SECTION 10 - TRANSOM

10.1 Making the transom.

10.1.1 The transom is made from 9mm ply but because it sits at an angle, the setting out and bevelling is slightly different from the frames (though the basic principles are the same) Around the hull edges the ply is thickened out to 25mm by the addition of 16mm fashion pieces. This provides a better faying surface (the surface the planks lie on and fix to) for the planking. The top edge is similarly thickened out to 25mm by the addition of a 16mm thick beam.

10.1.2 The fashion pieces can be cut from solid or ply. The beam is best made either from ply or laminated like the frame beams.

10.1.3 If the fashion pieces are made from solid timber, they can be cut from several pieces in order to avoid short grain, and the pieces simply butt joined (with the butts well wetted out and WEST bonded).

10.1.4 If the fashion pieces are made from ply, then this can be a single piece of 15mm or several thicknesses bonded together to make up the thickness. The actual thickness is not too vital (a single 15mm; 4 off 4mm to make 16mm; 2 off 9mm to make 18mm; 2 off 4mm + 1 off 9mm to make 17mm; etc.). If you make the fashion pieces from several layers you can use several short lengths butted together staggering the butts so that the butts on one layer are covered by the next layer. This uses the ply quite economically.

10.1.5 A small change of thickness will make little difference to the bevels. If you wish you can extrapolate a new bevel from the figures given for a 25 total thickness transom. So (on the second waterline up) the total bevel for 25mm is 573 - 563 = 10. 10 ÷ 25 = 0·4. Thus the bevel on this waterline is 0·4mm for every 1mm of thickness. So if you have decided to make the fashion pieces from 2 off 9mm ply (thus 2mm thicker) then you could increase the bevel by 0·8mm (in practice 1mm)

10.1.6 Once you have decided the thickness of your fashion pieces and if they are thicker than 16mm, mark on the drawing any dimensional changes caused by using the thicker pieces.

10.1.7 We don't need to draw the transom out on the setting-out floor, but rather directly on the ply.

10.1.8 Get out a piece of ply large enough to make the transom.

10.1.9 Draw the dwl and the centreline on one face of the ply. This will be the AFT face.

10.1.10 Mark out the shape of the top and hull edges on the aft face, using the aft face offsets and heights given on the transom drawing.

10.1.11 Transfer the centreline accurately to the other face of the ply (the FWD face). Transfer the dwl accurately to the fwd face of the ply but note that because of the transom angle this will not be the real dwl; the real fwd face dwl on a 25mm thick transom is 2mm (measured on the transom angle) below the aft face dwl. However we can use the aft face dwl

to measure heights on the fwd face - just remember when setting up that it is the dwl on the aft face only.

10.1.12 On the fwd face, mark out the hull outline only (not the top edge) using the fwd face heights and offsets given on the transom drawing (or as modified by you).

10.1.13 Now cut the ply out to shape. Cut the hull shape to the outline of the FWD face. Cut the top shape to the outline of the AFT face.

10.1.14 Make the fashion pieces 50mm wide (dummy the width off the outside shape). The fashion pieces will butt under the beam at the top and on to the sides of the backbone at the bottom.

10.1.15 Similarly mark out the shape of the beam and either cut this from ply or laminate up.

10.1.16 Bond the beam to the fwd face of the transom with the top edges of beam and transom flush.

10.1.17 Bond the fashion pieces to the fwd face of the transom so that their outer edges are flush with the outer edges of the transom ply.

10.1.18 Bevel the hull edges off on the aft face until the aft face matches its outline on the aft face of the ply.

10.1.19 Mark the top edge shape on the fwd face of the transom beam and bevel the top edge from the aft face down to the fwd face.

10.1.20 Make the sternpost tapering from 100 x 30 at the bottom to 100 x 16 (or whatever beam and fashion piece thickness is) at the top. Try it on to the transom and mark the top end to butt under the beam. Then cut the bottom end to the bevel shown on the drawing. Bond the sternpost to the transom.

10.1.21 With the outboard well, the stern knee is not required. It is replaced structurally by the sides of the outboard well.

10.1.22 Sand and WEST the transom as for the rest of the frames, mark the centreline and store until required.

SECTION 11 - FLOORS

11.1 Making the floors.

11.1.1 There are six intermediate floors in the boat which are positioned between the frames to provide additional strength and connectivity along the centreline.

11.1.2 The floors are all made from 25mm solid timber with the grain running horizontally.

11.1.3 The floors are set out in much the same way as the frames were, using the offsets and heights given on the little Table of Offsets shown with each floor. Even if the floor shapes are going to be marked out on patterns or directly on the timber (see ¶11.1.4) it's best to draw the floor shapes out on the setting-out floor so that you can lay the floors in place to check them for accuracy.

11.1.4 The floor shapes can be set out directly on the timber (transferring the

appropriate waterlines & buttocks from the setting-out floor). Or you could set the shapes out on hardboard or thin ply and cut these out as patterns - then lay the patterns on the timber and draw around them. This second method makes it easier to "nest" the floors together to use your timber most economically.

11.1.5 As with the frames, make the floors to the larger dimensions (check this carefully from the Tables of Offsets) and then bevel them back to the smaller dimensions.

11.1.6 Cut and bevel the notch for the backbone as you did for the frames.

11.1.7 As with the frames, the limbers are best cut after the backbone is in place but before planking commences.

11.1.8 In way of the centrecase, cut the slot and the stiffener notches and then join the floor up again with temporary pieces screwed across the slot - particularly check that they still match their outlines on the setting-out floor.

11.1.9 Sand the floors smooth and WEST them two coats - but only one coat on the edges and notches where later items will be bonded on.

11.1.10 Store the floors until required.

SECTION 12 - JIG & SETTING UP

12.1 Making the jig & setting up

12.1.1 Refer to the jig schematic drawing.

12.1.2 The purpose of the jig is to provide a means of setting the frames up in their correct positions, accurately vertical, accurately square across the vessel and with their centrelines straight and dwl level. The jig also provides the means to mount the transom and the floors, and laminate up the stem and backbone of the vessel.

12.1.3 The jig drawing shows certain sizes of timber - you do not need to stick to these particularly, as long as the primary objective is achieved to build a firm and accurate means of setting up the frames etc.. You can usefully use secondhand timber for making the jig. As well as the principal timbers shown on the drawing, you will need a fair bit of other timber for braces and struts.

12.1.4 Make the base of the jig. The jig base rails are set 1000mm inside face to inside face. Make jig base cross rails (same dimensions as base longitudinal rails) at each end, positioned so that the stem and transom posts will just notch into them. So the fwd cross rail will have its fwd face at about 150mm ahead of Position 000; the aft cross rail will have its aft face about 1075 aft of Position –4825. You will need further cross rails to take the –450, –1450 & –2115 frame posts. The –450 cross rail will have its aft face at Position –450. But the –1450 cross rail will need its fwd face at Position –1425, and the –2115 cross rail will need its fwd face at –2080, so that the frame posts come in the correct positions for their frames. Brace the jig base firmly square with some ply gussets (say 400mm arms) across the corners in way of the fwd and aft cross rails. These can be nailed top of the jig base rails. Set the jig base up level both across and

lengthways, on some blocks on the workshop floor.

12.1.5 Mark the centreline of the boat on the jig base cross rails. A thin wire can be stretched taut to give the centreline of the boat for the full length of the jig. Alternatively a length of timber (say 150 x 25 planed up) can be fixed the length of the jig base and the centreline marked on it. Mark the frame positions on the jig base, accurately square across the base.

12.1.6 Once the base is set up, the post for Frame –450 is set up. This is a single post on the centreline. The fwd face of the post should be accurately at Position –450 and the post accurately on the centreline. The top of the post should be at least 60mm below the dwl. Note that even with the boat upside down, we still use "above" and "below" the dwl in the sense they would have if the boat was the right way up - so above the dwl means nearer the sheer; below the dwl means nearer the keel. Fit temporary braces to hold the post firm and upright in both directions.

12.1.7 Fit a block on the fwd face of the post with its top edge 1039 above the dwl. make sure that it is firmly fixed and accurately positioned. We shall also require a strong rail (to take runners 'A') bolted firmly on the aft face of the post with its top edge accurately placed at 15 below the dwl, so that the top of runners 'A' will be at 60 below the dwl.

12.1.8 Place Frame –450 on the fwd face of the post so that the beam sits down on the block and cramp lightly in position. Check that its dwl is 1500 from the top of the jig base and its centreline plumb over the jig centreline. To hold the frame firmly in place make an L-shaped trig (say 100 long x 40 x 40 with a 17mm deep rebate); screw the trig to the post immediately above the ply floor section so that the frame is squeezed tightly to the post (because the 17mm rebate is over the 18mm thick floor section). A plain trig (with perhaps a 1mm deep reverse rebate) can be screwed to the bottom block to sandwich the beam section to the post. Brace the frame firmly square across the jig with braces from the frame edges (just below the shelf notch) fwd (or aft) to the jig base rails. Check for square by measuring from a point on the frame (say immediately below the shelf notch) diagonally to a known point on the jig base (say position –1450 cross rail). If you do this both side, the measurement will be identical if the frame is square and level; a non-identical measurement will mean that the frame is either out of square, or out of level - or both, so check and adjust as necessary.

12.1.9 Get out the forefoot chock and the post for the stem former. These should be 190mm wide - or better 191 wide so that ply trigs screwed to the sides of the post and chock will keep the 190mm wide apron laminates nicely in place without jamming them.

12.1.10 The lower end of the stem former should fit into an angled notch cut in the jig base fwd cross rail - so that the fwd face of the stem former at the jig base is 187 ahead of Position 000, as shown on the jig drawing. Set the chock and former assembly up, so that the aft end of the forefoot block rests against the fwd face of Frame –450. Fit ply gussets each side of the chock and support post to hold the assembly in place. Also fit a support post or ply gussets from the Frame –450 post to

support the aft end of the forefoot chock. Brace the assembly firmly. There is considerable pressure on the assembly when the apron etc. is laminated, so it does need to be secure. Mark the centreline down the outside face of the assembly.

12.1.11 Now set up the two posts for Frame –1450. The aft faces of the posts will be at Position –1425, and they are bolted to the jig cross rail so that they are 500mm apart, outside-to-outside (i.e. 250mm each side of centreline to outside of post). Fit the frame support rail (25 x 50) across the posts accurately at height 1292. Also bolt the 45 x 45 rail across the fwd faces of the posts at Height -15 (to take the aft ends of runners 'A'. Sit the frame on the posts so that the beam rests on the frame support rail. Adjust the frame so that it its centreline is accurately plum and plumb with the jig centreline; check that the frame dwl is on the jig dwl (1500 above the base rails). Hold the frame in firmly position with trigs from the posts and rail. Brace the frame firmly square across the jig with braces from just under the shelf notch running fwd and aft to the jig base rails.

12.1.12 Fit the runners'A', screwed or bolted to the rails on the Frame –450 and Frame –1450 posts. Be careful how you fasten these items - remember they have to be dismantled again after the hull is planked - so don't drive fastenings in places that will later become inaccessible.

12.1.13 Sit floor –815 on runners 'A', adjust so that the centreline is plumb over the jig centreline, and secure in place - screw square section lengths of timber to the runners each side of the floor and cramp them tightly together, sandwiching the floor in place. Brace the floor firmly square.

12.1.14 Fit the pair of posts for Frame –2115 (aft face of posts at –2080), bolted to the jig cross rail, 800 apart outside-to-outside (i.e. 400 from centreline to outside of post). Bolt the two frame support rails across the posts at Heights -160 & 1315. Bolt the rail on the fwd faces of the posts at Height -115 to take the aft ends of runners 'B'. Sit the fame on the posts with the beam resting on the 1316 cross rail and the floor resting on the -160 cross rail. Adjust the frame plumb and check the dwl. Hold in place with trigs screwed to the posts and rail. Brace the frame square across the jig.

12.1.15 Fit the runners 'B', 410 outside-to-outside, fastened to the cross rail on the –2115 posts and a 55 deep cross rail on runners 'A'. Note that the runners 'B' have to thread through Frame –1450 and that their top faces will be at Height -160. make sure that you can retrieve the fastenings once the hull is planked - in fact both runners 'A' and 'B' can be removed once the first few planks are on.

12.1.16 Sit Floors –1135 and –1780 on runners 'B' and secure in place, in their correct positions, square across the boat and with their centrelines accurately plumb over the jig centreline.

12.1.17 Fit the posts for Frames –3000 and –3875. Note that the nomenclature of the frames has changed so Frame –3000 has its aft face at Position –3000 whereas frame –3875 has its fwd face at Position –3875. This means that the posts from Frame –3000 need to be 25 ahead of the frame nominal position (i.e. at

Position –2975) the posts for Frame –3875 can be at the frame nominal position (i.e. at Position –3875). Both sets of posts are 1000 apart outside-to-outside, so can be bolted directly to the inside faces of the jig base rails.

12.1.18 Bolt the frame support rails at Heights 1348 & 1380 respectively, sit the frames on their posts and secure in place temporarily.

12.1.19 Fit the runners 'C', bolted to the insides of the frame posts and with their top faces at Height -160.

12.1.20 Now adjust Frames –3000 and –3875 so that they are accurately in place with their centrelines plumb over the jig centreline etc., secure them firmly to the posts and brace them square across.

12.1.21 Sit Floors –2560, –3425 & –4350 (note 10mm packing piece) on runners 'C'. Adjust the floors to their correct positions, square across the jig and with centrelines plumb over the jig centreline; secure in place.

12.1.22 Fit the posts for Frame –4825, bolted to the inside of the jig base rails, with a frame support rail at 50 below the dwl. Hang the frame on the posts, adjust for square etc. and secure in the usual way.

12.1.23 Fit a single centreline post for the transom, notched into the jig base cross rail. Set the post to the transom angle as given by the dimension on the drawing and brace it to this angle fwd down to the jig base rails (keep the braces above the transom - i.e. nearer to the jig base).

12.1.24 Fit a block on the transom post 870 above the dwl. If you have some good deep-throat cramps, you will be able to cramp the tip of the transom to the post and still leave room for the backbone laminations. Otherwise you can let a cross rail into the post (about 100 from the top) and cramp the edges of the transom to this. Once the backbone is fitted and bonded in place the tip of the transom will be held firm - but we need to hold it temporarily until that time. The top of the transom can be held firmly to the post with a cramp or a rebated trig screwed to the post. Offer the transom up to the post and secure in place. Brace the transom firmly to the jig base and also to Frame –4825, so that it is accurately square across the boat.

12.1.21 Have a good check round the boat that the frames, floors and transom are set square across, accurately on the centreline and accurately on the dwl. You may like to run a tape right around one side of the boat from the transom to the stem, with the tape positioned (say) immediately below the shelf notches. Record the frame locations and then repeat on the the other side. The frame locations should be the same (though there will almost certainly be a few minor variations). Then when you are satisfied that the frames etc. are all correct, tack light braces from frame to frame to help keep them sitting square. Use one set of braces right round the boat just below the shelf notches. Use a second set at the bottom of the boat just outside the hog notches; and a third set around the bilge.

SECTION 13 - APRON

13.1 Laminating the apron

13.1.1 The apron is laminated up on the blocks and formers set in the jig. It is laminated from 8 off 5mm thick laminations 190mm wide. However, check that 5mm thick material of the sort you intend to use will bend round the jig former because timber does vary in its bendability and kiln drying also tends to make it more brittle. Warming the laminates with an hot air gun will increase its flexibility. If you can't easily obtain 5mm laminates, or you find that 5mm is too thick to bend successfully, then use thinner material - 10 off 4mm sawn laminates or use 3mm Khaya sliced veneers which as for the frames. 13 off 3mm veneers should be sufficient. Sometimes these veneers are slightly less than 3mm thick - often 2·8mm - in which case you will need more of them. You should be able to obtain the veneers sufficiently long for the lamination. If this is not possible, the veneers can be butt joined as you make the lamination provided the butts are staggered by at least 100mm.

13.1.2 After laminating the apron, it is easier if it can be removed from the jig to clean up and bevel. So cover the face of the jig formers and the edges of the frame and floors with shiny brown parcel tape. This will prevent the laminations sticking to the jig, frames and floors. Also tape up the faces of the frames and floors in way of the lamination to prevent any runs of WEST sticking to them.

13.1.3 Screw some pieces of ply to the sides of the former. These are to hold the apron laminations in place sideways so they need to stick up from the former at least 40mm. Fit four pairs of such side pieces one pair at each end of the lamination and two pairs about equally in between. Check that a 190mm wide laminate will slide freely between the side pieces without jamming.

13.1.4 The inner 10mm of the lamination will start on the fwd face of Floor –1135. The next 15mm of the lamination can start further fwd if you wish - say about 180 fwd to trim back to a 200mm step. And the final 15mm of the lamination can be 200mm further fwd again. If you are using 5mm thick laminates then this is simple to arrange; with other thicknesses the steps do not necessarily occur conveniently at a full laminate. So, for example, if the laminates are 4mm, the first three (making 12mm) will need to run back to the fwd face of Floor –1135, the next four to the first step and the last three to the second step

13.1.5 At the top it is useful if the apron lamination can run higher than the stem lamination (even though it will eventually be cut off shorter). This allows the apron lamination to be fixed to the stem former while the stem is being laminated. If the apron is going to be laminated up all in one go, then the laminates can all finish at roughly the same place. But if you are going to do it in two or more goes, then step the top ends (first lamination longest) so that the first lamination can be secured to the former while the second is being bonded on and so forth.

13.1.6 Get out the laminations required for the apron. We are assuming that the laminates will be 5mm thick and that the lamination will be carried out in three goes. The first batch of two (the first 10mm thickness) should be 30mm longer at the stem head than the second batch

(of three = 15mm); the second batch 30mm longer than the first; and the apron lamination should be 30 to 50 longer than the stem lamination. So make the first batch finish about 100mm above the jig base. Try one gently round the former. It should go round quite easily but as mentioned previously timber varies considerably in its toughness and ability to bend. If the lamination feels as if it won't go round, then play a hot-air gun on it in the area of tightest bend and this will help ease it round. If you have to do this, pick out the first two laminates and pre-bend these using the hot air gun. Don't aim the gun just at one spot, but play it over the whole area of tight bend.

13.1.7 Now cramp the first two laminates fully in place round the jig. Cramp at the aft end first, gradually moving along to the stemhead Don't tighten any of the cramps (except the first one) fully at first, thus allowing the laminates to move over one another to take up the shape. You will need a pair of cramps at each cramping position - and the cramping positions will need to be about 100mm apart in the tight area around the forefoot, with increasing spacings on the straighter sections. You will require a cramping bar under each pair of cramps. This is a length of timber about 190mm long x 30 wide x 25 thick (dimensions not particularly important). If you don't have enough cramps, then make up pairs of cramping bars about 270 long x 40 wide x 25 thick, with a pair of black iron coach bolts (M8 or M10 would be suitable sizes) or similar passing through them each side of the lamination. These will work just as well as cramps. Instead of bolts you can use a spanish windlass. A spanish windlass consists of a loop of rope (say Ø6mm) tied around the two parts to be pulled together (in this case the ends of the cramping bars). A bar (say a length of Ø8 steel rod, or a screwdriver) is passed through the loop and twisted round and round to tighten the loop up and pull the parts together. The length of the loop is adjusted so that pressure is exerted after just a few turns. Once the windlass has achieved the necessary pressure, the turning bar is prevented from untwisting, usually by tying one end of it to something - or slipping one end of it over a nail driven in one of the cramping bars. This may all sound rather cumbersome and indeed too many spanish windlasses in a small space can get a bit confused; however they are effective and cheap, easily adjusted to suit a variety of cramping situations and can be quickly knocked up when you run out of cramps for example.

13.1.8 Whatever system or mixture of systems you are using, have a dry run (no glue) to check that it all works OK and that you have sufficient material and equipment to hand. Cover the cramping bars and the feet of the cramps with parcel tape or masking tape so that they don't get stuck to the lamination.

13.1.9 Mix up the WEST resin and hardener. Divide it into two portions. Add #403 microfibres to one portion (to a stiff mayonnaise consistency). Lay the first laminate down on the bench and wet out the top surface with plain WEST resin/hardener. Lay the second laminate down and also wet out the top surface with plain WEST resin/hardener. Apply the WEST/#403 to the wetted out surface of the first laminate. Lay the second laminate on top of the first, wetted-out face downwards. If there are more laminates, wet out the top surface of the second laminate - then wet out

one face of the third laminate; apply WEST/#403 to the wetted out top surface of the second laminate; lay the third laminate on top of the second, wetted-out face downwards - and proceed in this way until all the laminates are piled up on top of each other.

13.1.10 Pick up the bundle of laminates and lay it over the jig. Make sure that the laminates are pushed fully home against the fwd face of Floor –1135. Get the first cramp on and tighten up. Now cramp the lamination into place working gradually towards the stem head. As with the dry run, don't tighten any of the cramps (except the first one) fully at once but gradually tighten them all up, working from the aft end to the stem head each time so that the laminates can slide over each other as they take up the shape.

13.1.11 Clean of as much excess WEST as possible and allow the lamination to cure for at least 24 hours at a minimum of 10ºC, preferably 15ºC.

13.1.12 Once the WEST has gone off most of the cramping systems can be removed. Leave the aft end and stem head cramps in place to hold the lamination still firmly on the jig. Or you can replace the stem head cramps with a pair of screws. Ease the rest of the cramps off gradually rather than just taking them off willy-nilly. The lamination is not fully cured yet so requires care.

13.1.13 Now the next batch of laminates (15mm thickness) can be bonded on. These can start at about Position –930 and finish about 30 short of the first batch.

13.1.14 Prepare the laminations, wet out and apply WEST/#403, and bond into place in the same way as for the first bunch. Clean off excess WEST as usual. Leave to cure and remove the cramps (leaving the aft end and top cramps - or replacing the top cramps with screws). Then laminate on the final 15mm, starting at about Position –730 and finishing about 30 short of the second batch. leave to cure rather longer than the minimum, because the lamination is going to be removed from the jig for cleaning up and bevelling.

13.2 Finishing the apron

13.2.1 Once the apron lamination is cured hard, remove the cramping systems, apart from the first and last on the first batch - so that lamination still remains in its correct position on the jig. Scrape any excess WEST off the sides and outside face of the lamination. Mark the centreline up the outside face of the lamination. Mark in the sheer line at dwl + 1054. Mark in the cut-off lines for the hog laminations at –710 and –9910, across the face of the lamination. Mark in the dwl and wls 200, 400, 600 & 800 across the outside face and along the sides. Mark in Positions 000, –200 & –400 on the face and sides. Remove the lamination from the jig.

13.2.2 Refer to the faying surface details on the Longitudinal Structures plan. A faying surface is the bevelled off surface that the planking sits on. You will see that the shape of the apron is given for the wl's and positions marked out.

13.2.3 On the outside face, mark a line parallel to the centreline each side of it and

50mm out from it - to give the stem width of 100mm, which is also the width of the outside face of the apron.

13.2.4 Transfer the centreline to the inside face of the apron. At each waterline and at the sheer, mark in the offset given on the drawing (76 at the sheer, 76 at wl 800, 74 at wl 600 73 at wl 400, 71 at wl 200 and 74 at dwl) each side of the centreline. Similarly mark the offsets at s -200 and s -400. the apron runs out to full width (= offset 95) at about position –450 and runs parallel to the aft end. Join the marks with a batten to give a fair line. The shape may look slightly strange but it is a function of the hull shape and the stem curve and angle.

13.2.5 The top of the apron at the sheer is at Height 1054 - but on the centreline it is 8mm higher than this at 1062 because of the deck camber.

13.2.6 Cut off the top of the apron at Height 1062. Leave the head of the apron square across at the moment - we shall camber it after the hull is planked. Save the bit you have cut off because this will be fixed back on to the jig to provide a blocking to cramp the top part of the stem lamination to.

13.2.7 Plane off the faying surfaces to the lines marked out. Plane off so that the lines are only *just* showing; if the apron is left too big, the planking won't fair in nicely. After Position –450 the bevel will be planed off once the hog is laminated into place, so just let the bevel fade out quickly for the moment.

13.2.8 Cut the steps at the aft end at –910 and –710 for the hog laminates to fit into.

13.2.9 Fit the bit cut off the stem head back on the jig, and screw it in place. Remove the parcel tape from the frame and floors. Try the apron in place - it should pull cleanly down on to the jig. Drill for a pair of screws from the apron into jig stem former near the head of the apron (about 30mm down)

13.2.11 Now bond the apron in place - it bonds on to the base of Frame –450 and into the notch in Floor –815; the ends of the inner 10mm bond to the fwd face of Floor –1135. The hog will be laminated next, in situ on the jig. The apron can be cramped to the jig for the time being to retain it in place and the temporary screws driven at the head.

SECTION 14 - HOG

14.1 Laminating the hog.

14.1.1 The hog consists of two 15mm thick laminations 175mm wide. Fwd they fit into the stepped lamination of the apron. Aft they fit on to the end of the sternpost, which has already been cut to the correct bevel when the transom was made.

14.1.2 Get out the two lengths of timber for the hog, leaving some extra length (about 100mm) for the moment.

14.1.3 Fit the inner lamination into the notches in the aftermost three frames, with the end of the lamination pushed up against the transom. If necessary ease the sides of the notches so that the hog lamination pulls down easily. Mark the transom angle on to the

lamination. Lift the lamination out and cut the aft end off to the correct angle.

14.1.4 Refit the inner lamination full length now, with the aft end pushed up hard against the transom. Mark the fwd end to length to fit into the step in the apron. Cut the fwd end. Make sure that the action of pulling the hog lamination into place does not displace the frames. Add additional bracing from frame to frame if needed.

14.1.5 The inner lamination can now be bonded into place. You can drive permanent fastenings into the frames, floors and the sternpost end to hold the lamination in place while the WEST is curing. Drill off for these fastenings - not too near the outer edges fwd or else the screw heads will be a nuisance when planing the bevels on. Use 1.5" x 8g into the frames and floors, and 2" x 8g into the sternpost end.

14.1.6 Remove the lamination. Wet out the inner face in way of each frame and floor, the sternpost and the apron step. Wet out the frame and floor notches, the apron step and the sternpost end. Wet out the ends of the lamination thoroughly. Apply WEST/#403 and bond the lamination in place. Cramp the fwd end to the apron. Clean off excess WEST and allow to cure as usual.

14.1.7 Fit the outer lamination in the same way. Prepare sufficient cramps to cramp it to the inner lamination. You can use screws, but these should be temporary or else they will get in the way when cleaning off the bevels.

14.1.8 Wet out the surfaces of both laminates, the step in the apron and the ends of the outer lamination. Bond the outer lamination in place. Clean off excess WEST and allow to cure. Remove the cramps and scrape off any WEST on the hog sides.

14.2 Bevelling the hog.

14.2.1 You will need a batten, rather more than half the length of the hog.

14.2.2 At each frame position and at the transom, mark on the side of the hog where the edge of each frame and floor (and the transom) intersects with the side of the hog.

14.2.3 Lay the batten along the side of the hog so that it runs fair through the points marked. Tack the batten in place and join the marks up fair. Do this full length, both sides. Mark the centreline down the outer face of the hog and then mark a line parallel to it each side and 50mm out - to give a full width of 100mm for the keel..

14.2.4 Plane off the outer face of the hog from the 50mm lines to the lines marked on the side to give the faying surface bevels. Don't stray into the 1000mm flat down the centre for the keel. At the fwd end, fair the bevel into the apron bevel.

14.3 Centrecase slot

14.3.1 It is easier if the slot in the hog for the centrecase is cut at this stage. The slot is shown on the Centreboard Slot drawing. The slot in the hog is 50mm wide. It starts at the aft face of Frame –2115 and finishes on the fwd face of Frame –3875.

14.3.2 Mark out the slot on the outside face of the hog. Bore a Ø10 hole in each corner and then cut the slot out with an electric jig saw, using the correct blade for hardwood of this thickness. Make sure the blade is sharp and cutting square to the base.

14.3.3 Take care that the blade doesn't snap off where it gets to the intermediate frames and floors (if the gap is not quite perfect or it hits the temporary straps).

14.3.4 Clean up the inside faces of the slot with a sharp wide paring chisel. The slot can be a full 50mm in width as this will help retain WEST in the slot when the centrecase is slid in. In fact, if the slot is 50mm on the outside and about 54mm on the inside, then this will provide for a "wedge" of WEST to bond the case to the sides of the slot. The gap in the frame and floors can remain at a full 50mm - the taper for the wedge of WEST should not continue on in them.

14.3.5 WEST coat the inside of the slot and the cut-outs in the frames.

14.4 Outboard well

14.4.1 The hog in way of the outboard well is cut out later, together with the keel and planking in the area. Otherwise it is difficult to get the planking to run nicely.

14.5 Limbers.

14.5.1 Cut out the limbers in the frames and floors, alongside the hog.

14.5.2 Clean the limbers up and WEST them very thoroughly, 3 coats minimum.

SECTION 15 - KEEL

15.1 Keel inner laminate.

15.1.1 There are separate drawings for the Outboard Engine Version and the Inboard Engine Version. The principal difference is the back end of the aft deadwood.

15.1.2 The inner part of the keel consists of the inner full length laminate 100mm wide x 20mm thick. Get out the material for the inner laminate, a little over-length as usual.

15.1.3 The fwd end of the laminate starts at Position –510 (i.e. 200mm ahead of the fwd end of the outer hog laminate). Sit the laminate in place on the hog and cramp it to the hog. Check that it fits down to the hog and transom nicely. Drive a pair of nails (say every 1000mm or so) into the hog each side of the keel laminate to make sure it stays accurately on the centreline. The keel joining the hog makes the rebate for the garboard (the first hull plank) to land in.

15.1.4 In way of the 375mm length for the outboard well, carefully cover the outside surface of the hog with parcel tape, so that the keel laminate does not stick to it. Be absolutely sure that the tape is placed accurately so that once the outboard well piece is cut out the ends of the keel are properly bonded to the hog.

15.1.5 Wet out the bonding surfaces of keel laminate, hog and transom, and cramp and bond the keel laminate into place.

15.1.6 Cut the aft end of the laminate off flush with the aft face of the transom and at the transom angle.

16 1 7 Cut the centreboard slot in the keel. The slot in the keel is shorter and narrower than the slot in the hog. The slot is 1325mm long; it starts at 135mm aft of Frame –2115 and finishes 300 ahead of Frame –3875. The slot is 32mm wide. So mark the slot and cut it out with a jig saw. Clean up the inside of the slot and WEST coat it.

15.1.8 Don't cut out the 375mm long section of keel in way of the outboard slot at this stage - it will help stiffen the structures for the time being.

15.2 Aft deadwood.

15.2.1 The aft deadwood can be made from a single piece of 100mm finished thickness timber, or it can be built two (or more) 100mm pieces bonded together. This will depend on what timber you can obtain and whether or not you can machine it or get it machined to the correct thickness in the one width. If you are making the deadwood from a single piece of timber it might be worth making a ply or hardboard pattern to lay on the timber so as to be able to choose the best way to cut it to avoid splits and defects.

15.2.2 The fwd end of the deadwood swells out to 140 thick to match the ballast keel width. This is best done with cheeks bonded on to the sides of the 100mm wide deadwood and then cleaned off to shape.

15.2.3 The radiused chock at the back end is best bonded in place and shaped up after the keel outer laminates are bonded in place

15.2.4 If you are bonding two or more pieces together, it is probably easier to run them parallel to the underside of the deadwood as this is straight.

15.2.5 So, if you are making it from several pieces, bond these together in the usual way. Use some lengths of timber cramped lightly across the lamination to prevent it buckling up when the parts are cramped together, particularly if you are using spanish windlasses to pull the parts together.

15.2.6 Once you have the timber, either a single piece, or several pieces bonded together, mark the shape out direct on the timber. The radiused chock is fitted later on once the keel base laminates are bonded on to the keel.

15.2.7 Cut the deadwood out - leave a little (say 5mm) on the underside in case the face mating with the keel inner laminate needs fitting. If you bandsaw is powerful enough, this is the best saw to use to cut the deadwood out. Otherwise you can use a hand-held circular saw, probably needing to cut from both sides (so mark accurately and leave a little extra on). Or you can cut it out basically on the circular saw - cutting the top edge straight and planing it down to shape. Finally of course you can cut it out by hand (which, with a sharp rip saw set properly won't take as long as might be thought).

15.2.8 Plane the inner face up and try the deadwood on the keel. To check for high spots

rub some chalk over the outer face of the keel inner laminate; place the deadwood carefully in position and just rub it back and forward a few mm. Lift the deadwood off and the high spots should have chalk on them. The fit doesn't have to be perfect because the WEST will fill small gaps. It is important however that the deadwood sits on the keel laminate so that it is vertical

15.2.9 Once you are satisfied with the fit, check the depth dimensions of the deadwood and plane off the underside to the correct depth. If it has got too small during fitting, you can bond a slip of timber on the underside to rectify this.

15.2.10 Bond on two cheek pieces to swell the deadwood out to 140mm in way of the ballast keel. Clean these up to shape generally as shown on the drawing - swelling out over about 150mm length.

15.2.11 Cramp the deadwood in place and bore off for the M12 deadwood bolts. These are bored on the centreline through the deadwood, keel inner laminate and hog. Make sure you use the bolt schedule for your engine installation (Inboard or Outboard). Use a piece of straight batten cramped up the side of the deadwood at each bolt position to eye up as a guide for boring square. Counterbore the underside of the deadwood for the heads of the bolts, plus a washer. Push a stick through the holes to check for the correct lengths of the bolts. The bolts can be made from lengths of rod, threaded each end. If this is not available you can use stainless steel studding with a nut & washer each end - though plain round bar threaded at each end only is to be preferred. Stainless steel should be Grade 316 S16 or A4 (A2 is not good enough). As an alternative the bolts can be a good quality bronze (Silicon bronze or Aluminium bronze for preference)..

15.2.12 Remove the deadwood and blow away all the drillings. Work as much WEST as you can down the bolt holes - a pipe cleaner glued to a stick is good for this. Wet out the bonding surfaces very thoroughly and coat the inside of the hog in way of the washers. Bond the deadwood in place with WEST/#403; drive the bolts and tighten the nuts up on the inside.

15.2.13 Clean off the excess WEST. Fill over the heads of the bolts (WEST/#403 will do for this). Allow the WEST to cure as usual.

15.2.14 Give the deadwood at least one coat of WEST to prevent it splitting or distorting.

15.3 Keel outer laminations.

15.3.1 The three keel outer laminations are 100 x 25. At the fwd end the inner two form part of the scarph to the ballast keel; the third outer lamination starts 150mm aft of the fwd end of the aft deadwood, forming the butt end of the join to the ballast keel. The aft ends are cleaned off at the transom angle continued down and the upper face is angled off as dimensioned on the drawing.

15.3.2 At the fwd end there will need to be small swell pieces bonded on each side of the inner two laminates, to match the cheek pieces bonded on to the deadwood. These can be bonded on and cleaned off to shape after the three laminates are bonded in place and finished. The outer laminate will finish at 100

full width, without any swell pieces.

15.3.3 Get the material out for the laminates, a bit over length as usual. If you have cramps long enough, then bond the inner two laminates in place. Otherwise screw and bond the first laminate using 1.75" or 2" x 10g screws countersunk below the surface. Screw about every 100mm staggered from side to side.

15.3.4 Fit and bond the second laminate in a similar way. Aft of the deadwood, cramp the two laminates together; otherwise screw or cramp as necessary.

15.3.5 Bond on the swell pieces at the fwd end. Once the WEST has cured, plane off the fwd end to the ballast keel scarph line.

15.3.6 Fit and bond the third outer laminate. Aft of the deadwood, cramp the laminates together; otherwise screw or cramp as necessary. Screws should be 1.75" or 2" x 10g counterbored for dowels. Bond the dowels with WEST.

15.3.7 Once the WEST has cured, clean the lamination up and trim the aft ends shown.

15.3.6 Make the radiused chock between the aft end of the deadwood and the top of the keel outer laminates and bond into place.

15.3.7 Sand the lamination etc. and WEST one coat.

SECTION 16 - STEM

16.1 Making the stem.

16.1.1 The stem is made from 9 off 10mm laminates, 100mm wide. The main part of the stem is only 8 laminates (1 to 7 + 9) with the eighth laminate being introduced at the aft end (between the seventh and ninth laminates) to increase the moulded depth from 80mm to 90mm. Leave the stem at least 125mm long at the stem head - better 150mm long to allow for later cutting and cleaning off.

16.1.2 Check that 10mm will bend around the apron. Use a hot air gun to ease the laminates round if necessary. Otherwise use more, thinner laminates. The laminates are numbered 1 to 9 in the instructions that follow assuming that 10mm will bend round. If you do use thinner laminates, then the best thickness is 5mm, so that two 5mm laminates will equal one 10mm laminate.

16.1.3 Bond on the inner two laminates first, with their aft ends butting up to the end of the keel inner laminate. Bond in the usual way, wetting out the bonding surfaces first; also wet out the face of the apron. Drive pairs of nails in the apron 100mm apart, to keep the stem laminations accurately on the centreline.

16.1.4 After the first two laminates have cured, you can cramp some side pieces on them to keep the rest of the laminates from slipping sideways.

16.1.5 Bond on laminates 3 & 4 with their aft ends starting at 200mm aft of Floor –815.

16.1.6 Bond on laminates 5 & 6 with their aft ends starting at the –815.

16.1.7 Bond on laminates 7 & 8 with their aft ends starting at 200 fwd of –815. Note that laminate 7 is full length but laminate 8 only runs fwd to Position –207. When the WEST has cured, plane off the face of laminate 8 to run from zero thickness at Position –207 to full thickness at the aft end.

16.1.8 Bond on laminate No. 9, full length.

16.1.9 Clean up the sides of the stem. mark the centreline around the outside face. The stem sides will be shaped up after the planking is completed.

SECTION 17 - FWD DEADWOOD.

17.1 Making & fitting the deadwood

17.1.1 The fwd deadwood is 100mm thick, swelling out to 140mm at the aft end in way of the ballast keel - in a similar way to the fwd end of the aft deadwood.

17.1.2 The deadwood can be made from a single piece of timber (about 130 deep x 1400 long) planed up to 100mm finished thickness. If wished, it can be made from two pieces (say 70 thick), or more pieces, bonded together.

17.1.3 Make a thin ply pattern of the deadwood, shaped to the dimensions given on the drawing. Try this in place and adjust as necessary to get a good fit on the stem and inner keel laminate.

17.1.4 Lay the pattern on the deadwood timber (either the one solid piece, or the several pieces bonded together) and mark out the correct shape. Cut the deadwood out (using the same method you used for the aft deadwood).

17.1.5 Clean the deadwood up and try it in place; adjust the fit as necessary.

17.1.6 Fit and bond the swell pieces at the aft end. When the WEST has cured, plane these off to shape.

17.1.7 Clean the ballast keel scarph up to nice and flat.

17.1.8 Bond the deadwood in place, wetting out thoroughly as usual. You should be able to cramp the deadwood OK either using conventional cramps, or cramping bars and bolts. Make sure that the deadwood sits accurately over the centreline - use side pieces cramped on the keel and stem to retain it in place sideways.

17.1.9 Once the WEST has cured, clean and sand the deadwood up and WEST it on e coat.

SECTION 18 - SHELF

18.1 Fitting the shelf.

18.1.1 If you don't have long enough timber for the shelf, the scarph it up from two lengths - scarph 6 to 8 times the thickness. Make the shelf long enough to allow for a bit of fitting at the fwd end. Make sure that the timber for the shelf is wide enough. The notches are 50mm but have a habit of creeping a bit deeper sometimes when bevelling them. So, before getting the timber out, just check the depth of

the notches and make your timber accordingly. In any case it does not matter if the shelf is, say 3mm too deep as this will get planed off when the hull is sheered down - i.e. when the sheer is planed off fair with the boat the right way up. Don't make it more than this however or else you will give yourself a lot of work planing the top edge off.

18.1.2 The fwd end of the shelf can either simply blade off on to the aft face of the apron, or you can cut a housing (say 20mm fore-&-aft x 20mm deep x 50mm high) for the shelf to house into the apron. In either case, the outer face of the shelf will be flush with the faying surface on the apron.

18.1.3 The outside top corner of the shelf intersects with the aft face of the apron at Height 1049 above the dwl. because of the deck camber, the inside top corner is higher than this, intersecting with the aft face of the apron at Height 1054 (it is only coincidence that this is the same height as the sheer edge at the aft face of the stem). However, if you have made your shelf a little deeper than finished depth, then don't forget the the top of the shelf will be that much higher at the stem as well.

18.1.4 Fit the shelf around the boat in the shelf notches up forward but with the aft end lying over the transom. Push the shelf fwd until the fwd end is hard against the apron. Cramp the fwd part of the shelf into the notches. Be careful when bending the shelf round that the frames are not pulled out of position. If you have trouble getting it round, just let the aft end lay away from the boat for now, supported so that does not break.

18.1.5 Mark the apron face angles (or the housing angles if you cat a housing) back off on to the shelf, using a "dummy" if necessary. Remove the shelf and cut the fwd end. Fit it up again and adjust as necessary until you have a reasonable fit.

18.1.6 If the shelf is simply blading off on to the apron, there is not much to fasten the fwd end of the shelf to at the moment (a breasthook will be fitted later), so screw a temporary piece of timber to the outside face of the shelf, and screw this temporarily into the apron faying surface. If you have cut a housing, then the shelf can be screw fastened (and finally bonded) into this.

18.1.7 Now, with the fwd end correctly in position we need to mark the aft end. If the shelf is difficult to pull round, fit the fwd end on the other side of the boat and then use a spanish windlass to pull both aft ends in together.

18.1.8 At the transom the shelf will lay on the edge of the transom until it is cut to length. Make sure that the shelf is at the correct height - on the sheer point of the transom (or slightly higher if you have made the shelf slightly deeper).

18.1.9 You will have to estimate the line to cut the aft end of the shelf as the action of pushing the shelf a further 20mm in will alter the angles etc. a little. As with the fwd ends, there is not much to support the shelf/transom join until the planking and deck is bonded on. Try to make the join as close as possible - though it is not finally of much structural significance.

18.1.10 Once you are happy with the fit of the shelf it can be bonded into place. It is probably best to drive some (permanent) screws from the shelf into the frames to hold the shelf in place while the WEST is curing. Use two 1.5" x 8g screws and drill off for these before the WEST is applied. Be careful to drill them parallel to the frame faces so the screws don't break out of the frame. At the aft end, screw a temporary piece of timber to the outside face of the shelf, and screw this temporarily into the transom edge.

18.1.11 Now bond the shelf in place with WEST/#403, wetting out thoroughly as usual. If the shelf was hard to pull round, leave the spanish windlass (or windlasses) in place until the WEST cures.

18.1.12 Fit and bond the other side shelf.

SECTION 19 - PLANKING

The good thing about planking is that once you have mastered the first plank, you know that you can complete the remainder - because neither the principle nor the procedure varies much.

19.1 Marking out

19.1.1 There are eleven planks each side of the boat and they are all going to show equal width at any one position. The first plank (abutting the keel) is known as the "garboard" and the final plank is known as the "sheer strake" - strake is another word for plank. The actual widths of the planks will be the width they show plus the lap - apart from the sheer strake, which will be the actual width (because there is no further plank to lap on top of it).

19.1.2 The first thing to do is to establish the distance around the perimeter of each frame from the keel to the sheer. This is known as the "half-girth". The plank width at each frame will then be one-eleventh of the half girth + the lap; the sheer strake will just be the plain one-eleventh girth. In theory half-girths are as follows:

Frame –450	1199
Frame –1450	1481
Frame –2115	1615
Frame –3000	1730
Frame –3875	1664
Frame –4825	1467

19.1.3 This would give apparent plank widths at one-eleventh of the above figures:

Frame –450	109
Frame –1450	135
Frame –2115	147
Frame –3000	157
Frame –3875	151
Frame –4825	133

To these apparent widths, for all the planks apart from the sheer strake, we must add the lap to arrive at the actual plank widths. The lap is usually 3 times the plank thickness - so we shall use a lap of 30mm. This would give actual plank widths of:

Frame –450	139
Frame –1450	165
Frame –2115	177
Frame –3000	187
Frame –3875	181

Frame –4825 163

19.1.4 So, in case your frames are a little different from theory, measure with a tape around each frame from the rebate (the corner the keel side makes with the hog) to the sheer and write out your own table of half-girths, apparent plank widths and actual plank widths (apparent + 30mm) for each frame position. Do this on both sides of the boat in case there is any difference from side to side. If there is a difference (of more than the odd millimetre) get rid of this in the first few planks, so by the time you reach the waterline the planks are the same on both sides. Measure around the transom and obtain actual and apparent widths in the same way

19.1.5 Now mark the top edges of all the planks on the edge of each frame and the transom. The top edge of the garboard will be the actual plank width away from the keel. All the rest will be the apparent plank width from each other, because they will lap on to the previous plank; the planks themselves will be the actual plank width - it is just that their top edges will be their apparent plank width away from the previous plank top edge.

19.1.6 You will now need a batten to fair the planks in to the stem. The batten should be long enough to stretch over at least three or four frames - something about 3750mm would be fine. Clean softwood is the best, though a bit of clean hardwood will do. The cross section should be about 30 x 15 (size not critical).

8.1.7 Tack the batten so that one edge is on the lines for the top edge of the garboard, in such a way that the batten reaches the apron faying surface. Hold the batten so that it lays on the apron faying surface and is taking up a fair line with the top-of-garboard marks on the frames. Mark this line on the apron faying surface. Do the same with the second plank. Also do the same with the top edge of the plank No. 10 (the one before the sheer strake) and mark this on to the faying surface of the apron. Now measure up the angle of the stem the distance between the top of No.2 and the top of No. 10 and divide the answer by eight - mark off these distances, which should be roughly the top edges of planks 3 - 9.

19.1.8 Check each top edge to see if the marks on the faying surface of the apron do in fact run fair with the top edges of the planks previously marked on the frames. You may need to make a few minor adjustments to allow for the fact that the stem angle is not constant.

19.1.9 The actual position of the plank tops is not in itself vital - we are aiming for planks that run fair to the eye and are of fairly equal apparent width. Try all the top edge lines with a batten to see that they do run fair to the eye. If you get any problem it is almost certainly to be at the fwd end, caused by having got the runs of the garboard and plank No. 2 not quite right.

19.1.10 You will now have the top edges of all the planks marked out on all the frames, the stem and the transom. From time to time during the planking, you may find that the planks themselves depart a little from the marks - because of faulty taking-off of the plank shape, or just the general cussedness of timber. This does not matter too much - but when (if) it occurs, then you will need to re-establish the plank widths for the remaining planks (by

measuring the remaining half-girths etc. etc.).

19.1.11 If you have difficulty bending the planks round the boat in the sections that follow, remember to try a hot air gun on the plank to improve its plasticity.

19.2 Garboard

19.2.1 The next task is to establish the shape of the garboard to be cut out of the flat ply sheet, so that when it is laid around the boat it is the correct shape and fits the keel rebate on one edge and the top-of-plank marks on the other. The garboard is in fact the most difficult plank as it has to fit into the rebate - all the remaining planks just have to lap over each other and look fair.

19.2.2 The method we will adopt for this (one of many variants) is to use a pattern batten which is flexible enough to bend around the hull, but wide enough not to bend on edge. Three lengths of 9mm ply, about 150mm wide, scarphed together would do this job nicely. They can be butted and the butt supported by a butt strap if you prefer but this makes the batten more cumbersome.

19.2.3 The pattern batten does not have to be a straight edge - the important thing is that it does not bend on edge. There is some advantage by having the pattern batten in a slight banana shape as this. reduces the distance to measure from the edge of the batten to the plank line and thus reduces the inaccuracies.

19.2.4 So, lay the pattern batten on the boat, up near the keel rebate - so that its edge is as near the rebate as it will go without bending the batten on edge. This is most important - don't try to spring it on edge, just let it lay naturally around the hull - we are relying on the batten being essentially the same shape when laid flat as it is when curved around the hull. Tack the batten in place so that it lays nicely on each frame.

19.2.5 Tick off the accurate position of each frame (choose one edge) on to the batten. Now at regular intervals along the batten (say every 200mm) make a mark and measure from the edge of the batten into the rebate - note the measurement down on the batten by the mark - try to measure square off. Towards the stem (for the garboard particularly) you may need to make the measuring points a bit closer together. You can dummy off the stem angle on to the batten but this will only give you the angle, not the actual position, of the plank end because the batten is not in the same place as the plank will be. So take sufficient measurements at the front end to establish where the front end is and enable you to cut the plank out (a bit long for now - the plank will be adjusted when it actually fits up into the rebate). Do the same at the transom end. Remove the batten from the boat.

19.2.6 The garboard is made from three lengths scarphed together - two full sheet lengths and a shorter length on the end. On the garboard, start the full lengths from fwd, so the short length is at the end aft. On the alternate planks, start the full lengths from aft so that the short length is fwd so that the scarph joints will not come above one another on adjacent planks. But see ¶19.2.25. There is no need to arrange the scarphs to come over frames, or at any point in particular as a properly made and bonded scarph is as strong as the rest of the ply. In

fact, a properly supported butt is also structurally perfectly satisfactory, but rather discounted nowadays as being unacceptable. If you butt the plank joins, then the butt strap should be at least 150mm long with the ends bevelled off so as to produce a gradual change of section. The butt strap will be the apparent plank width as you can't fit a butt where the planks are lapped - the previous plank supports the butt very adequately. The following instructions are written assuming that you will scarph the planks, but are generally equally applicable for butted plank joins

19.2.7 Lay three sheets of ply on the floor and lay the pattern batten on top. The scarphs will be 100mm long, so they will reduce the lengths of the sheets by this amount (plus a bit for fitting etc.) We will start by making the fwd section of garboard. But read ¶19.2.25 for alternatives before proceeding further. So be sure that the is sufficient ply at the fwd end to mark the fwd end out from the measurements taken (see ¶19.2.5), and a bit to spare for fitting. Transfer the frame positions from the pattern to the ply. Also transfer the measuring ticks (at 200mm or less spacings, whatever you chose) and measure up from the edge of the batten on to the ply the measurements noted by each position tick

19.2.8 At the front end, dummy the plank end angle off from the batten on to the ply. From the measurements you took, establish roughly where the plank end is and transfer the angle to this position.

19.2.9 Remove the pattern from the ply. Join all the measurement ticks with a fairing batten - they should run fair but some may be a bit out - so run the line fair, on as good an average as you can. This line should be the rebate line against the keel, when the plank is bent around the hull.

19.2.10 Refer to your table of actual plank widths (apparent + 30mm) and at each frame position. Mark off the actual width, measuring down from the line of the rebate edge drawn in ¶19.2.9. Do the same at the stem, measuring the width along the stem angle (dummied on to the ply). Join these points with a batten - again make it an average fair line. This line should be the top-of-garboard line that is marked on the frame edges.

19.2.11 This is one instance where we are not going to cut accurately to the line everywhere. Cut the rebate edge of the plank accurately to the line drawn, but allow 15mm on the line drawn for the other (the top) edge to allow for fitting the plank into the rebate. You will soon pick up how accurately you are taking off the plank shapes and be able to reduce this allowance as you proceed to the later planks. So cut the plank out.

19.2.12 Put the plank up on to the boat, with the frame marks in position over the frames and as close as the plank will fit into the rebate and cramp it down. If it is a close fit (say within 2mm at the bottom corner - the gap will be wider on the outside of the plank because the rebate is not 90°), then you can dummy off the stem angle. If the gap at the bottom is more than 2mm, then mark the adjustments necessary using a thin piece of timber as a dummy against the keel side. Remove the plank and make the necessary adjustments.

19.2.13 Fit the plank up again and now dummy the stem end. Also check the gap on the outside of the plank to the keel all the way along and note it at relevant intervals. Remove the plank. Cut the front end, leaving a little (say 5mm) on. Transfer the outside gap measurements to the inside of the plank, join these up and plane the necessary bevel on the plank edge. Fit the plank up again and check for a good fit (obviously, we can use the gap filling properties of WEST here if necessary - but it is nice to get the fit to about 1mm). Make a final dummy of the front end angle and bevel. Remove the plank and make the final adjustments.

19.2.14 Now from the inside rebate edge of the plank, measure the plank widths on each frame position to give you a new top edge - join these with a batten and plane or cut (as appropriate) the new top edge - plane it fair. Mark the scarph at the aft end and cut the scarph (scarph length 10 times plank thickness). You can use a WEST™ scarpher for this job, though it will only cut about half the scarph in one go. Choose the scarph line across the plank to be as near possible at 90° to the plank edges at that point or else your scarphs won't fit very well.

19.2.15 You're now ready to fit the plank permanently. However before doing this, turn it over and mark its mirror image on the ply for the plank the other side - its very irritating indeed to forget to do this and have to go through the whole process again unnecessarily.

19.2.16 The plank is bonded to each frame, the keel rebate and the stem rebate. Fit the plank up (yet again) dry and bore off for the fastenings - also just check that the top edge of your plank is about on the top-of-plank marks on the frames. Use 0.75" x 6g or 1" x 6g screws at about 150mm spacings into the hog (stagger these a little); six 1" x 6g screws in two rows of three staggered, into the stem (these are called the hood end fastenings) and one screw into each frame about 15mm in from the top edge of the plank. If you are going to dowel over the screws (only necessary really above the waterline if clear finished), then use a Stanley "screwsink" to bore off for the screws - probably a good idea to use this in any case - and countersink absolute max. 4mm. If you are not going to dowel, then don't bore the countersink very deep - just about 1mm (the screws will pull just below the surface and can be filled over with WEST/#407) If you don't countersink at all, the screws will pull a dent in the surface of the ply which will be very difficult to fill nicely because it will have no very definite boundaries. Remove the plank, blow off the drillings, WEST down the screw holes and then bond the plank into place, using your usual process of wetting out first, then applying the #403 thickened resin as the glue.

19.2.17 You can now make, fit and bond the forward section of the garboard plank on the other side of the boat in the same way, except that you will have already marked an accurate shape out on the ply, using the first side as a pattern. So only the bevelling and the final fitting will be necessary.

19.2.18 The mid sections of both garboard planks are fitted in the same way as the forward sections, but with a scarph on both ends. Mark the plank out from the pattern batten, leaving about 120mm on the fwd end for the scarph.

Cut the plank out to shape and leave the ends square (i.e. no scarph). Offer the plank up to the boat, letting the fwd end lap over the plank section already fitted by the 120mm. Adjust the plank to fit as you did for the fwd section. When the plank is fitting properly along the keel, mark off the aft end of the fwd scarph on the inside of the plank. Remove the plank and mark off the length of the scarph, parallel to the line marked for the aft end. Cut the scarph. Offer the plank up again and check for the fit of the scarph. Adjust as necessary so the scarph fits well. Hopefully this will not alter the fit of the plank generally, but if it does you will have to keep on making adjustments until you are satisfied with the fit of the scarph and the plank generally. Then measure off the actual plank widths again and fair the top edge. Cut the scarph on the aft end. Don't forget to mark out the plank for the other side.

19.2.19 When gluing up the scarph, cramp spare pieces of ply (waxed or covered in parcel tape) both sides of the scarph to pull it together. Wet out the surfaces of the scarph twice, to ensure plenty of WEST penetration. If you are going to clear finish the hull, the scarph will need to be better visually than if you are going to paint the hull - the two parts squarer to each other and the feather ends straighter. This is difficult to achieve at first - but at least the bottom is painted, so you will get the opportunity to improve.

19.2.20 Fit and bond the mid section of the garboard on the other side of the boat.

19.2.21 Make and fit the aft section, both sides of the boat in the same way. Just let the aft ends hang over the transom a little and trim off later. Drive three 1.25" x 6g hood end fastenings into the transom edge - these screws are longer because they don't get such a good hold into the end grain of ply.

19.2 22 In the heyday of timber boatbuilding it used to be a matter of pride (not to say physical effort) to only have to offer up a plank once - a "first time fitter" - and the inside of the planks had to be "soled out" (hollowed out) to suit the hull vertical curvature as well. Well maybe we shan't quite have all first time fitters but you will find that as you progress with the planking you will not need to offer up the plank many times to get it to fit. It is mostly a question of taking an accurate pattern.

19.2.23 Once the garboard planks are completed and the WEST has gone off hard, the plank top edges have to be bevelled. First of all make sure that the edges in way of the scarph joints are fair - if not just fair them up. Then run a pencil line (not a metal gauge mark) along the outside face of the plank, 30mm in from the top edge. A gauge made from an odd bit of wood with a 30mm (or better say 29mm) rebate in it does this job well - run it along the edge of the plank with the pencil held against the inner edge and this will draw a nice smooth line 30mm parallel to the edge

19.2.24 Now have a short length of stick (as long at least as the widest actual plank width). Lay this on the garboard at each frame, so that the end of the stick is on the top-of-plank mark for plank no. 2. The gap between the stick and the 30mm parallel line will be the amount of bevel required. In practice, the stick may lay at a tangent to the edge of the frame before it reaches the top-of-plank mark for plank No. 2.

- in which case this will still show the gap that equals the bevel. Make a note of the bevels at each frame - mark them on the edge of the plank and join the lines up. The plank is bevelled from the 30mm line to the bevel line on the edge. The bevel required should not anywhere be the full thickness of the plank - but if it does become so, then just take of to almost full thickness (leaving about 1mm on the top edge). When you are planing off for the bevel be careful not to plane more than 30mm in from the edge or more than the depth line on the edge - in fact just leave both pencil lines visible all the way along.

19.2.25 An alternative to scarphing the planks up on the job like this is to scarph up 3 sheets of ply to start with and mark and cut each plank out full length in one go. This is considerably more wasteful of material, but the scarphs are easier to fit and glue up as this can all be done on the floor. If it is too much to scarph complete sheets, then you can halve them lengthways and scarph up the half sheets. Although either of these methods makes the scarphing easier, handling and fitting the planks is considerably more difficult however, unless you have help. The only problem with fitting scarphs on the job is if the scarph comes in an area of considerable twist. This happens particularly on the first few planks at the fwd end where the upright stem causes the transition from a relatively horizontal plank to a relatively vertical plank to happen in a short distance. Adjusting the scarph position can usually help to relieve the problem.

19.3 The rest of the planking

19.3.1 Now fit the next plank - plank No. 2. The plank sections are made in the same way as the garboard, using the pattern in exactly the same way. The only difference is that you will be measuring to the 30mm parallel line on the previous plank rather than into the keel rebate and the plank edge finishes square. Also, the scarphs should come in different places to those in the garboard - it is not good practice to have scarph joints immediately above one another in adjacent planks. Try to have at least 1000mm stagger between scarphs in adjacent planks. Because considerable twist may develop in the fwd part of this plank, it is probably best to make the fwd scarph about 1500mm back from the stem, then a full length mid-section and a slightly shorter aft section.

19.3.2 Also there is one extra operation to be carried out on this and succeeding planks. At each end it will be necessary to rebate the inside face of the plank so that it fits down closely on to the faying surface of the stem and transom - otherwise there would be a gap between the plank face and the faying surface (because the bevel on the previous plank did not run off to a feather edge).

19.3.3 So when the forward section of the plank is fitted finally, but not fixed, draw along the top of the garboard on to the inside face of plank No. 2, for a distance of about 350mm back from the stem. Take the plank off and turn it over. Cramp a little batten parallel to the line you have drawn but about 5mm nearer the bottom edge of the plank . Use a rebate plane - or any small plane the blade of which comes right to the edge. Plane out a rebate, starting a no depth about 350mm back from the end of the plank and arriving at the forward end to the depth remaining on the garboard top edge. The

maximum depth of the rebate should not be more than 4·5mm - if it appears to need to be more than this, a shallow rebate will have to be taken out of the garboard as well. This applies to all succeeding planks.

19.3.4 Now remove the guide batten and plane the other face of the rebate so that the angle between the two faces is an obtuse one, approximately equalling the angle on the garboard between the edge and bevelled face. The edge of the rebate should now also be on the line you have drawn on the inner face of the plank. Try the plank up and check from inside that the inside faces of the planks are flush with each other as they arrive at the stem.

19.3.5 The WEST will fill any gaps but if the planks do not fit reasonably flush the hood end fastenings will tend to pull the plank down and into the gap cause it to split - this is much more of a problem with traditional clinker than it is with ply lapstrake as ply is much more resistant to splitting.

19.3.6 Carry out the same process at the aft end on to the transom. Again, WEST will fill minor aberrations.

19.3.7 Plank No. 2 and succeeding planks are fastened into the frames and at the hood ends (three into the transom, six staggered into the stem). In way of the frames, drive a screw about 15mm in from each edge of the plank. The plank will have to take up some curvature across itself (particularly around the bilge) and the screw in the top edge will not be sufficient to draw the plank down, or even hold it down until the glue has gone off, so they will need to be cramped before screwing. In some areas it may not be easy to cramp because of the depth of the frames and then you will have to resort to other methods - a spanish windlass around the frame and a stick resting on the frame edge and over the plank edge - an L-shaped chock cramped to the face of the frame (put a cramping piece on the other face so that you don't get cramp marks on the frame) with a wedge driven between arm of the "L" and the plank edge - a shore from the roof - a spanish windlass right round the boat etc. etc. A hot air gun on the plank will also help it take up shape. If it is not possible to induce the necessary curvature across the plank, the edge of the frame can be straightened a little in the offending area.

19.3.8 The planks are also bonded to each other along the 30mm wide lap. This is what gives the system much of its structural strength as well as watertightness, so a good bond is essential. The lap joints will need to be held together while the glue goes off. The usual way to do this is to have a series of ply rectangles about 100mm wide by about 50mm longer than the plank width, with a approx. 25mm wide slot cut in them, a little longer than the width of the plank. Together with these is required a fair number of shallow wedges, about 20mm wide - remember the longer the taper on a wedge the more effect it achieves, so make the wedges from nothing to about 5mm thick in about 50mm length . Pass the ply over the planks and drive the wedges between the ply "cramp" and the plank (in way of the lap) to hold the plank surfaces together. You will need two or three of these between each frame, maybe more in some places.

19.3.9 When the planking is completed, the lands (the "corner" formed by the edge of one

plank and the face of the next) are fillet jointed inside and out with WEST/#405 filleting blend filler, which completes the structural bond and also fills any minor gaps between the face of the plank and the bevel on the preceding plank.

19.3.10 Carry on planking the boat. Plank equally on both sides - do not plank all one side and then the other. Once you are away from the garboard, check that the action of pulling the planks round the frames is not causing them to be displaced from their proper positions. Add extra bracing if necessary.

19.3.11 The sheer strake is fitted just like all the other planks but it is bonded and screwed to the shelf along its top edge. It will not touch the shelf across the whole width of the shelf, so use plenty of fairly thick WEST/#403 when gluing it on, to fill the gap. The screws into the shelf should be at about 200mm intervals and about 15mm down from the top edge. The top of the sheer strake is finished flush with the top of the shelf (the deck goes on top of it), but you should perhaps leave it a few mm high to allow for final sheering down.

19.3.12 The aft ends of the planks can be trimmed every three or four planks, to end planed off flush with the face of the transom.

SECTION 20 - BALLAST KEEL DEADWOODS & BILGE RUNNERS

20.1 Ballast keel deadwoods

20.1.1 The ballast keel deadwoods fit each side of the keel inner laminate, on top of the garboard plank. Their purpose is to swell the width of the keel out to 140mm in way of the ballast keel. The bottom faces of the deadwoods will be flush with the face of the keel inner laminate and level across.

20.1.2 The fwd ends of the deadwoods start at Position –1625, which is where the fwd deadwood starts to swell from 100 to 140 width; the aft ends will finish at Position –4175, which is similarly where the aft deadwood starts to swell out. It may be easier if the fwd and aft ends are fitted as separate pieces in way of the fwd and aft deadwoods - they will be 150mm long, which is the length of the deadwood swells.

20.1.3 Establish the amount of bevel required by tacking a short length of straight timber to the outer face of the keel inner laminate and measuring down to the garboard at 50mm offset (i.e adjacent to the keel side) and 70mm offset (i.e. the outside of the deadwoods). The bevel will be the inner measurement subtracted from the outer. Take this bevel about every 200mm along the deadwood length. The largest outer measurement will also give you the minimum thickness of the timber for the deadwoods.

20.1.4 Get out the basic material for the keel deadwoods. Each deadwood can be in more than one length if this is more convenient - and the lengths can be butt joined together on the job. The timber will need to be say 5mm thicker than your largest measurement to allow for fitting.. Also allow the material to finish about 2mm wider than necessary - this extra material will be cleaned off after the ballast keel is fitted (in case the ballast keel comes out big from the foundry).

20.1.5 Mark the amount of bevel to be taken off the inside of the deadwood, at the 200mm intervals along the deadwood and join the marks as usual. Plane the bevel off the top face of the deadwood. Plane a small chamfer off the inside top corner, to ensure a tight fit up into the keel/garboard "corner".

20.1.6 Bend the deadwood around the boat, close up to the keel sides. Cramp it sideways to the keel inner laminate - you can hold the deadwood down by temporary strips fixed across the keel inner laminate. Check for fit to the garboard - adjust if necessary.

20.1.7 It is probably much easier to clean the outer faces of the deadwood off flush with the keel laminate on the boat after the deadwoods are bonded on - so leave it proud of the keel laminate for now.

20.1.8 Drill off for fastenings down into the garboard/hog - 1.5" x 8g screws about every 150mm. Alternatively, you can just have one or two screws to position the deadwoods and apply pressure with cramps sideways and pieces of timber fixed across the keel for downwards pressure. Keep screws clear of where you will bore off for keel bolt holes.

20.1.9 Bond the deadwoods to the garboards and keel inner laminate sides.

20.1.10 When the WEST has cured, clean off the outside face of the deadwoods flush with the face of the keel inner laminate and level and flat across.

20.1.11 Fit and bond on the short lengths each end in way of the fwd and aft deadwoods and, when the WEST has cured, plane to outer faces of these off flush with the outer face of the keel inner laminate.

20.1.12 Taper the width of the deadwood ends off to run from 140 full width (+2mm each side) to 100mm full width (+2mm each side).

20.2 Bilge runners

20.2.1 The bilge runners can be any reasonable size - say 30 wide x 25 thick. They are screwed (use 1.5" x 10g) about every 125mm) and bonded onto the the lap of the fourth and fifth planks (i.e. on to the face of the fifth plank where it laps over the fourth plank). Their actual extent lengthways is not particularly important, but from Position –1780 to Position –4350 will be about right.

20.2.2 The last 100mm each end can taper from 25mm thick down to 12mm.

20.2.3 You can fit brass strip (25 x 3 or similar) to the underside of the bilge runners. Bore off for this at about 100mm intervals - but don't screw the strip down until the hull is finished off and WESTed. When you do screw the strips on, bed them on Sikaflex 221.

20.3 Profiling the stem.

20.3.1 The stem is tapered from rectangular section 100mm full width at Position –400 to 100 at the root (where the garboard runs off on to the stem) tapering to 20 full width at the outside face by about Position 000. Thereafter it maintains this profile round the forefoot and up the stem to wl 600, when it flares out again

to reach rectangular profile 100 full width by about wl 700 or so. This is shown on the faying surface detail on the Longitudinal Structures drawing.

20.3.2 In practice it is easier and better to start the root taper about 10 to 15mm out from the actual join of the planking to the stem as this makes it easier to run a plane up the sides of the stem without damaging the planking. You may find that you want to increase the full width of the stem outer face from 20 to 25mm to allow for moving the root out.

20.3.3 The top of the stem finishes level through at height 1179. Mark this now while you have the jig to measure from - but it will be easier to cut it off when the boat is the right way up.

20.3.4 Run a 3mm radius up the stem outer corners.

SECTION 21 - OUTBOARD WELL PART A

21.1 Before turning over.

21.1.1 At this stage the keel and hog can be cut for the outboard well aperture and the aperture itself cut in the planking. The outboard well shown suits a wide variety of long shaft outboards of 4 to 6 bhp, single cylinder with remote tank - but check that the outboard model that you are proposing to use will fit OK. It is difficult to get accurate dimensioned drawings of outboards - so either buy the model you want at this stage or at least have a really good look (and measure up) of one in the showroom

21.1.2 The remainder of the work - fitting the ends, sides, doublers & stiffeners - is carried out later on at the same time as fitting the cockpit sides.

21.1.3 Mark out the outboard well aperture on the planking. It is important to get the fore-&-aft length accurate so that the aperture finishes flush inside the fwd and aft ends. The width (225mm) is not so vital within a mm or so.

21.1.4 Make a little pattern from thin ply. The pattern should be 375 long and (in theory) 62·5mm wide (62·5 = 225÷2, minus 50, which is half the keel width). Radius two outer corners to R50.

21.1.5 Position –5310 is the aft face of the aft deadwood. Mark this on the keel inner laminate sides and face. Lay the pattern on the planking hard alongside the keel inner laminate and with the fwd edge at the –5310 mark. Draw round the pattern on the planking. Repeat on the other side.

21.1.6 Mark the aft end on the outboard well aperture up the sides of the keel inner laminate and across the face.

21.1.7 Carefully saw across the keel inner laminate at the fwd and aft ends. The keel inner laminate piece shouldn't be bonded to the hog because this area was taped over when bonding the keel inner laminate on - it may be a little stuck at the ends possibly. Remove the 375 length of keel inner laminate, chiselling it

out as necessary if bonded.

21.1.8 Bore two holes through the planking at appropriate places to start a jig saw in, to cut the outboard well aperture.

21.1.9 Cut carefully and slowly with a good sharp blade. provided you go carefully, the jig saw should cut right through the hog together with the planking.

21.1.10 Clean up the aperture edges. The rebate in the ends of the hog is easier cut later on when the boat is the right way up.

21.1.11 WEST the aperture edges as the rest of the hull is WESTed.

SECTION 22 - FINISHING OFF

22.1 Filleting outside

22.1.1 Sand the hull exterior up smooth; make sure the plank ends at the transom are truly flush with the face of the transom and sanded off really smooth. WEST the hull exterior one coat, working plenty of WEST into all fastening holes.

22.1.2 Fill (or dowel if the exterior is to be clear finished) over all fastening holes. If filling, use WEST/#407.

22.1.3 Sand the hull smooth again all over the outside.

22.1.4 Now the plank lands (the "corners" made by the lap of one plank over the other) have to be filleted. A fillet is a cove shaped application of thickened epoxy bridging an inside corner. Use WEST/#405 for this purpose.

22.1.5 For forming and smoothing the fillet you will need a narrow spatula with a rounded off end - the rounded off end will form the concave radius of the fillet. For a fillet this size something like a lolly stick is probably about right, but you will need to experiment. The arms of the fillet will be quite small - just the depth of the plank lands up the plank edges and about 10mm across the planks.

22.1.6 Filleting can be messy and a bit of practice on odd bits of timber nailed together to emulate the plank lands will be worthwhile.

22.1.7 Make a little dummy stick 10mm wide and use this with a pencil to draw a line on the surface of each plank 10mm away from each plank land. Stick masking tape along the surface of each plank with the edge on the 10mm parallel line. Also stick masking tape on the top edge of each plank immediately above the lands. The masking tape will make it much easier to finish the fillets accurately and not get WEST/#405 spread about all over the planking.

22.1.8 You will need a piece of 10mm or 12mm ply about 250mm square, with a handle fixed centrally on one side of it (a 150mm length of broom stick does fine) - like a plasterer's hawk. Mix the WEST/#405 to a non-sagging peanut butter like consistency and put it on the hawk - it will last longer spread out like this and excess material can be scraped back on to the hawk easily. You can add a small amount of #406 colloidal silica to the mix

to improve the smoothness - too much #406 will make the fillet tough to sand however. Try about 10% (of the total additive)

22.1.9 Using a trowel knife (about 50mm wide), trowel swiftly along the land, depositing a small but regular amount of WEST/#405. Draw the spatula along pressing down quite hard so that the fillet runs off to a feather edge on the plank land edge and along the 10mm parallel line (marked with masking tape). Try to just have the one run rather than keep poking about with it. There will be a point in the cure of the WEST when it is ideal for smoothing - but it is difficult to arrange for this to happen throughout. If the fillets sag away down the hull, then your mix is too thin. If the fillet material drags up very rough then you mix is too thick, or the WEST has started to cure beyond use. Remove the excess material (which should have deposited itself on the masking tape just clear of the fillet joint) using a narrow trowel, chisel or similar. Take care not to tear the masking tape. Make sure that the fillet joint is not running over the masking tape or else you will have difficulty removing it later

22.1.10 When the fillet joint has gone off, but not cured fully hard, pull off the masking tape carefully, bringing with it the remaining excess material.

22.1.11 When the fillet has cured fully, sand it up (using about 80 or 100 grit paper).

22.1.12 The joint between the garboard and the keel sides is <u>no</u>t filleted. Any gap should be filled out flush, preferably with WEST/#406 colloidal silica.

22.1.13 Sand the whole hull exterior smooth and apply one coat WEST. It's probably not worth applying the full WEST system to the ballast keel deadwood sides as they will more than likely have to be cleaned off flush with the ballast keel after it is fitted

22.2 Marking the waterlines

22.2.1 The waterline is marked at 75mm above (nearer the sheer) the dwl. This will be the antifouling line. The boottop (if required) is painted parallel vertically to the waterline. This will mean that the actual width on the planking will vary according to the hull angles, but that viewed level, the boottop will appear parallel.

22.2.2 The waterline and boottop line are marked in pencil before the final WEST coatings, so that they are permanent.

22.2.3 Rig up two posts just aft of the transom and two posts just fwd of the stem. The posts should be a reasonable distance apart - say 2000mm - and fixed firmly and braced fore-&-aft. The posts do not need to be dead upright, but it is just as easy to make them so. Nor do they need to be exactly square to the centreline.

22.2.4 Fix a long board (say 25 x 150) across the posts each end. The planks must have a straight top edge and must be set on the posts so that they are level across. They should be positioned vertically so that their top edges are 75mm above the dwl - You can measure this off the jig rails. the planks need to be about 3000mm long if possible, sticking

out about equally each side of the boat.

22.2.5 The basic method of marking the waterline is to stretch a thin strong line from the top of the aft plank to the top of the fwd plank. Adjust the line sideways so that it just touches the hull about amidships. Tick off this point on the hull. The move one end of the line in and the other out, so that the line just touches the hull about 100mm to 150mm away from the first place. Mark this point. Continue in this way, moving the line so that it lies tangential to the hull at about 100mm to 150mm intervals, marking each point off on the hull.

22.2.6 Unless your planks are very long, they will not be wide enough to mark the ends. You will need to set up a third post each side. These will have a length of level plank fixed to them, the inner end of which can rest on a waterline mark already made on the hull. You will need to set these up first as near the stern as possible and mark the waterline round the hull to the transom. Then move the third set of posts etc. forward and repeat the procedure round on to the stem.

22.2.7 To mark the waterline in fully, you will need a batten and several people to hold it in place. Hold the batten around the hull so that it lays fair over the waterline marks. Mark the waterline in taking care to mark it fully into the plank lands.

22.2.8 To mark a vertically parallel boottop, you follow exactly the same procedure with the planks set the boottop width higher - or easier, with a boottop thickness block held on top of the planks. If you use blocks under the line, then you can mark the boottop at the same time as the waterline, which saves setting up the planks etc. twice. A good width for a boottop would be about 60mm.

22.2.10 The waterline can be marked straight across the transom. To look traditional, it can be marked in a half-moon rather than a straight line. Boottops are not usually marked across the transom - and certainly not if the water is marked as a half-moon.

22.2.11 Then have a final sand over the hull and apply two further full WEST coats.

22.2.12 It's probably not worth applying the full WEST system to the ballast keel deadwood sides as they will more than likely have to be cleaned off flush with the ballast keel after it is fitted

SECTION 23 - BALLAST KEEL PATTERN

23.1 Basics.

23.1.1 To cast the keel the foundry will need a pattern. They will make this from the Ballast Keel drawing , or you can make it yourself. If you make it yourself, the the responsibilities of the foundry (with regard to accuracy of shape and weight etc.) will be rather less - though of course they will be responsible for casting the keel properly from your pattern.

23.1.2 Basically the keel pattern is set in casting sand, which is packed firmly around it. The pattern is then withdrawn from the sand,

leaving a mould into which the molten metal can be poured.

23.1.3 Some keels are of such a shape that neither they nor the pattern can be withdrawn from a simple mould like this, so then a split mould is made, so that it can be split in two to get the pattern out.

23.1.4 Your keel will probably be cast on its side so that there is a flat top for the molten metal to level to.

23.1.5 It is worth talking to the foundry before you make the pattern to find out how they intend to cast the keel and whether they have any preferred methods of making or finishing the pattern. Three copies of the ballast keel drawing are included so that you can send copies out to two different foundries for quote etc. Please ask if you need more copies.

23.1.6 As the molten metal in the mould cools it will shrink. Thus to get a keel the correct size the pattern has to be made bigger to allow for this shrinkage. The foundry will usually quote you a shrinkage figure. If this information is not available from the foundry, then make the pattern 1·042% bigger. The allowance for shrinkage has to be applied overall. So, if you were positioning bolt holes on the pattern for instance you would make their spacing just over 1% greater than the real spacing - so the bolts spaced at 370mm on your keel would be spaced at 374mm apart, and so on.

23.1.7 To form the centreboard slot a "core" is required. This sits in the mould where the slot is required, so that in the keel, a slot is formed. The foundry will make this as it is usually made from metal (often aluminium). You can indicate the position of the slot by a "core plug" on the top of the keel. This will be a strip of timber the width and length of the slot, and about 30mm high, bonded to the pattern. This gives the foundry a slot in the mould in which to place the core. You can do the same for keel bolt holes and the centreboard pivot hole if they are to be cast in.

23.1.8 However, for this keel, it is likely that the foundry will prefer to position the slot core themselves, so no core plug on the keel will be necessary. The same applies to the bolt holes and pivot hole - they will almost certainly prefer to drill these. So again check with the foundry first.

23.2 Making the pattern

23.2.1 The pattern can be made in a variety of ways - the principal requirement is that is is correct to shape (allowing for shrinkage), stable & strong, and well finished.

23.2.2 The two principal ways to make keel patterns are "bread-&-butter" or "planked". Bread-&-butter uses horizontal boards of timber glued one to the other to make up the pattern. Planked is built rather like a carvel boat hull - a top, bottom and planked sides on internal bulkheads. The planked method is usually used for large keels and the bread-&-butter method for smaller ones. The individual board of the bread-&-butter method can be hollowed out in the centre to reduce weight, leaving walls about 20 to 25mm thick.

23.2.3 For this keel the bread-&-butter method is the simplest and most effective and to keep the weight down and to ease handling, hollow out the inner bread-&-butter sections, leaving walls about 25 thick.

23.2.4 The easiest way is to make the bread-&-butter slices vertical rather than horizontal.

23.2.5 Make a pattern of the keel profile (i.e. with the curved top and bottom edges) on thin ply. Make the keel pattern from dry 150 x 25 joiners' quality softwood planed to a full 20mm thick, so that seven pieces will make up the width of the keel pattern (141·5mm, including shrinkage allowance of 1·042%). The boards will need to be 2650mm or so in length. Don't forget to allow shrinkage on the lengths and heights when you mark out and make the pattern.

23.2.6 Also, try the ply pattern against the boat in the keel position, where the ballast keel will fit - it won't fit in the place because it is longer, but by holding it alongside you should be able to get a good idea how near your boat is to the theoretical shape. The curve won't be quite the same because of the shrinkage allowance on the pattern.

23.2.7 If your boat seems very different, then you can alter you ply pattern to suit your boat's shape. The eventual ballast keel will be bonded to the boat using WEST/#406 Silica and this will easily cope with gaps of up to say 7mm (it will cope with bigger gaps but you may feel that this is becoming unsatisfactory). Also the lead ballast keel will bend a bit to suit the boat. Don't worry if your boat is a different shape: the accumulated small errors of making the components, making the jig and setting up and the stresses imposed by planking etc. can all cause such changes.

23.2.8 Lay the finished ply pattern on each of the planed up boards and mark out the keel shape. Dummy in to leave walls 25mm thick on the five boards to be used on the inside; leave the last 300mm each end solid. Cut the boards out to shape (leave a little oversize for cleaning up); cut the inside hollow out of the five inside boards boards.

23.2.7 WEST bond the boards together, making sure to keep the top and bottom of the keel square to the sides - you can nail the boards together to apply pressure while the WEST cures.

23.2.8 Once the WEST has cured, clean the keel pattern up accurately to shape, checking with the ply pattern.

23.2.9 Sand the pattern smooth and WEST at least two coats, so that the grain etc. is properly filled (WEST fill if necessary) and the keel pattern is a smooth, stable finish.

23.2.10 Ask the foundary whether they want any particular finish, marks etc. painted on.

23.2.11 If the foundary are going to bore the bolt holes, you can make an accurate ply pattern on the keel top (without shrinkage allowance) with the hole centres pricked through (1·5mm drill). They can lay this on the keel when cast to mark the holes out - and

you can also lay it on the boat to drill the keel bolt holes. An alternative is to let them drill the holes by measurement (using the drawing dimensions) and then offer the keel up to the boat and spot the holes through. The bolt holes do need to be accurately placed because there is not much spare space around the case - make this point clear to the foundry.

23.2.12 Paint your name & address or some other identifying mark/number on the pattern - the foundry make quote you a job number for example.

SECTION 24 - TURN OVER & SET UP

24.1 Turning over

24.1.1 It is best to turn the boat over complete with the jig. This helps you set the boat up level - using the jig members for levelling. You will need some old tyres, old mattresses, or a big canvas cover(s) folded up - in fact anything soft enough to cushion the hull side and edge from the concrete floor and spread the load along the boat a bit. Then you can (with several helpers) pick up one side of the boat and roll her over, holding her at balance point while most of the people transfer to the other side to lower her down.

24.2 Setting up

24.2.1 You should sit the keel on some blocks - three in the length of the boat at –4825, –3000 and –1450. Set the boat up on the fwd and aft blocks so that she is dead level fore-&-aft - you can use the jig rails to check for level. Then tuck the third, middle set of blocks in with a pair of folding wedges tapped home lightly. Folding wedges are a pair of very shallow wedges, driven one over the other from opposite directions, so they form a sort of expanding rectangle. Drive a couple of nails through the wedges to the block, so the wedges cannot work loose.

24.2.2 To hold the boat upright you will need some bilge chocks each side of the boat. The principal pair should be at –3000 so they bear on the hull in way of a frame and so that they can be tied in to the middle keel chock by timber braces. This will stop them working out with vibration as the boat is worked on.

24.2.3 Make each of the chocks from two pieces of ply, with 100 x 50 softwood sandwiched between. Arrange the height and top angle of the chocks so that the bilge runner sits nicely on the top face. If you are building on grass you could nail a length of 12mm ply about 150 to 200 wide on the bottom of the chocks to give a better bearing surface. Also wrap the top face with a few layers of canvas or similar just to cushion it against the boat.

24.2.4 Push these chocks firmly in under the bilge each side and adjust until the boat is level across and cannot rock from side to side - i.e. so that the canvas cushion on the top of the chocks is well compressed. Fix a couple of braces either from chock to chock, or from chock to centre block, to retain the blocks in place.

24.2.5 Make two further pairs of chocks of similar design, one pair on Frame –4825 and the other on Frame –1450 or Floor –1780. Tie these together with braces also, so they do not

work out. Also tie the chocks together with lengthwise braces to further secure them in position

24.2.6 Finally check the boat for level both fore-&-aft and athwartships.

24.2.7 Remove the jig structure.

24.2.8 Lay some planks on the frames inside the bottom of the boat, so that you can walk about inside the boat and work comfortably. Wear soft shoes.

SECTION 25 - FILLETING INSIDE

25.1 Filleting.

25.1.1 Sand the hull interior and WEST throughout one coat. You have already WESTed some of the frames, so you don't need to do any more to them at the moment.

25.1.2 Fillet joint the plank lands inside in exactly the same way as the outside lands.

25.1.3 We also need to fillet the frames and floors to the hull skin - not for strength but as the easiest way to stop water getting trapped in the wedge shaped space above the plank lands.

25.1.4 First WEST fill all the spaces between the frames & floors, and the hull. Then run a small fillet (about 10mm arms) between the sides of the floors & frames, and the hull. These fillets can taper off to nothing at the top of each plank if you wish.

25.1.5 Sand and WEST coat the interior of the hull 2 further coats and catch up any WESTing on the frames etc., so that the whole structure has had a minimum of three coats, preferably four. Do not coat the gunwhale (the top of the sheer strake and the shelf) yet.

END