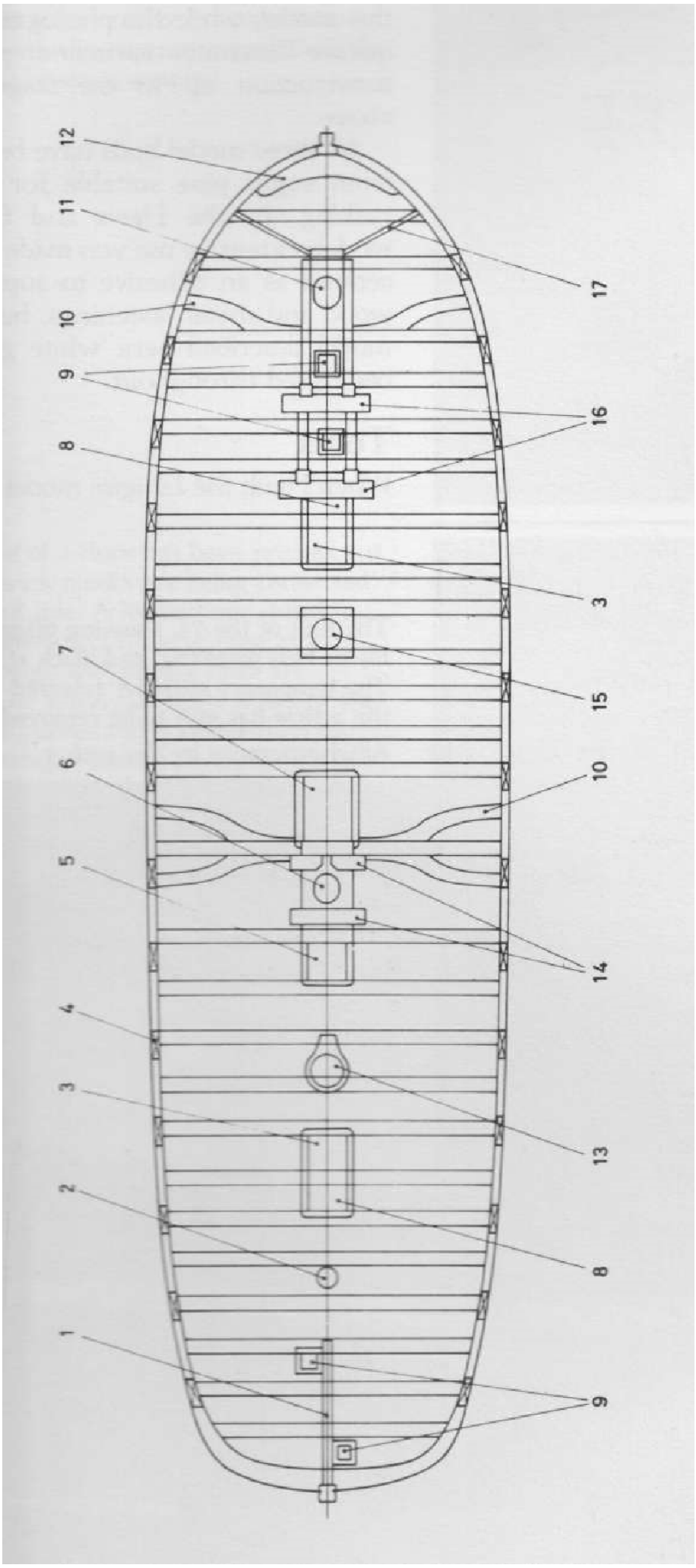


Figure 8

A continuous deck
- the gun deck of a 74 gun ship c.1780

1. standard
2. mizzen mast
3. grating
4. gun port
5. mizzen hatchway
6. mainmast
7. main hatchway
8. Ladderway
9. scuttle
10. beam arm
11. foremast
12. deck hook
13. main capstan
14. chain pump cisterns
15. fore jeer capstan
16. riding bitts
17. manger board

4. Disposition of Frame

In order to fully appreciate the draught entitled Disposition of Frame it is neces-sary to understand what is actually meant by frames and also the way in which they were constructed. Strictly speaking a frame was a single tier of transverse timbers formed to the shape of a ship's hull. When two frames were bolted together in a fore and aft direc -tion they were known as a bend. In other words a bend was a specific type of frame: a double one. However, many authors and historians treat the words frame and bend as being synonymous and this has led to a certain amount of confusion. A further complication arises from the fact that frames was also used as a generic term to cover both frames and bends, either separately or together and that frame was used to describe the complete framing structure of a ship.

The size and shape of the framing precluded any possibility of their being made from a single piece of timber, a so they were fabricated from a number of components; floors, futtocks, and toptimbers. The most important part the frame structure was the bend. As already mentioned it was composed two frames bolted together; the floors and futtocks being arranged so that the components of one frame formed lap joints with the other. In order to do this the two frames had to be built differently and the way that this was done is shown in Fig 1. The main part the bend was the floor and this was only timber to cross the keel. It existed in only one frame of the bend, which was completed by the addition of second and fourth futtocks. For ease of description it is convenient to refer to 1 type of frame as a primary frame. 1 other frame completing the bend, secondary frame, was built up from first (or lower) futtocks, third futtocks and toptimbers

Fig 2 is a plan view showing how one side of a bend would appear if flattened out, and demonstrates how primary and secondary frames formed lap joints with one another. (It must be emphasised that the expressions primary frame and secondary frame are used to simplify description only. They were not terms used by the wooden shipbuilder.)

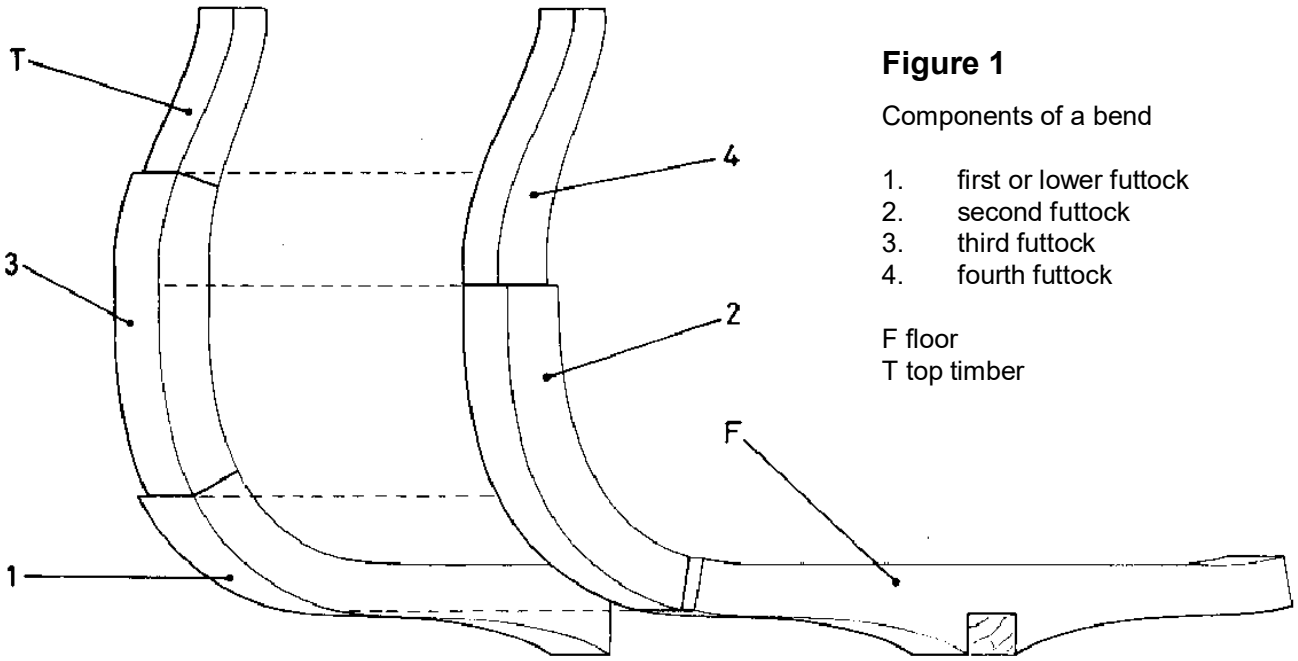


Figure 1

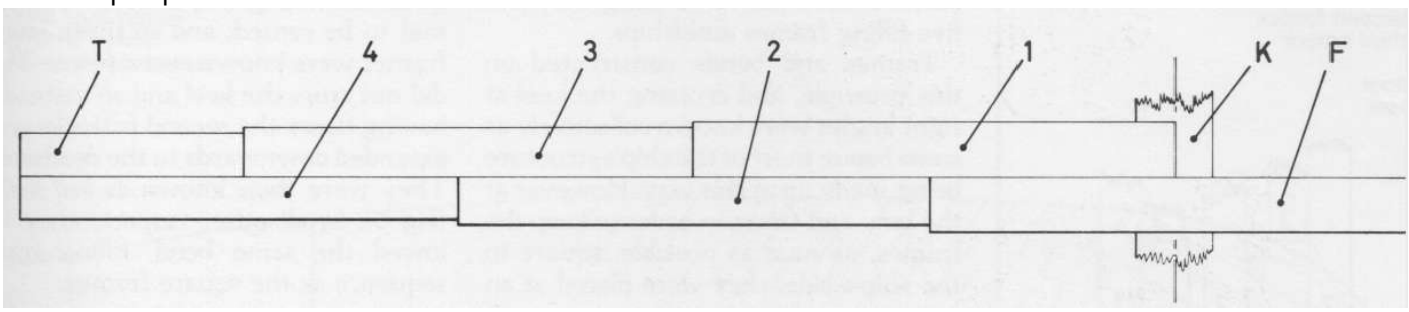
Components of a bend

1. first or lower futtock
2. second futtock
3. third futtock
4. fourth futtock

F floor
T top timber

Figure 2

Developed plan view of half a bend



The bends were built up at right angles to the ship's middle line at a distance apart between the joint lines of twice the room and space and the interval between two bends was filled in with a further pair of primary and secondary frames, known as filling frames. The joint line was the line of the mutual face of the frames forming the bend and the room and space was half the distance between two adjacent joint lines (Fig 3a). The total siding of a bend and a filling frame made up the room, and the space was the sum of the distance between the bend and filling frame, plus

half the distance between the two filling frames.

Unlike the bends the filling frames were not bolted together and in some cases where the frames composing the bends had spacers between them, most frequently between the upper futtocks, they appear at first glance to be filling frames also. However they can be distinguished on the Disposition of Frame because where the faces of the primary and secondary frames do not actually fay together the joint lines are shown ticked (Fig 3b).

Figure 3a

Bends and filling frames
B bend
F filling frame
R room and space

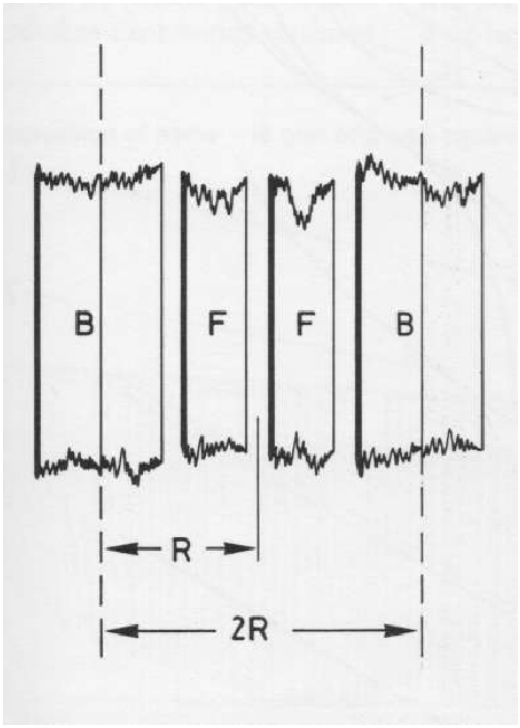
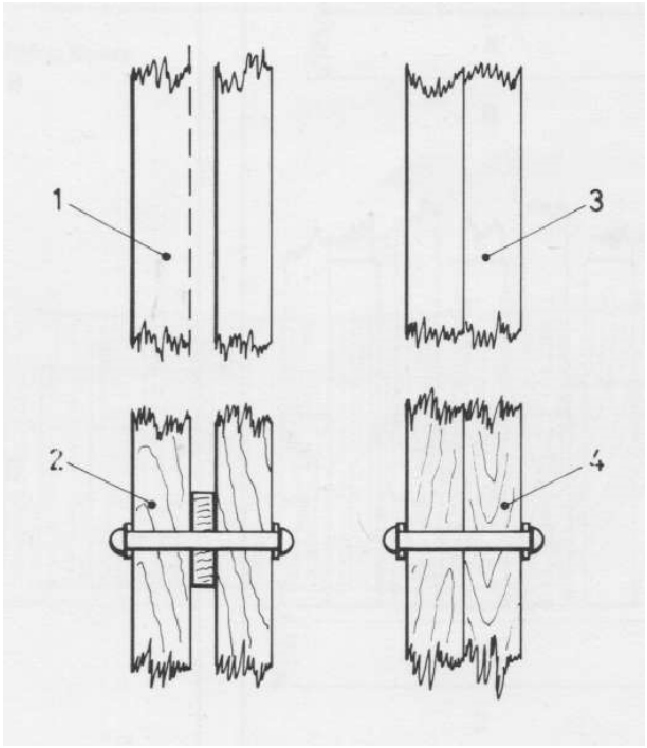


Figure 3b

1. Frames bolted together to form a bend
2. spaced bend as shown on the disposition of frame
3. spaced bend sectioned in way of bolt and spacer
4. fayed bend as shown on the disposition of frame



It was standard practice for the bend to be built into the ship with the floor on their fore side in the fore body and on the after side in the after body, order to achieve this, and to keep the frames alternately primary and secondary throughout the length of the ship, it was necessary to have an odd number of filling frames around midships. This usually took the form either one or three filling frames between two bends at this point instead of the two which occurred the rest of the hull (Fig 4). Inevitably there were exceptions to the rule Some small vessels had only one filling frame between the bends throughout and at least one ship, the 32-gun frigate Narcissus of 1801, was designed with five filling frames amidships

Frames and bends constructed on this principle, and crossing the keel at right angles were known collectively as square frames; most of the ship's structure being made up in this way. However at the bow and stern, in order to keep the frames, as near as possible, square to the ship's side, they were placed at an acute angle to the middle line. In shipwrights7 parlance anything placed at an acute angle to another object is said to be canted, and so these angled frames were known as cant frames. They did not cross the keel and so instead of having floors the second futtocks were extended downwards to the deadwood. They were then known as half timbers (Fig 5). In all other respects they fol-lowed the same bend, filling frame sequence as the square frames.

The construction of square frames and their fastening to the keel is dealt with in greater detail in part four of the series Traditional Wooden Ship- building' in Model Shipwright 53. Cant frames will be similarly dealt with in part five of the same series, in Model Shipwright 55.)

Fig 6 is a diagramatic half breadth showing the relative positions of the square and cant frames. It also shows that the cant frames did not extend fully to the stem or stern post. In ships with a round tuck stern, the remaining gap aft was filled in with a series of transverse horizontal timbers known as transoms. These were supported at their outer ends by fashion pieces which may be regarded as cant bends without a fourth futtock (Figs 8 and 9).

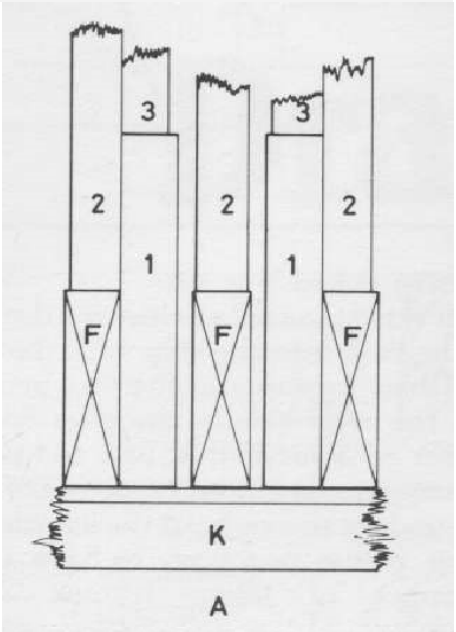
Forward the space was filled in by means of hawse pieces, which were in effect a series of fore and aft half frames,

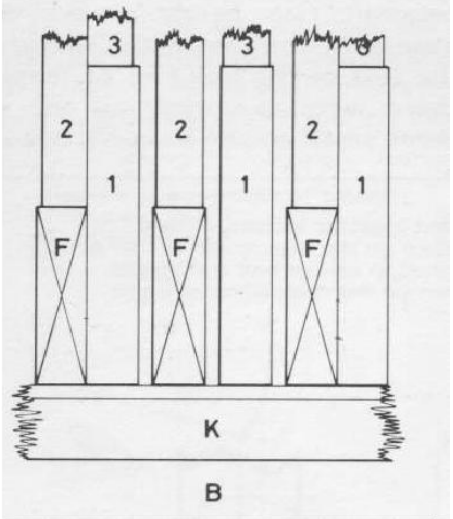
Figure 4

Single (A)
double (B)
triple ©

1. filling frames
2. first or lower futtock
3. second futtock
4. third futtock

F floor
K keel





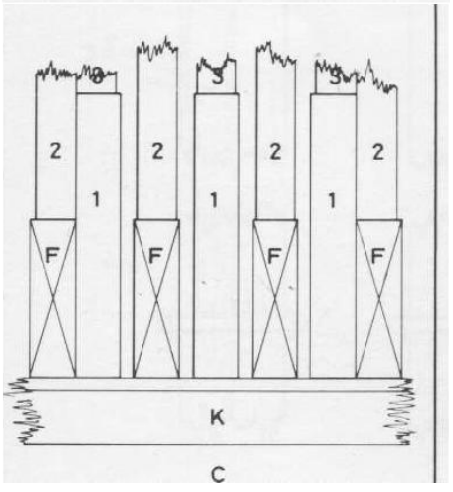
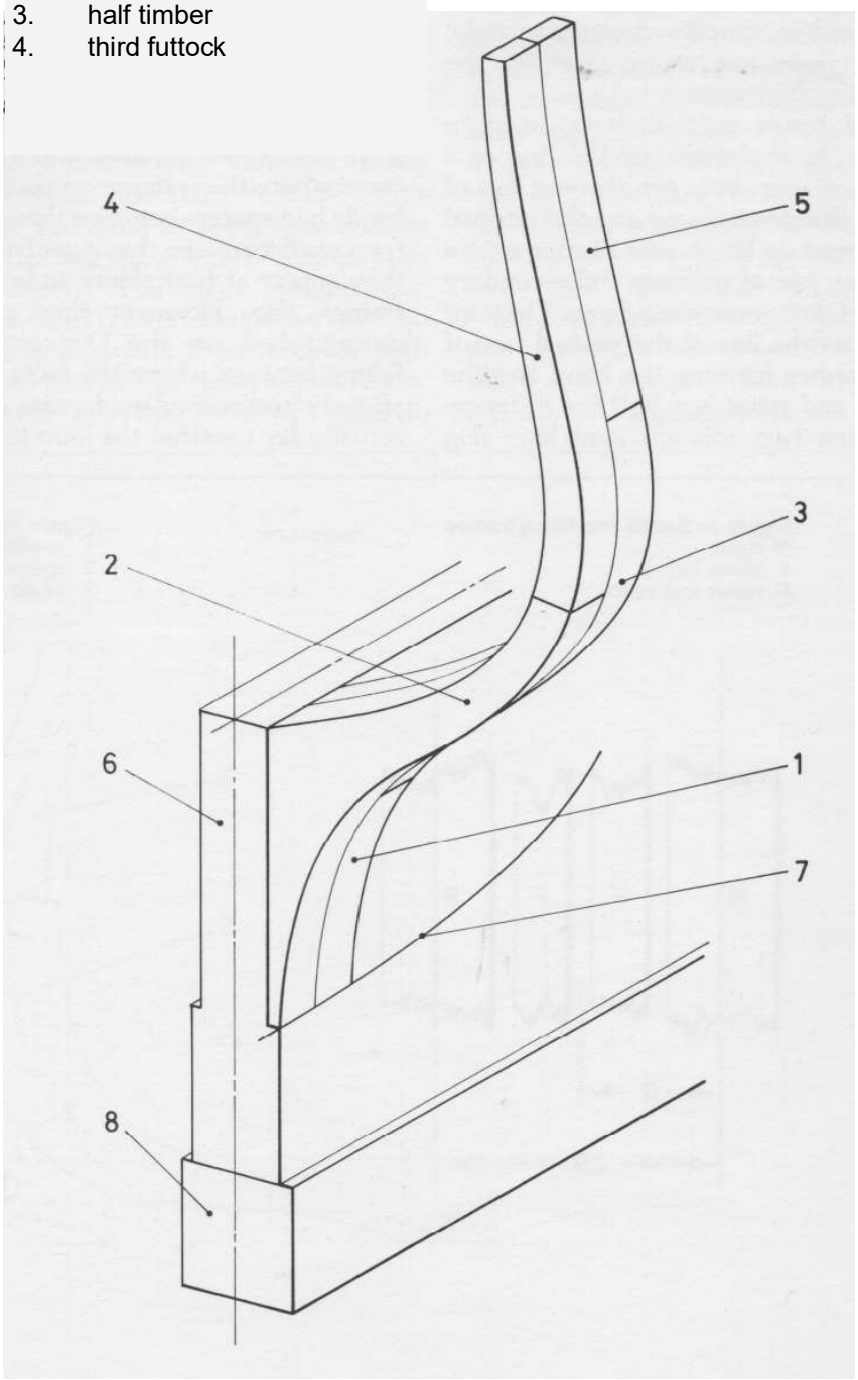


Figure 5

1. Cant bend
2. first or lower futtock
3. half timber
4. third futtock



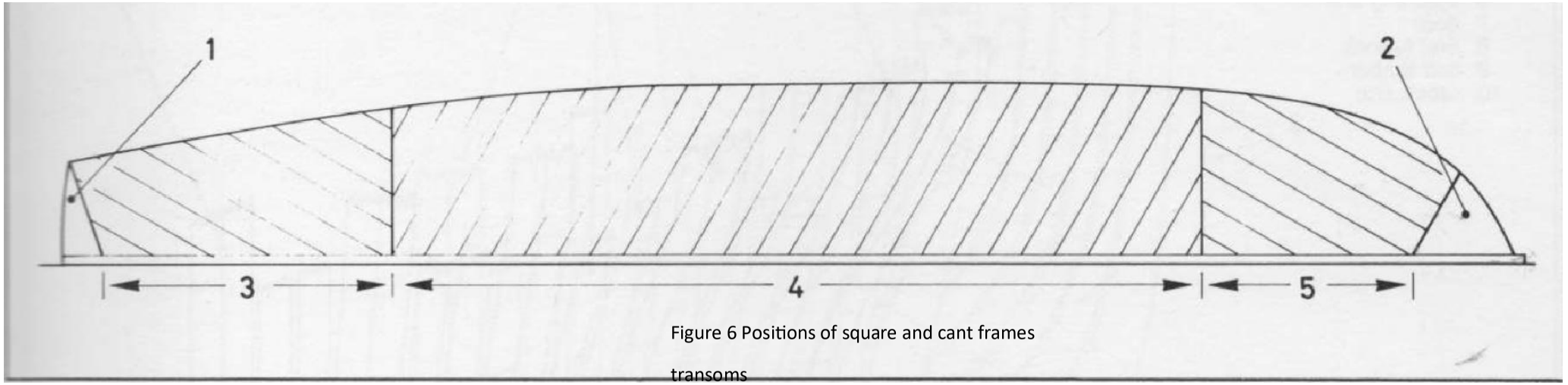


Figure 6 Positions of square and cant frames

transoms

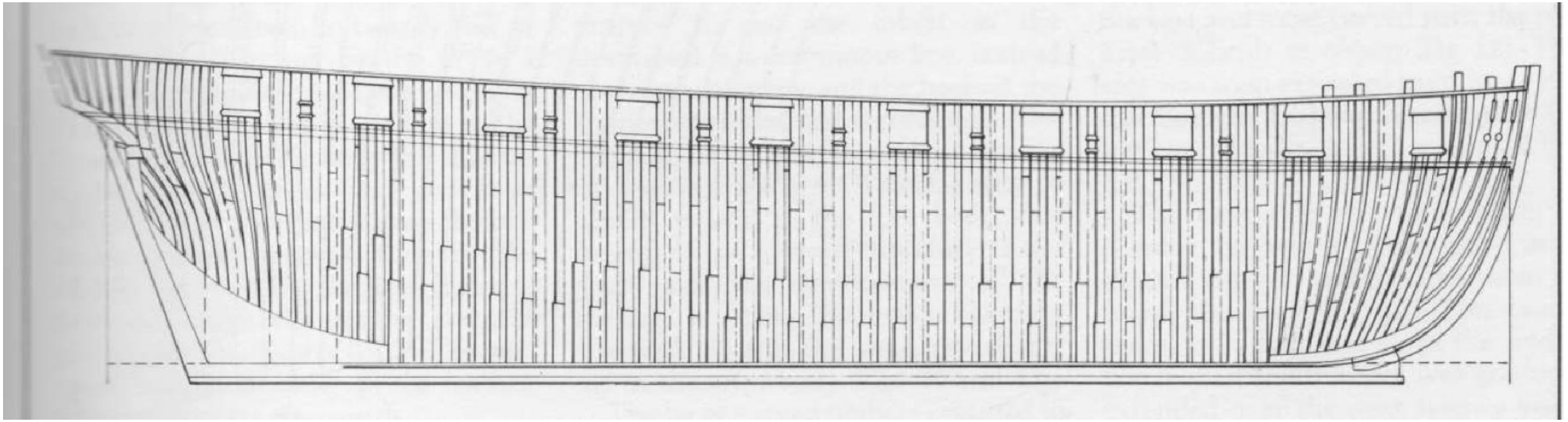
hawse pieces

after cant frames

square frames

forward cant frames

figure 7 Disposition of frame - 18 gun brig with square tuck stern and single filling frame



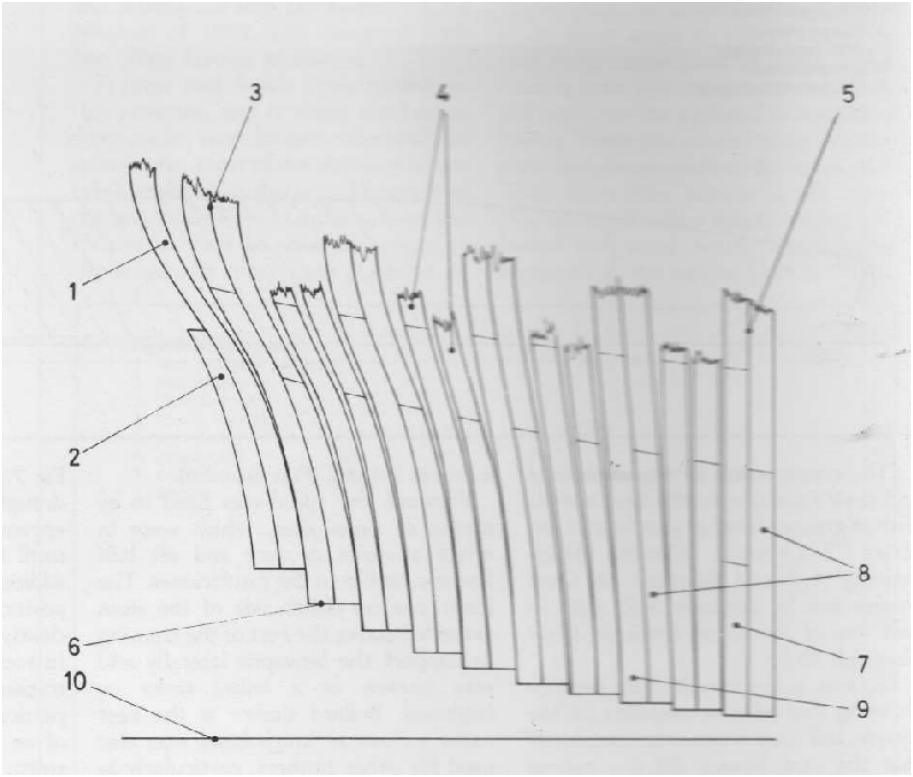


Figure 8

After stepping line

1. forward fashion piece
2. after fashion piece
3. cant bend
4. filling cant frames
5. after square bend
6. stepping line
7. floor
8. first futtock
9. half timber
10. rabett line

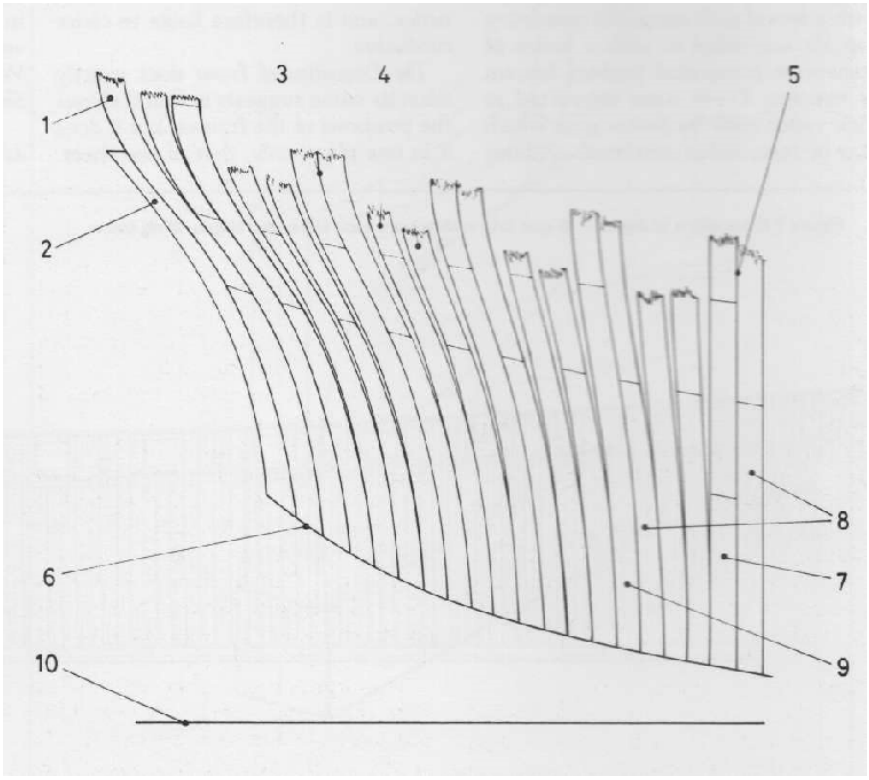


Figure 9

After bearding line

1. forward fashion piece
2. after fashion piece
3. cant bend
4. filling cant frames
5. after square bend
6. bearding line
7. floor
8. first futtock
9. half timber
10. rabett line

similar to the cant frames. The inner one on either side of the stem extended above the rest of the framing to support the bowsprit laterally and was known as a bollard timber or knighthead. Bollard timber is the best name to use as knighthead was also used for other timbers, particularly in the sixteenth and seventeenth cen-turies, and is therefore liable to cause confusion.

The Disposition of Frame does exactly what its name suggests in that it shows the positions of the frames, but it does it in one plane only, that of the sheer.

Fig 7 is a typical Disposition of Frame draught, in the form which it first appeared in the 1770s and which lasted until the end of the wooden ship. In addition to giving the fore and aft position of each frame and bend, it clearly indicates the line of the floor and futtock heads and the positions of the transoms and hawse pieces. This particular Disposition of Frame is that of an 18-gun brig with a square tuck stern, and consequently only one tran-som. The appearance of the transoms in a ship with a round tuck stern can be seen in Fig 12 of part 3 of Traditional Wooden Shipbuilding' in Model Shipwright 51.

The first attempts to show frames on draughts as a regular feature appeared around the middle of the eighteenth century, when the midship bend only, began to be drawn in this form on some sneer draughts. This was soon extended to include one or more bends ether side of midships, together with the appropriate filling frames. By the 1760s it had spread in many cases to include some fifteen to twenty feet of the middle body and by the 1770s a separate draught, the Disposition of Frame had appeared. In addition to the frames of the middle body this also in-duded the foremost and aftermost square bends, the cant frames, bollard timbers and transoms. One of the earliest, and possibly the first, frame to be shown in this way was that of the 28 r un frigate Greyhound of 1773. The next stage, that of showing all the frames, followed shortly afterwards.

In the after body the lines of the hull were so fine that the frames no longer extended as far down as the keel, but terminated on the deadwood. Prior to the last quarter of the eighteenth century the heels of these frames were cut square and the deadwood was rabetted in a series of steps to accom-modate them. The line of these rabetts was consequently known as the stepping line (Fig 8). Around 1780 it became the practice to cut the rabett in the deadwood in a continuous line, instead of a series of steps, and the heels of the frames were bearded accordingly.

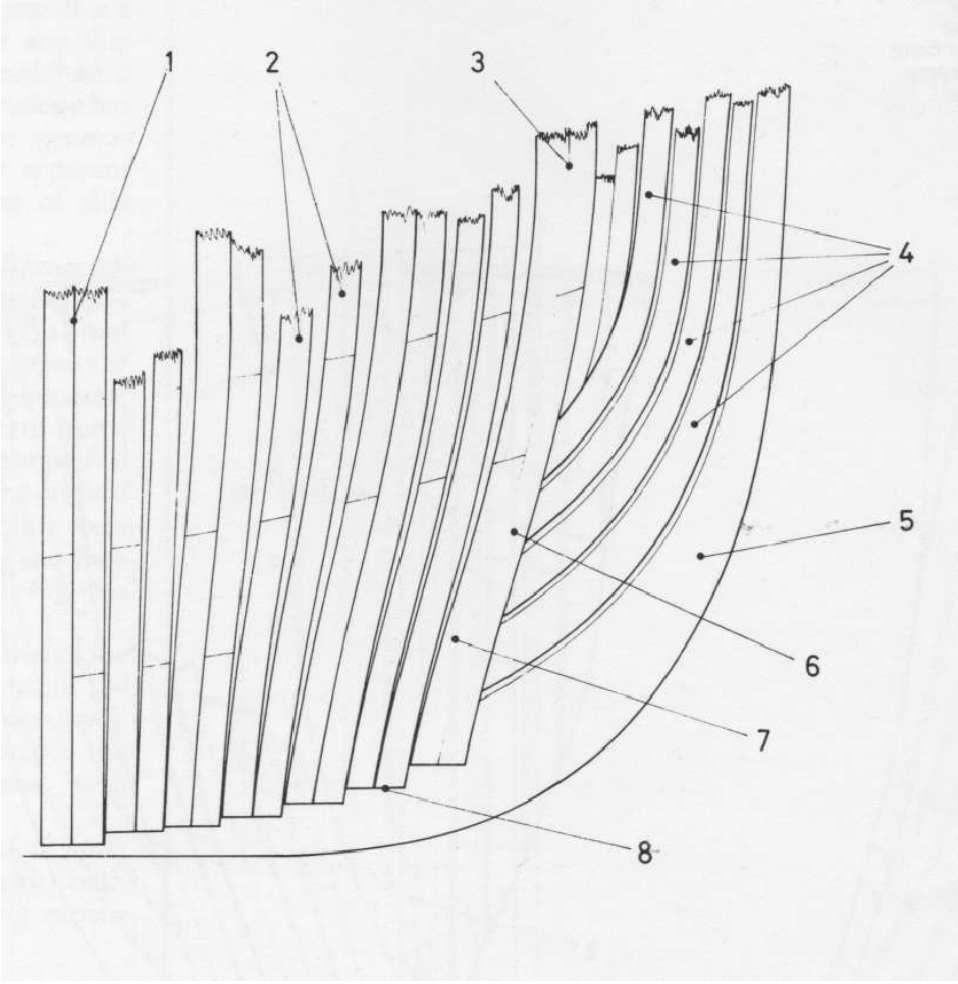


Figure 10

forward stepping line

1. forward square bend
2. filling cant frames
3. cant bend
4. hawse pieces
5. bollard timber
6. half timber
7. first futtock
8. stepping line

The stepping line then became known as the bearding line (Fig 9). A similar state of affairs existed in the fore body, due largely to the upward curvature of the stem, and the development of the forward stepping line into a bearding line took place at the same time that it did in the after body (Figs 10 and 11).

The large curved timbers required to form the hawse pieces were very difficult to obtain and so in the last decade of the eighteenth century, when the Revolutionary War with France demanded an enormous increase in s building, a further half timber was introduced on the fore side of the foremost cant frame. The heels of hawse pieces seated on this and consequently they were shorter by the thickness of the half timber, just at their thickest and most curved part; the p most difficult to obtain (Fig 12). This idea was soon extended to embrace two half timbers, enabling even smaller and less curved hawse pieces to be used (Fig 13).

The next step was to increase number of hawse pieces, thus us thinner timber, and to taper them wards the heels (Fig 14). This caused them to radiate out from the mid line in plan and this idea was gradually extended over the next twenty years; culminating in the form shown in 15. Here the hawse pieces have fanned out and merged with the cant frames.

The cant frames were also tapered to the heels and so they and the hawse pieces became structurally identical. This produced the true round bow. It is a common misconception that any ship without a beakhead bulkhead had a round bow. This loose terminology has been fostered by successive genera-tions of historians with no apparent knowledge

or understanding of ship construction.

Figs 11,12,13 and 14 are all from 38- gun frigates of the Artois class. Fig 11 is the original design and Figs 12, 13 and 14 show the stages of development of the timber/hawse piece combination. (Note also the single filling cant frame in Fig 11.) All three of these modified forms were actually used in the original six ships of this class and as they were all launched between January and June 1794 it can be seen how rapidly this idea progressed.

The round bow in Fig 15 is that of the 50-gun Java of 1815. It is beyond the scope of this article, but perhaps it will give those acquainted with the Seppings' circular stern some fresh thoughts on its origin.

The last article in this series, in Model Shipwright 56, will deal with both internal and external planking expansions

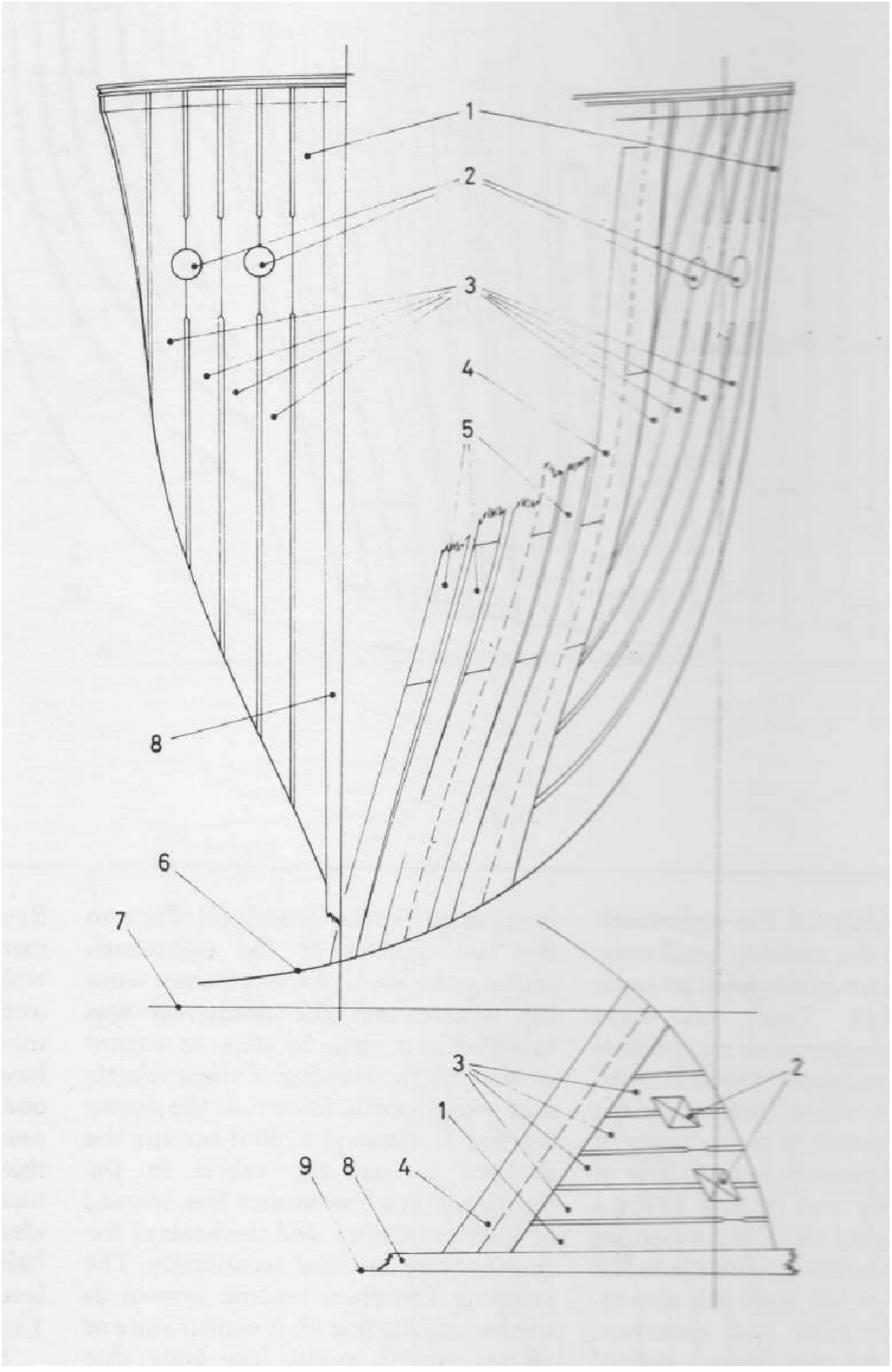


Figure 11

Forward bearding line
1. bollard timber
2. hawse holes
3. hawse pieces
4. forward cant bend
5. filling cant frame
6. bearding line
7. rabett line
8. stem
9. middle line

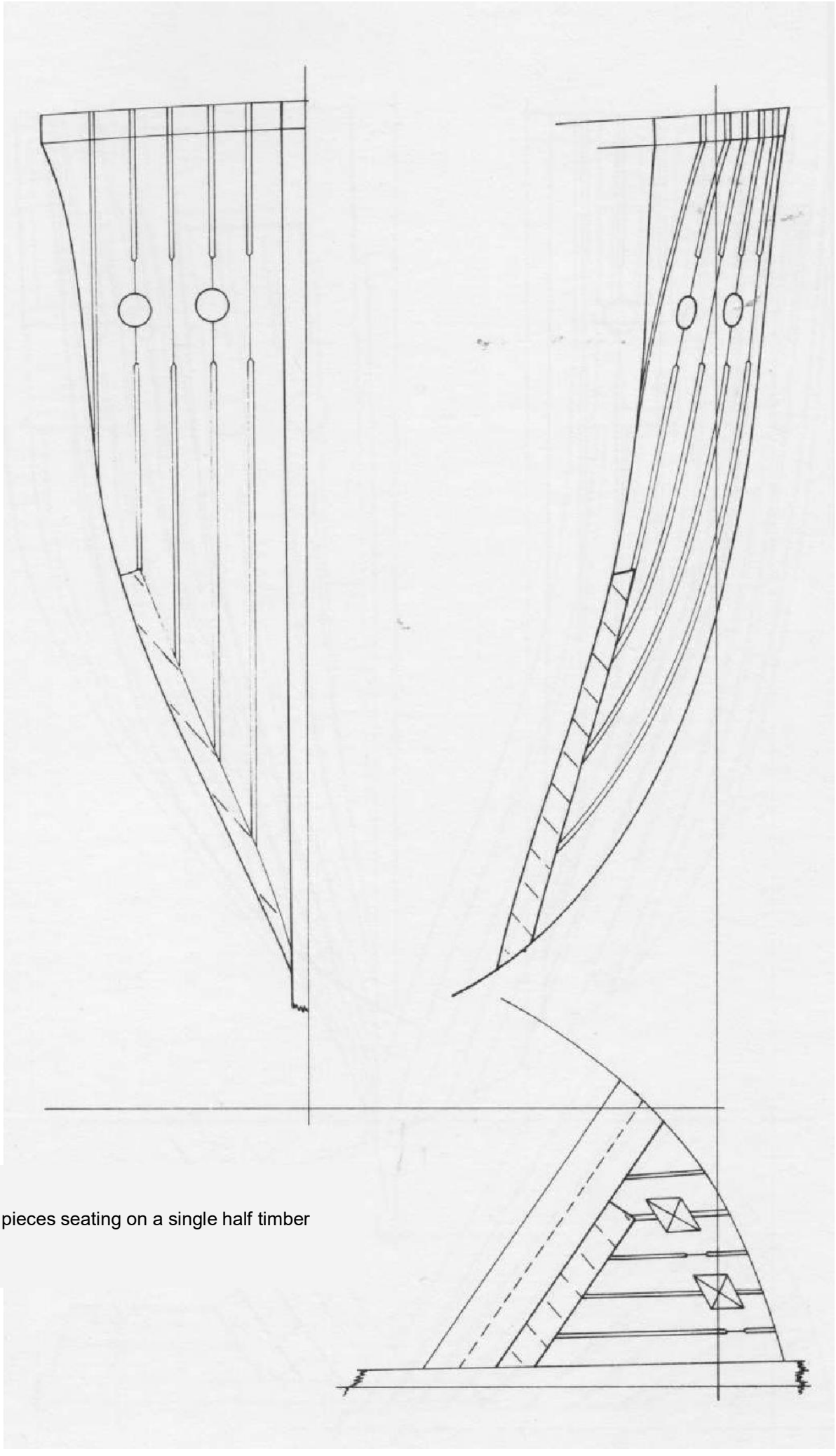


Figure 12

Parallel hawse pieces seating on a single half timber

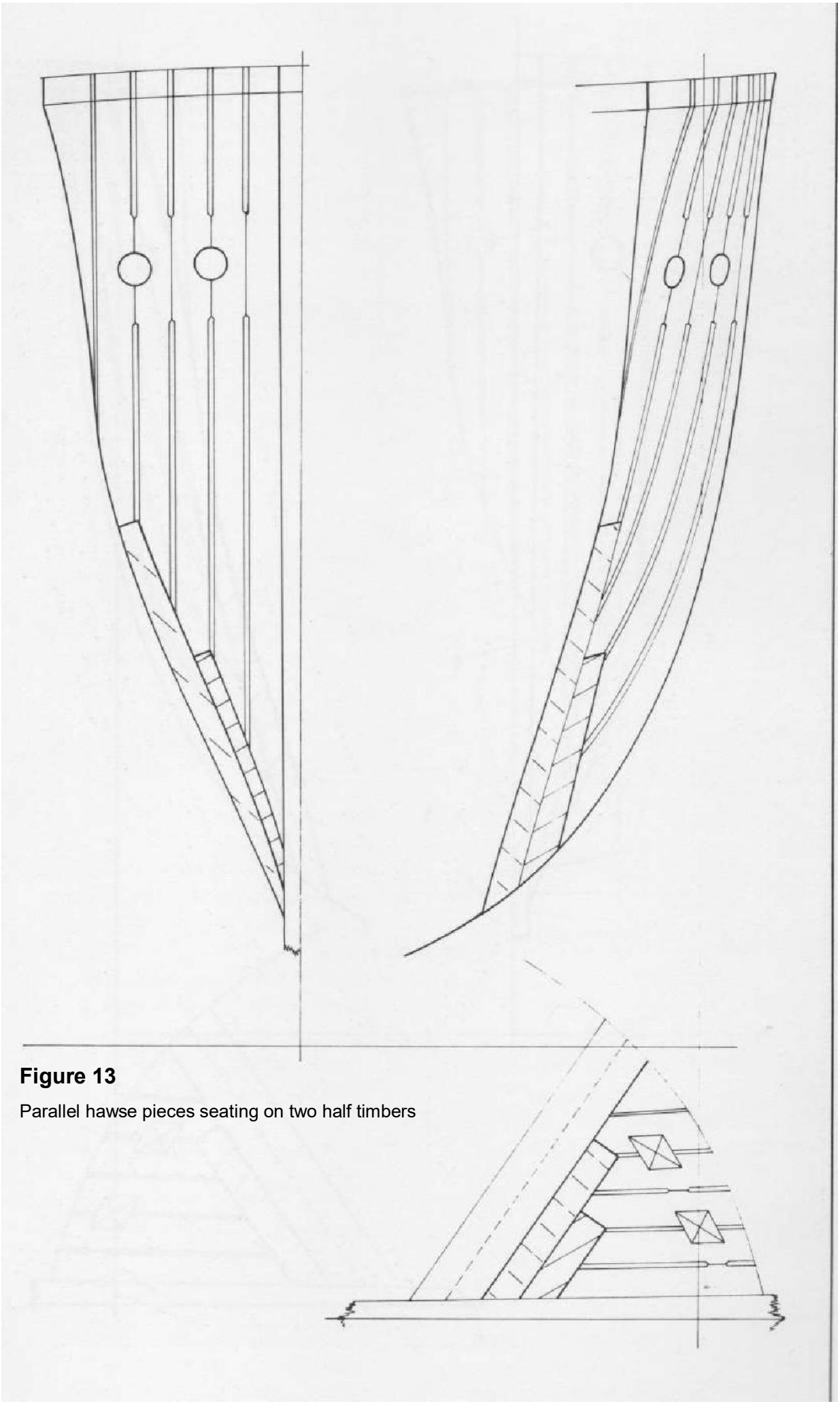


Figure 13

Parallel hawse pieces seating on two half timbers

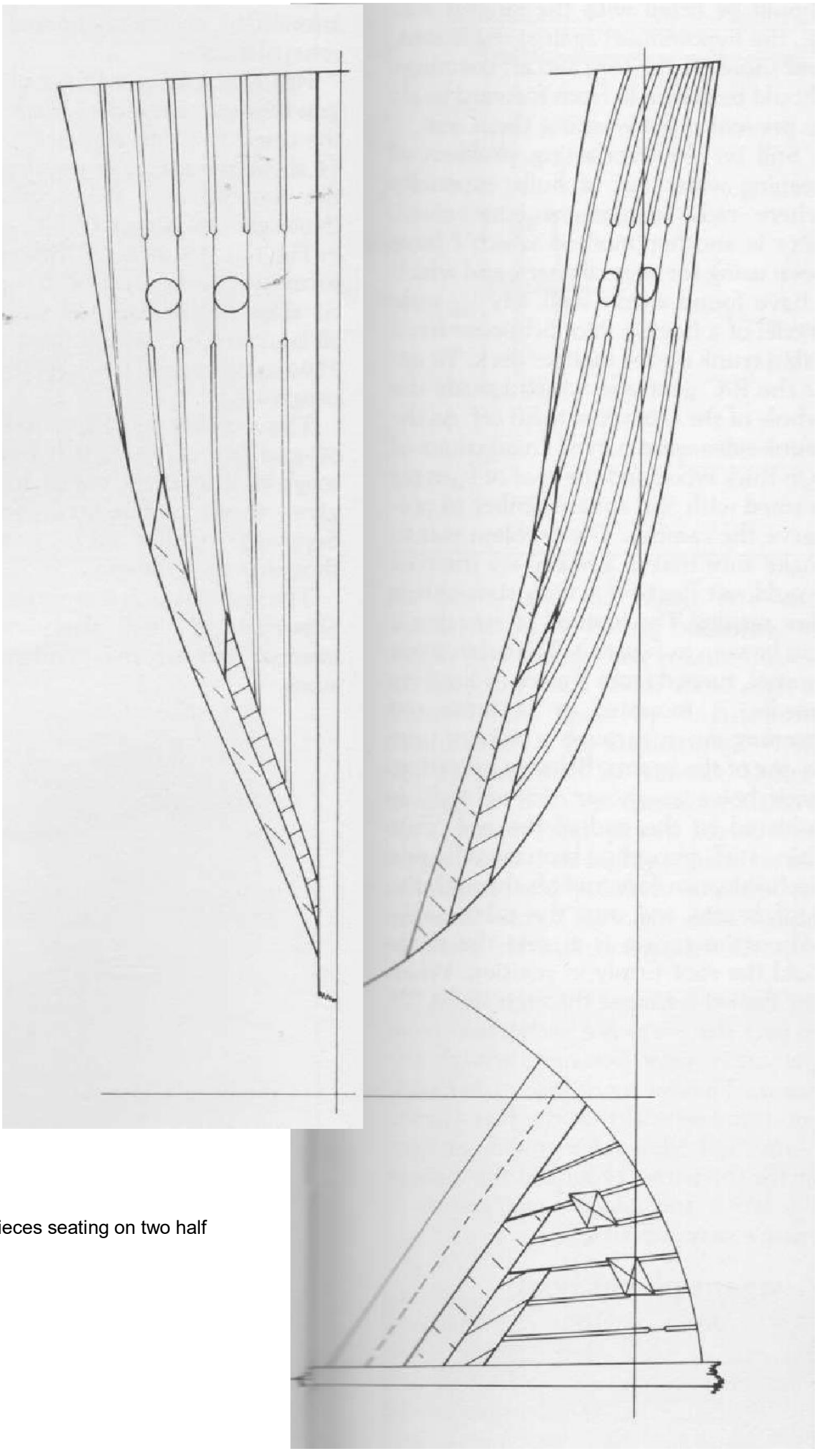


Figure 14

Radial hawse pieces seating on two half timbers

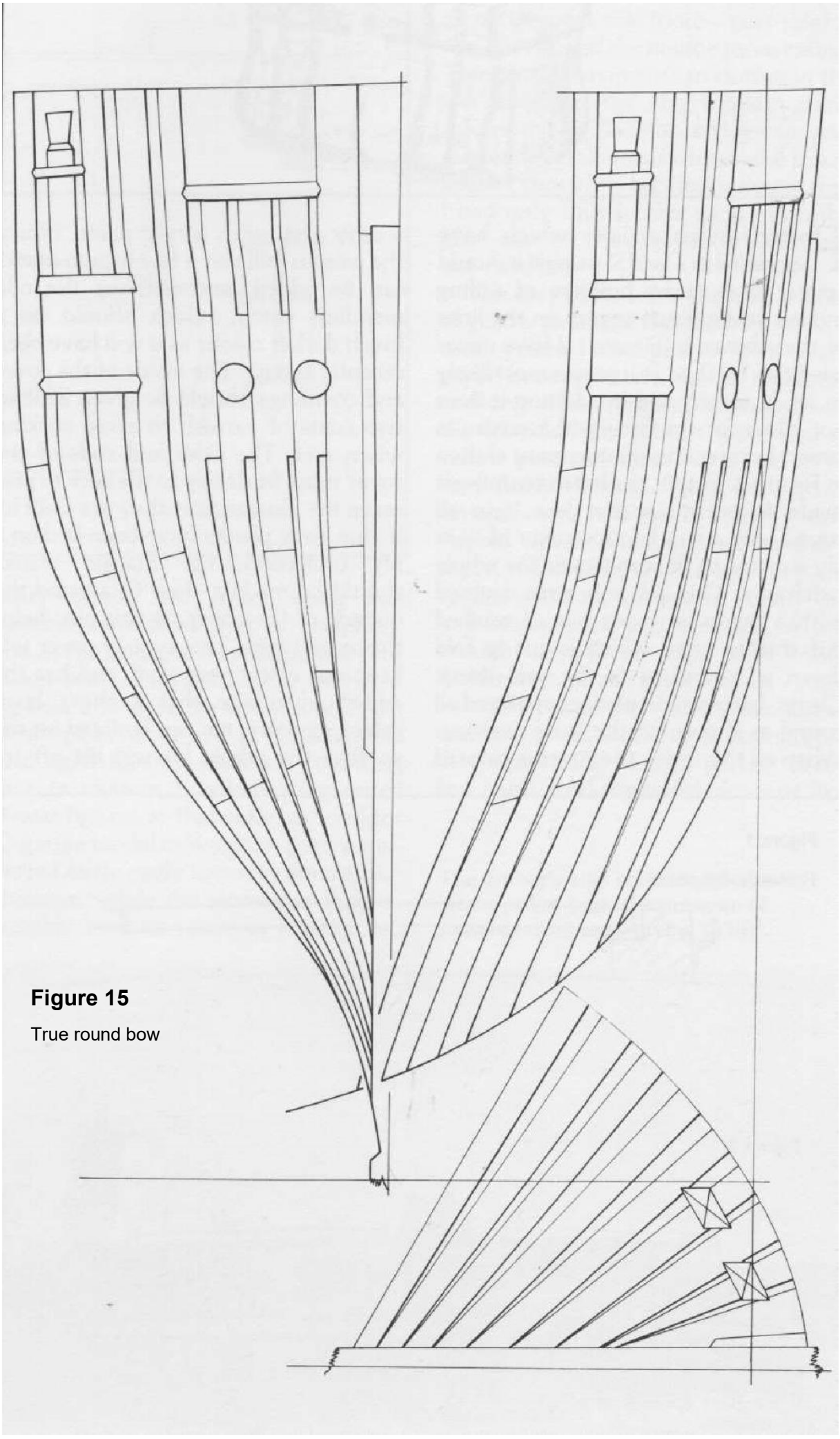


Figure 15

True round bow

5. Planking Expansions

From time to time in the first half of the eighteenth century outline profiles showing the positions and shift of butts of the wales were produced. Whilst these were of great use to the shipwright in determining where the butts should be, they were inadequate in that they gave a foreshortened picture at the extremities of the ship. Here the wales curved away from the fore and aft direction, so that although the positions of the butts could be established relative to the frame bends, it was impossible to find the actual length of the individual timbers. It was however a comparatively simple matter to develop the half breadth of the wales to show the true lengths. The half breadth in fig 1 shows how this was done in the fore body.

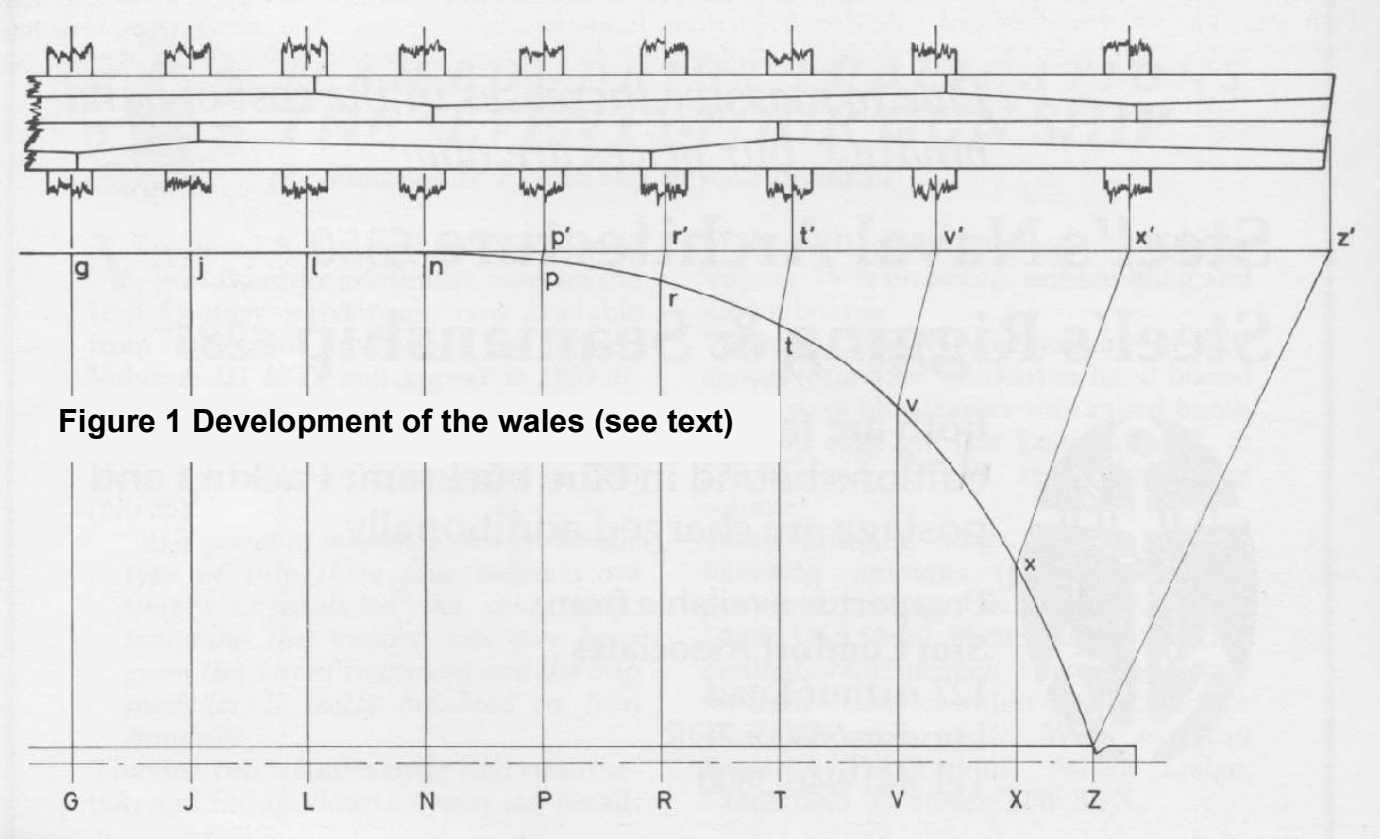


Figure 1 Development of the wales (see text)

GZ is the middle line of the fore body, gZ the moulded line of the mid height of the main wale and Gg, Jj, Ll ... Xx are the joint lines. The parallel middle body ends at n so that np is slightly greater than NP. A line gz' is drawn parallel to the middle line and the distance np marked off along it to become np'. The length pr is then marked off along gz' as pV and so on until z is reached. In practice the mid points of np, pr, rt... vz (ie o, q, s,... w) would have also been marked so that for all practical purposes it could be assumed that no, op, pq ... yZ are straight lines. Therefore for all practical purposes gz' represents the actual length of the wale from g to Z around the curve of the hull. In other words, by using this method, the two dimensional moulded line of the wales in the half breadth has been developed, or flattened, into one dimension. By drawing verticals through the points op7... z the shipwright could now work out the lengths of the component timbers of the wales, ensuring an adequate shift of butts, and with the butts falling in the right positions for fastening to the futtocks.

It may have been noticed that this simple method of development ignored the third dimension, the sheer of the wales, but again for practical purposes

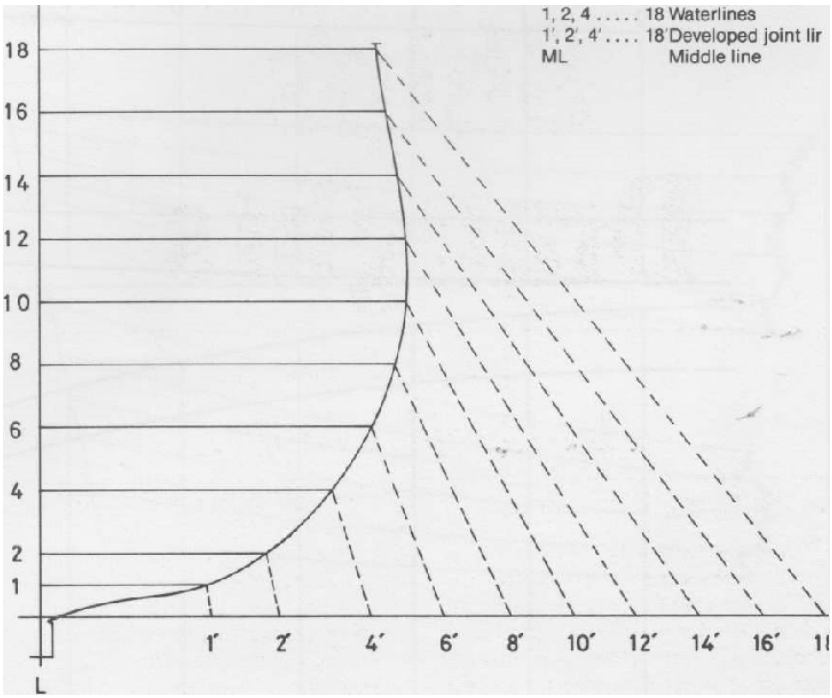
this was acceptable. At a scale of y4in to ift (1/48) the inaccuracies involved would be indistinguishable - in most cases less than the thickness of the pencil lines. The whole exercise would, of course, have to be repeated in large ships with more than one wale.

It soon became apparent that this idea could be expanded to produce a draught showing the whole of the planking of the ship's side. Now, however, a third dimension had to be taken into account; the curve of the hull in the vertical plane as portrayed by the joint lines in the body plan. These lines could be flattened out just as the half breadth of the wales had been, but using waterlines instead of joint lines (fig 2). If each joint line was developed in this way then, in sheer, the result looked like fig 3. As this produced ex-treme distortion above the maximum breadth in vessels with more than one deck and/or excessive tumble home, it became the practice in these cases to draw the expansion in two parts; from the rabbet line up to the upper edge of the main wale and from the upper edge of the sheer strake down to the lower edge of the main wale. The main wale thus appeared twice and this can be seen in fig 4. (Try flattening a banana skin to get the same result).

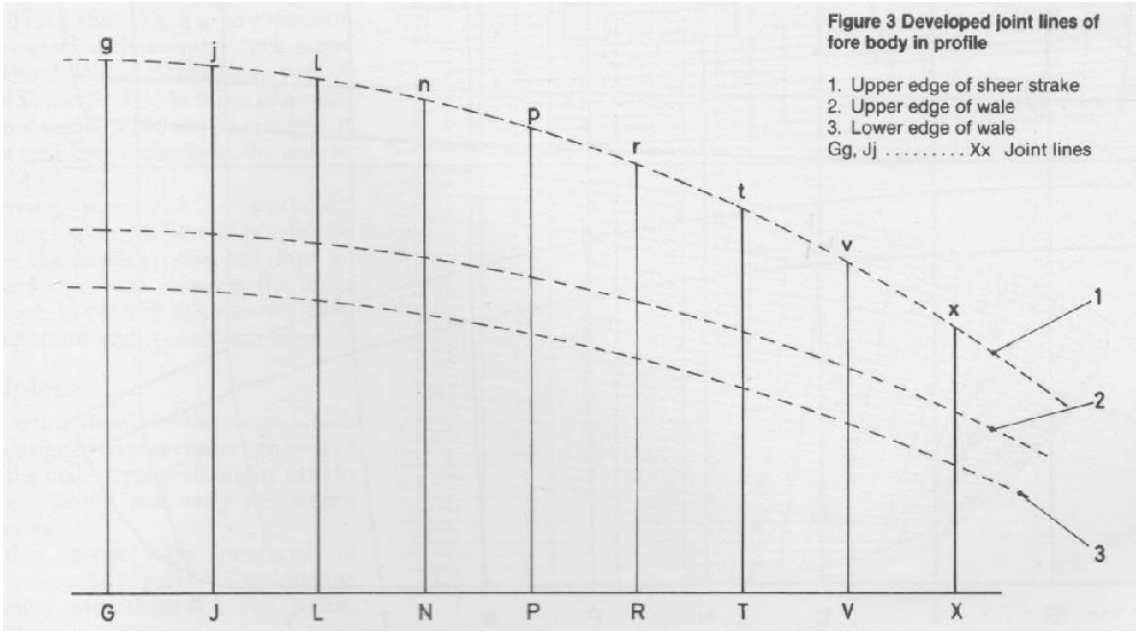
Each waterline was then developed in the same way that the line of the wales was treated in fig 1. Fig 5 shows the

Figure 2

Development of joint line
1-18 Waterlines
1'-18' Developed joint line
ML Middle line



effect on the shape of the joint lines when plotted in conjunction with the developed waterlines. It now became a straightforward job to add the lines of the floor and futtock heads, the rabbe lines of the stem and stern post and th< positions of the transoms and haws< pieces. The result was a flattenec projection of the hull surface upor which the whole of the planking could be drawn, butts could be positioned correctly, sizes of individual planks could be



measured and the necessity for steelers and drop strakes determined. One of the great advantages of the planking expansion was, in fact, that the planking could be arranged to cut out a great many steelers and drop strakes.

(Steels Naval Architecture of 1805 defines steeler as 'A name given to the foremost or aftermost planks, in a strake which drops short of the stem and stern post, and of which the end or butt nearest the rabbet is worked very narrow and well forward and aft. Their use is, to take out the snying edge occasioned by a full bow, or sudden circular buttock7. What this means is that where, because of the rapid change of section of the hull, a strake becomes impractically wide, a plank is fayed to it to make up the width. This is a steeler, which nowadays is spelt stealer, and which is illustrated in fig 6 together with a drop strake.)

This projection was dimensionally correct in both the fore and aft and vertical directions. What it did not show was the actual shape of the individual planks. These appeared in a distorted form, but this was of minor significance as the planks would be cut straight anyway, before being bent to fit.

Fig 7 shows the completed outboard expansion for the forward end of a frigate in 1808. Fig 8 represents the after body of the same ship, which has a round tuck stern. Fig 9 is an expansion for a vessel with a square tuck stern. {Traditional Wooden Shipbuilding, part 3, Model Shipwright 51). As this is of a small shallow vessel, a 250 ton 14 gun

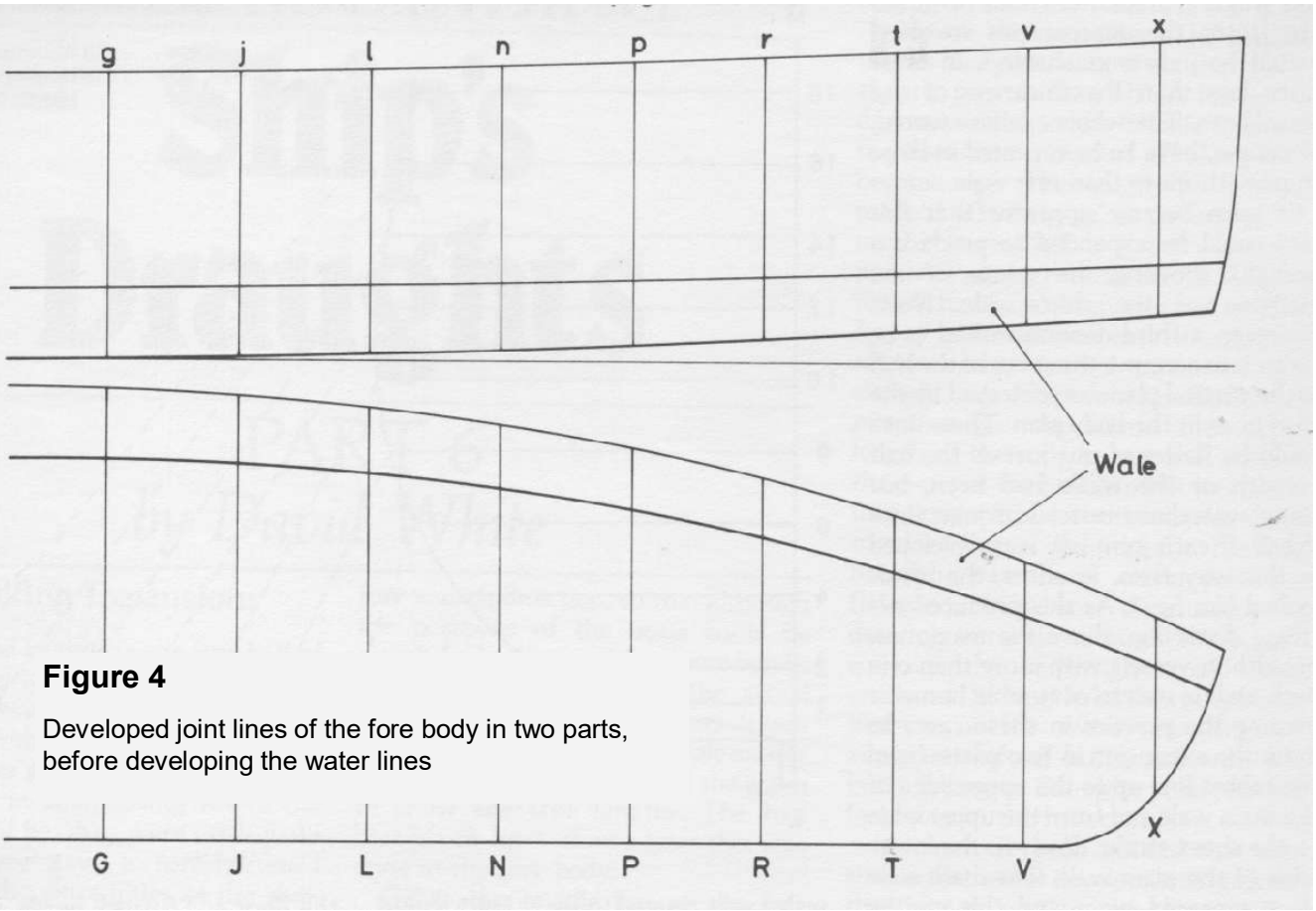


Figure 4

Developed joint lines of the fore body in two parts, before developing the water lines

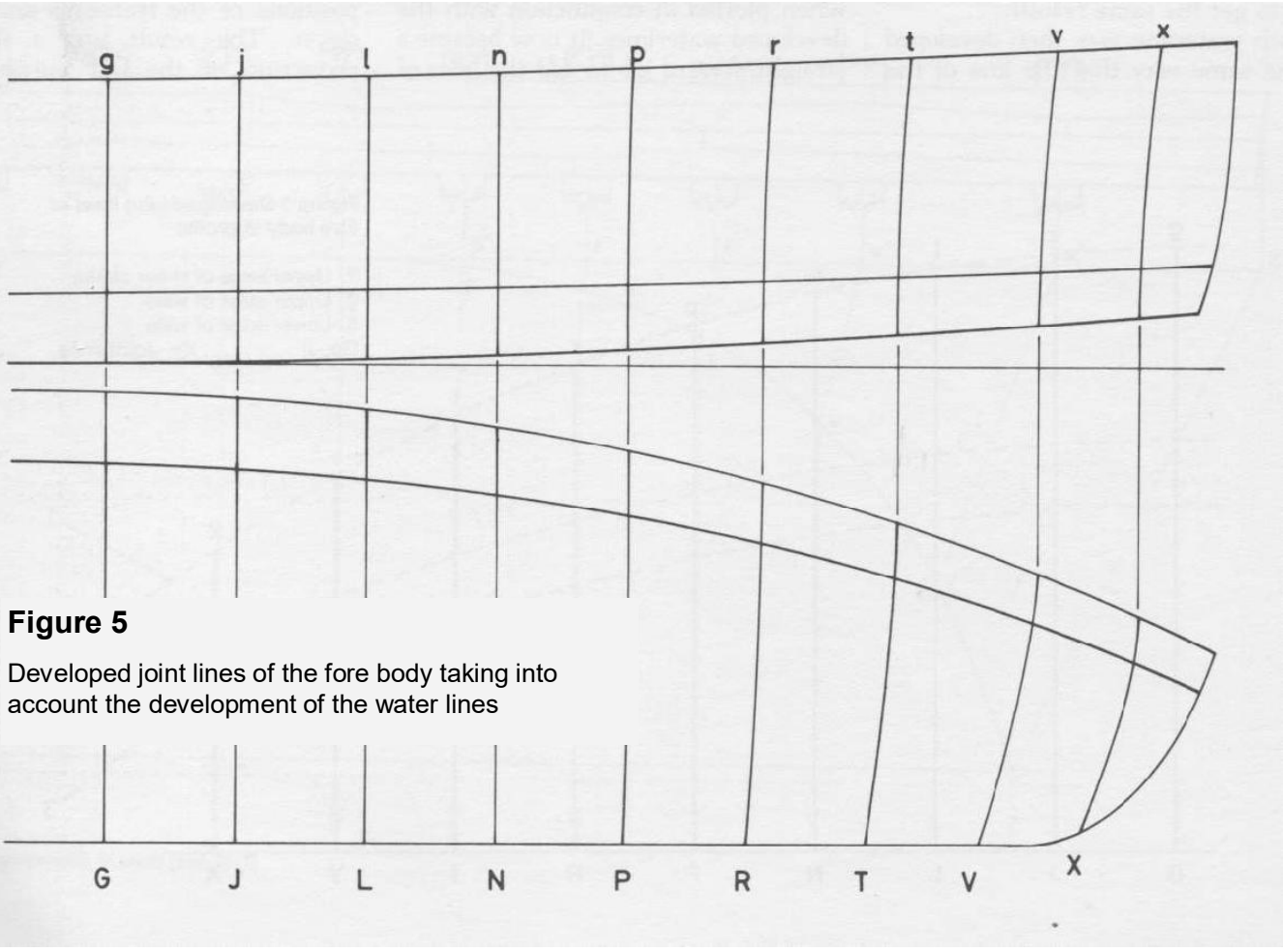


Figure 5

Developed joint lines of the fore body taking into account the development of the water lines

brig, it is not split longitudinally at the wale as in fig 4.

Having produced an outboard planking expansion, it was possible to repeat the whole process and draw an inboard expansion showing the inner planking. In practice this was not really so important and was seldom done.

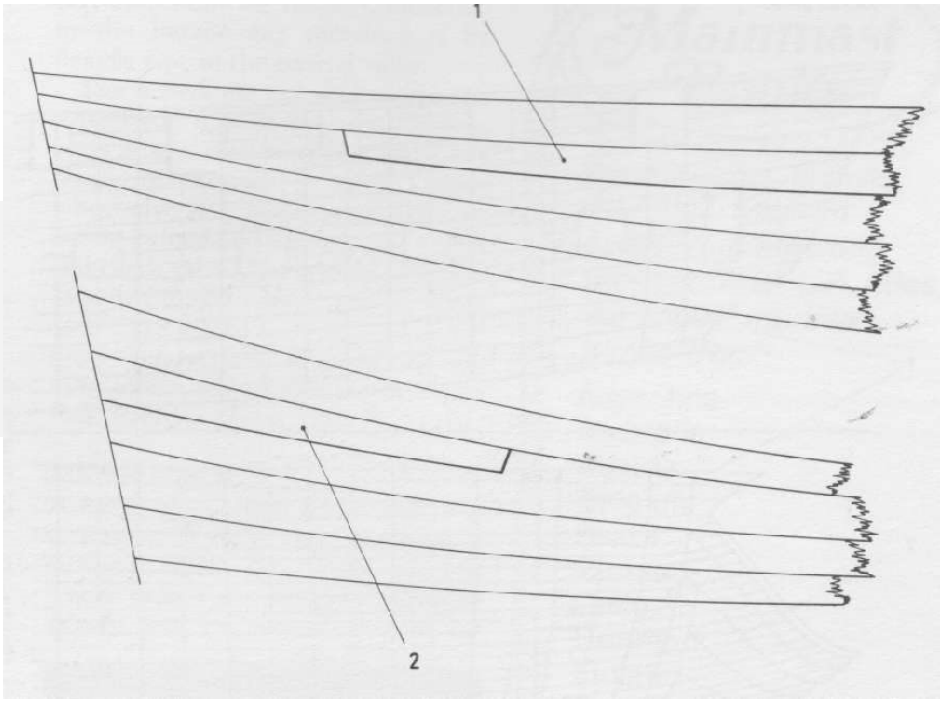
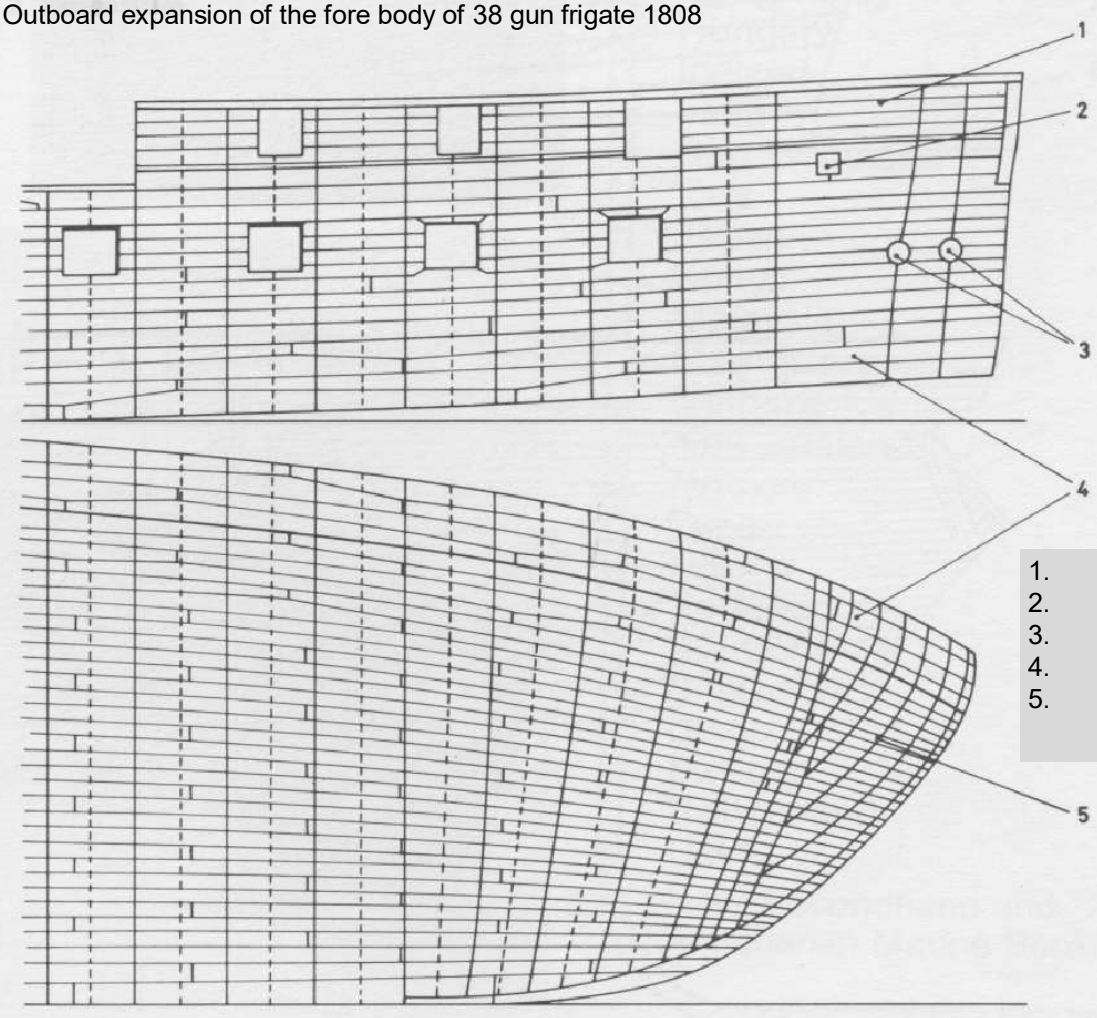


Figure 4

Steelers and drop strakes
1. Drop strakes
2. Stealers

Figure 7

Outboard expansion of the fore body of 38 gun frigate 1808



1. Forecastle bulwark
2. Cat head
3. Hawse holes
4. Wales
5. Hawes pieces

Tailpiece

This article concludes the series, which was designed to give readers an insight into the main types of draughts used in the eighteenth and early nineteenth centuries.

Other plans were produced of course, usually of parts of ships such as sections, elevations of the stern, figureheads, etc. These, when not of a complete ship or full deck, were always referred to as sketches. They were usually striaghtforward and require little or no explanation. Regrettably very few have survived. Hopefully the series has proved of interest to readers and has given them an insight into how our forefathers designed and recorded that work of art, the wooden sailing ship. If, additionally, it has inspired a few to delve deeper into the subject, then all the burning of midnight oil that has gone into writing it and producing the illustrations will have all been even more worthwhile

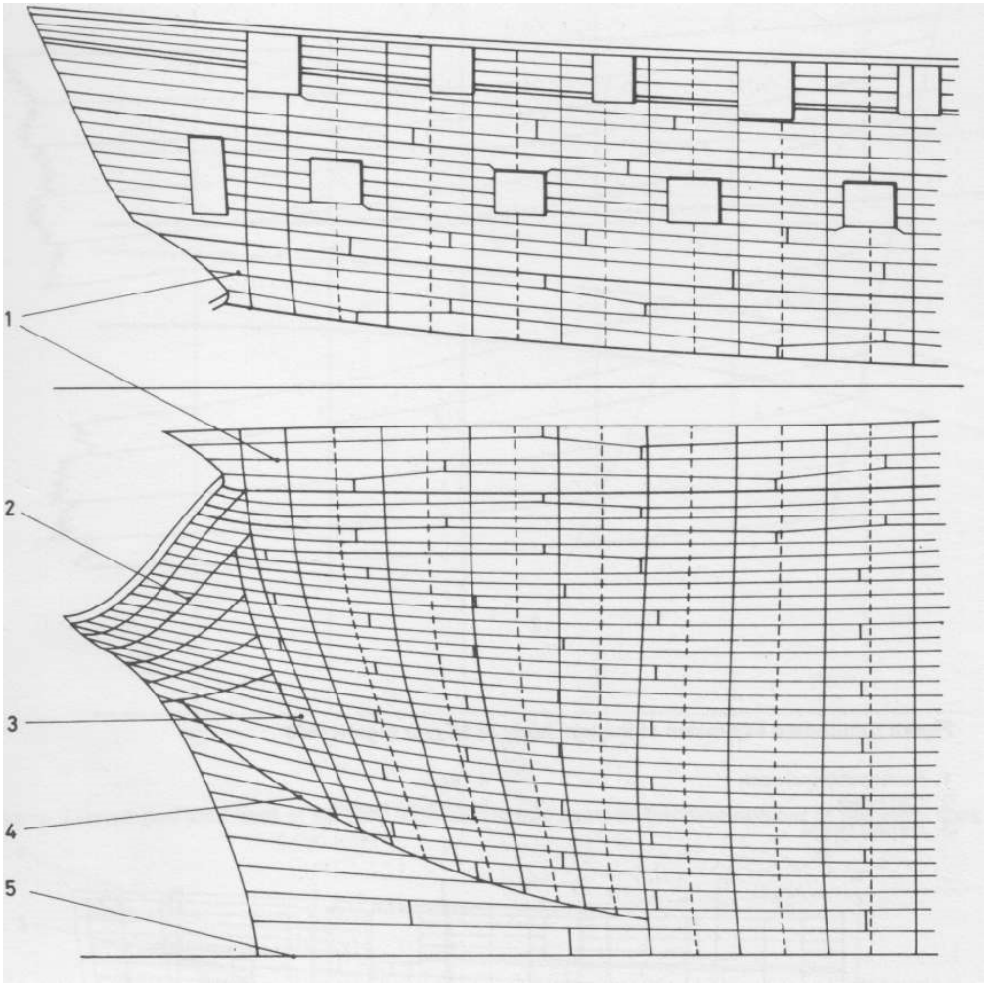


Figure 8

Outboard expansion of the after body of a 38 gun frigate 1808

1. Wale
2. Transoms
3. Fashion piece
4. Bearding line
5. Rabbet

Figure 9

External expansion of a 14 gun brig

1. Square tuck stern
2. Wale
3. Rabbet