Appendix 4.

How to draw the patterns for the Jib Panels.

This is an attempt to explain how to draw the patterns to make the 'jibs' of the split junk rig.

I suggest you draw a scale drawing on an A4 page to get the idea before drawing up full size on pattern material (in my case lining wall paper). If you understand it well enough then a scale drawing could be transferred directly onto the sail material, but please note that this will give the outline of the material and that no allowance has been made for seam overlap or for luff and leech hems (tabling)

This example is for the parallelogram panels, but if drawing the pattern for the third down panel then simply draw the battens at the correct angle and distance apart.

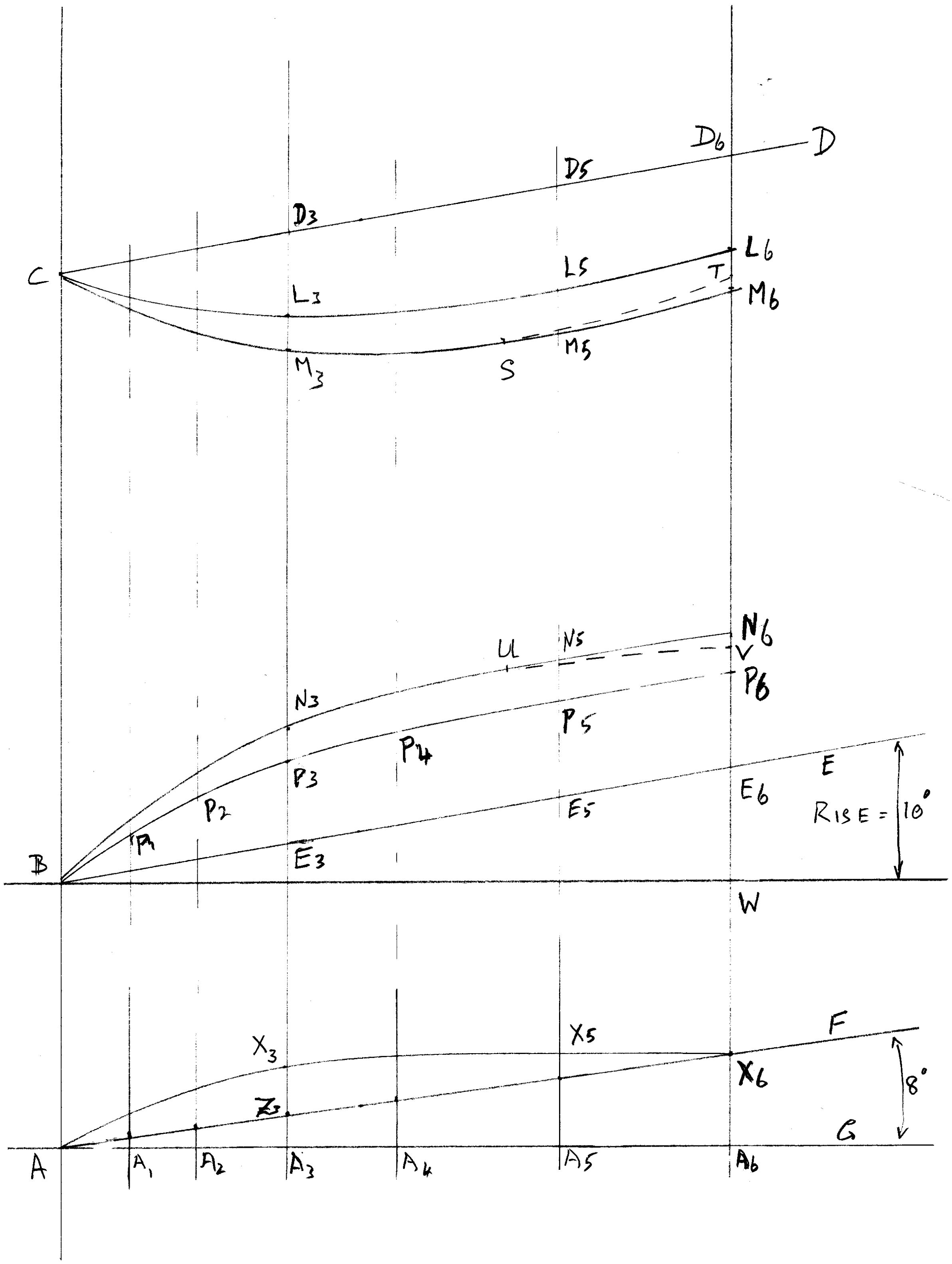
Please refer to the diagram which follows.

1. Draw a vertical datum line down the left hand side of the page, line ABC.
2. Draw a horizontal datum line at the bottom of the page, A towards G.
3. Draw a line at 8° to AG. Line A towards F. (This is the 'sheeting' angle).
4. Draw a horizontal line above AF, line B towards W.
5. Draw a line at your rise angle above BW, and mark the end E. See note 1.
6. Mark the length B to E6 equal to the length of chord of the Jib panel. See note 2.
7. Mark a point C above B such that the length BC equals the distance between the centre line of your battens. (Make appropriate allowances for your selected batten pocket and panel joining system).
8. From C draw a line parallel to BE, line C and mark the end D. (For Parallel battens).
9. Draw a vertical line through E6 to cross all other lines and get points A6, X6, & D6.
10. Mark points along base line AG such that the distance A to A1 is 10% of A6, A to A2 is 20%, A to A3 is 33.3%, A to A4 is 50% and A to A5 is 75%.
11. From point A3 draw a vertical line up to the line CD, and mark the points Z3, E3 and D3.
12. Now mark point X3 on the line above Z3 at a distance given by the chosen jib camber. See note 3.
13. Draw in the camber curve A-X3-X6, using X3 as the point of maximum camber with a smooth curve from A to above point (4) and almost a straight line from above (4) to X6. See note 4.
14. Mark point P3 at the same distance above E3 as X3 is above A3, and mark point L3 at the same distance below D3.
15. Now mark point N3 at a distance of 1.414 times the distance A3 to X3 above point E3, and mark point M3 at the same distance below D3. See note 5.
16. Now repeat 15 and 16 for all the other points A1 to A6 and mark points P1, N1, M1, L1 and P2, etc.
17. Now draw a curve through the points B (luff), P1, P2, P3, P4, P5, to P6 on the leech.
18. Similar for points B through the Ns to N6.
19. Similar for points C through the Ls to L6.
20. Similar for points C through the Ms to M6.
21. You now have the shape of the centre panel which is B to C, along the Ls curve to L6, to P6 along the Ps curve back to B.
22. The shape for the top 'lens' for the mark 1 version that I initially used is given by C to D6 to M6 along the Ms curve back to C.
23. The shape for the bottom 'lens' for the mark 1 version is given by B to E6 to N6 and along the Ns curve back to B.
24. I have modify my sail to the Mk 2 version by broad seaming the lens panels to the dotted lines S to T and U to V. S and U are at 60% chord (see note 6 below) and the distance from T to M6 and V to N6 is (see note 7 below).
25. When you stick and sew the lenses to the centre panel start at the luff and the leech will not be a straight line as the points T and L (and V and M) will not line up. The leech will have to be trimmed with a straight line from T/ L6 to V/ P6, and from D to T/ L6 and from E6 to T/ L6. Remember that the leech reinforcement will be added on top.

Note 1. I used 10° as recommended in Practical Junk Rig.
Note 2. On Poppy I made the mainsail chord 70% of the total chord, and the jib chord as 24% of the total chord, leaving the split as 6% of total chord. If building another I would increase the balance even further.

Note 3. I used 7% camber in the jib and that is 7% of the distance A to X6. (I believe this should be greater and is wide open to discussion).
Note 4. To help draw the camber curve, draw a light line parallel to AF through point X3 and then sketch in the camber line bending down to point A and to point F. Make the curve almost the arc of a circle from A to be a tangent to the light line at X3, and continue it back to the 50% chord point and then draw it as a straight line to point F. (But see Appendix 5 and Chapter 4 on this subject. They were written after this Appendix).
Note 5. The number 1.414 is a result of my calculating the shelf as angled at 45° to the horizontal.
Note 6. The 60% is the guess I used. I think it must be over 50 % chord but it is important that it is a smooth gentle curve away from the Mk 1 line and must end up at the right point. There is no room of anything other than smooth curves. On my jibs I used 41mm at 100%, 25mm @ 90%, 15mm @ 80%, 6mm @ 70%, &0 @ 60%. 10% = 15 cm.
Note 7. I don't know the answer for sure yet, but I have modified my sail so that the distance from N6 to V is 11% of E6 to N6 (41mm). It seems to be all right, but I'm not sure if the boat is as fast as before.

Diagram on next page.



Split Junk Jib yy-mm-dd.tif

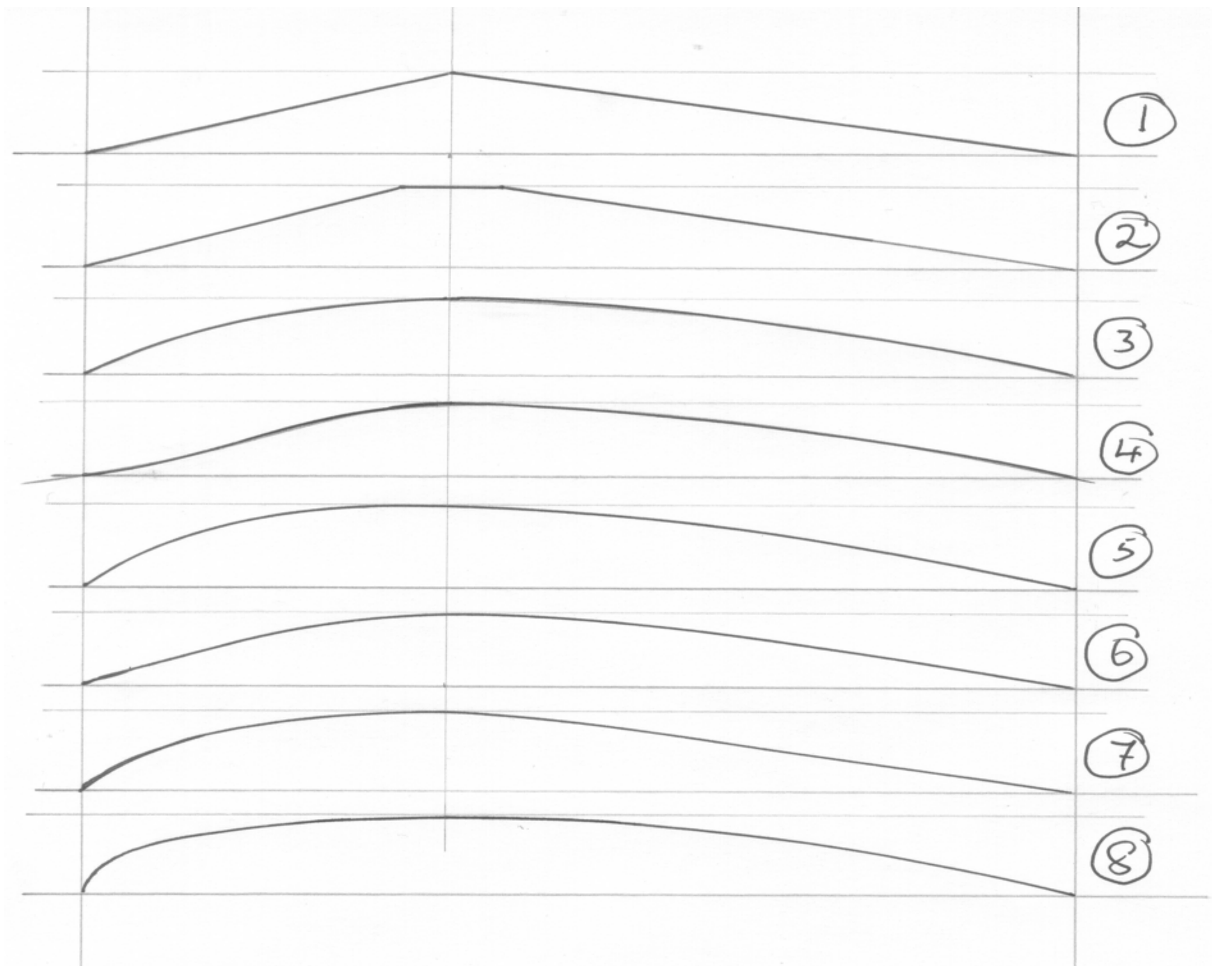
Appendix 5.

Drawing the Camber curves.

This is one situation where WYSIWYG does not apply. Regardless of how much care you take in deciding on the camber you want, and how carefully you cut it into the material of the panels you will still end up with something with a different shape. The trick is to modify the curve used for cutting the material to achieve the shape you want the finished panel to have. Unfortunately too many of the existing cambered sails have ignored this situation and the sail makers are not looking critically at the achieved camber when checking their products.

The question is what shape is going to give the best performance for any particular boat? Everyone seems to have their own answer to this, which is not surprising when we remember the wide variation in performance that can come from different Bermudan sails, even from the same loft and for the same boat. The best we can do is try to understand how the performance varies with the different shapes that we can actually build.

When discussing camber we tend to talk about the maximum camber and its position on the sail. We define camber as the ratio of the maximum depth of the sail curvature, D, to the sail chord, C, and normally quote it as a percentage. The other parameter quoted is the position of the maximum chord, again as a percentage of the chord and measured from the luff.

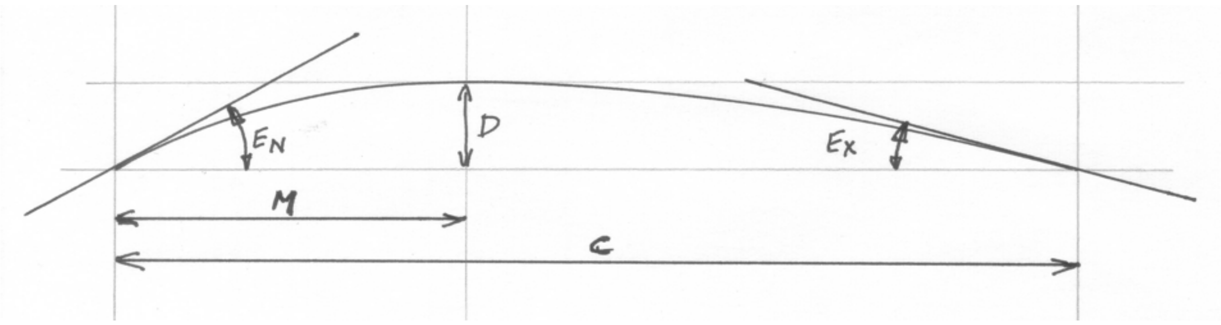


The drawings below show a series of shapes all being 10% camber centred at 37% chord, yet all are quite different, and will produce widely different performances.

There is a certain amount of artistic licence in these drawings, but they are not untypical.
No.1 would be typical of a single hinged batten section, though it's unlikely that it would have as much as 10% camber.
No. 2 would be like a 2 hinge batten rig which I believe are still being recommended by commercial suppliers for Jester Challenge boats for crossing the Atlantic, even though there have been reliability problems with them.
No. 3 is a well-rounded shape, with the curve carried right back towards the leech.
No.4 is a slightly exaggerated camber of the S-bending that can form on a bendy batten rig.
No. 5 is similar to number 3, but with the camber carried further forward to change the entry angle.
No. 6 is again similar to 3, but with a flat entry and almost straight line over the first 15% of the sail, reminiscent of the camber on a Bermudan roller reefing head sail.
No. 7 has a similar entry to 5, but has a straight line exit for the last 50% of the sail.
No. 8 has been drawn to show a very rounded entry, though the after section is also well rounded.

The big point is that all of these are different and will have different characteristics and performance. It is possible to think of the curve before the maximum camber point and that behind the point separately, and taking the forward curve from one section and the after section from another.

The point of this exercise is to show that simply defining maximum camber and its position is not enough to define the curve.



In the diagram above the entry angle E_N and exit angle E_X are marked and if these are drawn as well as the maximum camber and its position then it is easier to bend a spline to be a tangent to the angle lines and complete a fair curve. One important point about using splines is that they should be supported beyond the end of the finished curve so that they are still curved at the final point and not allowed to become straight at, for example, the luff. (Plastic curtain rail can be used as a spline for drawing long curves if well supported).

Reading through the various text books it becomes clear that these angles have a significant effect on the performance. C.A. Marchaj, is his book 'Sail Performance, Theory and Practice' writes that "*for sailing up wind in light conditions a well rounded entry will give improved performance.*" Upwind in light conditions is probably the weakest point of the earlier junk rigs so this simple statement makes a very important point.

Regarding exit angle he states that as "*the surface of the foil is inclined aft behind the maximum camber point it is desirable to have the last portion of the foil fairly flat to discourage the development of suction at this position and the associated drag*." This suggests that the exit angle should be small. James L Grant in his book on Design of Jib Sails suggests that 8% camber is 'normal' for most headsails. He compares two curves similar to No. 3 and 8 in the earlier diagram and states that "*the rounded entry curve will be more tolerant to wind shifts and inattentive helmsmen, and will also be less inclined to stall when sailing in rough seas whereas the flat entry sail should be faster in smooth water and with a helmsman who is concentrating on what he is doing."* Here again the weak point of the older junk rig could be improved on by using the well-rounded entry.

James Grant continues by pointing out that "*the curvature towards the leech can have a large effect on the drag of the sail and therefore the windward ability*." He reminds us that "*when allowed Bermudan mainsails and jibs fit battens at the leech. These are not only to support the roach but are also used to keep the sail as flat as possible in this area".*

Both these writers show the sort of compromise that has to be made in selecting the camber curve. We regularly read the debates about the amount of camber and the position of maximum camber point yet we rarely hear mention about the possibly more important entry angle and the exit angle.

Note that Marchaj also states - "*There must be as little opportunity as possible for the creation of flow disturbances near the leading edge, because this is the place where the greatest pressure differences (large suction) across the sail occur, and these pressure differences contribute most to the driving force. Thus the shape of the sail entry, and hence what we may call the entrance efficiency, becomes the factor which primarily determines sail driving power."* (Thus suggesting that the Split junk rig is worth the effort involved and the performance seems to confirm this statement).

So what shape of camber do we want? Bermudan mainsails of boats with small headsails often have camber between 8 and 15%, and despite being behind a mast can have the maximum camber point as far forward as 33% chord. One sail maker recently admitted that his computer programme for Bermudan sails cannot draw sails with less than 8% camber.

As with Bermudan rigs, the **amount of camber** required will depend on the shape of the hull. A heavy displacement boat will require more drive and probably heel less than a slim lightweight design, and will therefore benefit from having more camber in the rig. Despite Arne having built his first deeply cambered sail back in the mid '90s there are still few boats sailing with deeply cambered sails. It does not seem to make sense to go to the trouble to build a cambered panel sail and not put a useful amount of camber in it. For a single sail rig on an average cruising hull it would seem to make sense to use at least 8 to 10% camber, and those who have used these figures have found them to work well.

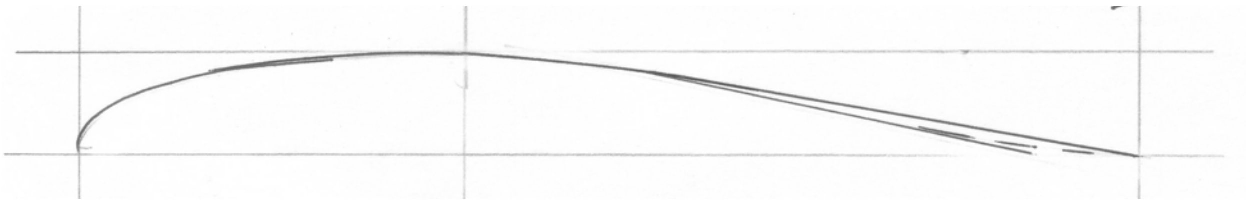
For a two masted boat, be it ketch or schooner, it would seem to be desirable to use at least 10% camber in the fore sail and 8% in the aft sail, again assuming a cruising type of hull. If rigged as a yawl then it would seem reasonable to ignore the mizzen when deciding what camber to put in the other mast(s).

As stronger winds require less camber then it is reasonable to decrease the amount of camber in the top storm canvas panels.

The **position of maximum camber** causes a lot of discussion in the pub, but in practice 35 to 40% chord appears to be the norm in rigs with good performance. On Poppy a figure of 37% was used and there seems to be no reason to change it as the results are good.
All indications are that **the entry angle** should be as large as practical in an effort to combat the weaknesses in the junk rig's performance, and equally **the exit angle** should be as low as possible for the same reasons.

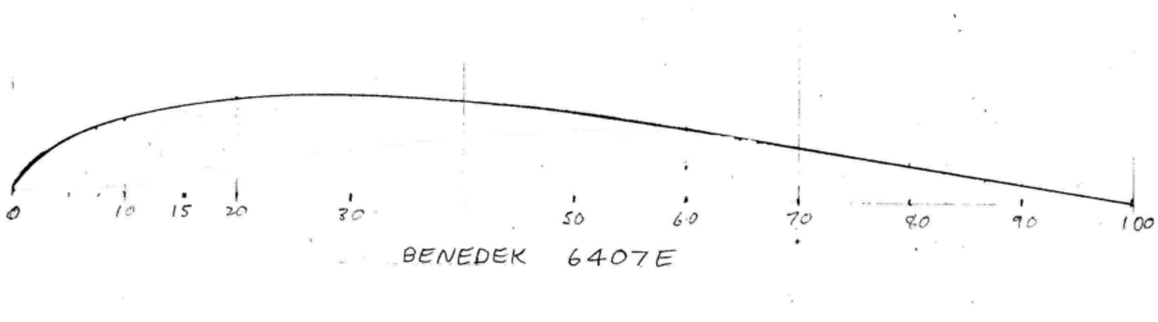
Once these 4 parameters have been defined then it is a case of cutting the material to a drawn curve that will actually give the desired shape. In practice the drawn curve may require some interesting distortions to achieve the desired result. The end result will not be an exact reproduction of the designed shape, however if the builder does not start out with a design target it is probable that the final result will be much less than ideal.

These features were used when cutting the curves in cambered panels for Poppy. The exit angle was drawn with a straight line for the last 40% of the chord right to the leech, yet when the photos of the boat sail are examined there appears to be more camber than desired at about 80 to 90% chord. This is one example where **the shape of the camber cut has to be modified to give the result required** in practice. For any future sail it would seem advisable to modify the straight line for the last 40% of the curve to a slight hollow or reflex shape to achieve the desired finished shape. The emphasis is on the word 'slight', as this is new ground and the required amount is unclear. One clear thing is that flat shelf foot sails with the curve carried aft seem to have unnecessary drag and less than optimum performance. They also can have weather helm problems.



Not easy to draw in small size and with blunt instruments, but the above drawing might give some idea of how to put a little reflex in the camber towards the leech as depicted by the dotted line.

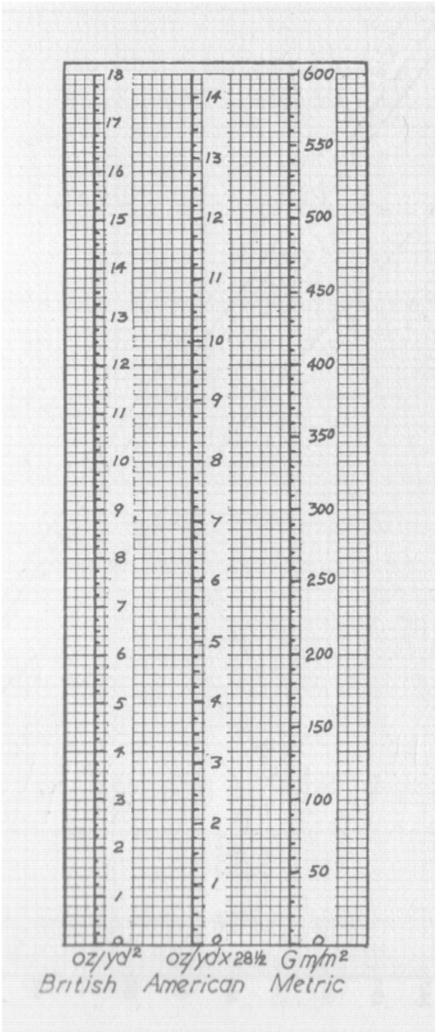
The diagram below is to think about??????????, And should be removed?????



Appendix 6.
Imperial - Metric Conversions. Sail material weights, US/ UK/ Metric.

Imperial to Metric
1 inch = 25.4000 mm
1 foot = 0.3048 m
1 square foot = 0.0929 m^2
1 pound = 0.4536 kg
1 long ton (UK) = 2240 lb = 1016.047 kg
= 1.0160 t
1 short ton (US) = 2000 lb = 907.185 kg
= 0.9072 t

Metric to Imperial
1 millimetre = 0.0394 in
1 metre = 39.37 in = 3.2808 ft
1 square metre = 10.764 sq.ft.
1 kilogram = 2.2046 lb
1 tonne= 2204.6 lb = 0.9843 long tons (UK)
= 1.1023 short tons (US)



Appendix 7.

Biblogrophy.

Practical Junk Rig. (PJR)
Blondie Hasler collaborated with his friend Jock NcLeod and they wrote the book *Practical Junk Rig*, a book which is still considered by many to be the Bible of Junk Rig, though following the recent developments in design and performance it should perhaps be more accurately called 'The Old Testament'(In Christian terms). This book has certainly had a major influence on amateur building of junk rigs in the western world, though as can often happen many builders of the rig do not necessarily get the best out of the information presented.

'The Chinese Sailing Rig, Design and Build your own Junk Rig', by Derek van Loan.
This is a simpler book on the subject but still *a well thumbed manual. With the lower yard angle there are lower stresses in this rig than in the PJR rig. Grossly underrated.*

…..........................

Arne's files. Give details and links.

http://www.junkrigassociation.org/arne

http://groups.yahoo.com/group/junkrig/files/Arne%20Kverneland%27s%20files/
?????????????
…..........................

Mainsails, their design & Construction, by James Lowell Grant.
Jibsails, their design & Construction, by James Lowell Grant.
Spinnakers, their design & Construction, by James Lowell Grant.

These three books are available from Sailrite (www.sailrite.com) and were probably produced to encourage sailors to buy their products, from sewing machines to materials and fittings. They are excellent little books for anyone who is considering making their own sails, whether from a kit provided by Sailrite, or from the raw materials as there is a lot of design information for Bermudan sails.

From the junk sailor's point of view the Mainsails book is the best as there is a small mention of Gaff as well as Lugsails as well as the information on Bermudan, but the Jibsails book is also of interest. With the information included there is no reason why anyone cruising in a Bermudan rigged boat should not consider building their own sails from scratch. There is good detail on how to actually construct the sails and to finish off the sails and reinforce them.

…..................................

The works of **C.A. Marchaj.**

Photo Pages? Galleries. Pictures.
In due course.

Extra page .