Making the Fourth Plank in Starboard (S4)

The fourth plank on the starboard side (S4) is now on the boat. Hopefully, this will be the last plank that I'll have to make from scratch. Others will be a repair and/or a refitting.

I learned a lot making P4, which helped me do a better job with S4. It so happens that the condition of the original S4 was repairable, but I had to replace it anyway. Why? Because the shape of the planks differ significantly port/starboard, but I didn't realize this when I made S3. So now the old S4 won't fit the new S3! Oh well. I can use the practice!

The first step in making the new S4 is to establish the location of the bottom edge of S5. After my experience with P4, I was more careful in establishing the bottom edge of S5. I still couldn't fasten S5 to the boat since the holes in the backbone and frames had been plugged, but as an alternative I clamped S5 to the boat and, using a pen through the fastener holes in the plank, marked the fastener locations on the backbone and frames. I could then confirm that the plank was in position by observing that the pen marks and plugs coincided.

Even after this careful check, the notch in S5 to take the nib end of S4 was too high on a first fit. I fixed this by wedging S5 down against the keel rabbet forward of the notch. I then rechecked S5's position using the same pen technique. The position of the hood end was pretty close to the original, but it did not fit perfectly into the stern rabbet – the bottom of the plank was about 1/8" from the base of the rabbet, while the top was a close fit. I'm not sure why this occurred since the rest of the plank seemed to line up well with the fastener holes. In any case, I will have to address this now that S4 is in place. Worse case I'll have to scarf on some extra length and reshape the hood end, as I did for P5. Note that the gap between S5 and S6 was fairly large, but I was reluctant to wedge S5

upward since it lined up well with the fastener holes. Of course, I plan to eliminate these gaps by eventually moving S6 down.

In marking the bottom edge of S5, I used a special scribing tool (Fig. 1) that is razor sharp, which allowed me to accurately locate the edge.

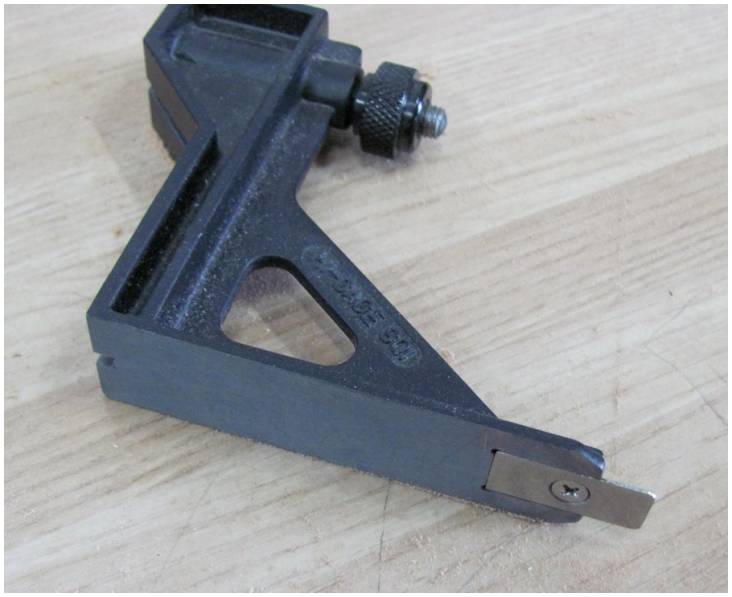

Fig. 1

While S5 was in place, I made the bevel templates for the top edge of S4 (a.k.a. bottom edge of S5). A sample is shown in Fig. 2.

Fig. 2

The shape of these templates is not critical; however, it is important that

1. The long edge (top in the figure) is straight.

2. The (right) end point of this edge corresponds to the corner between S3 and the frame/backbone.
3. The (left) end point of this edge corresponds to the corner between S5 and the frame/backbone.
4. It helps if the template wedges securely between S3 and S5 so that it's easier to make measurements.

With the template wedged in place use a small straight edge to draw a line parallel to the bottom edge of S5. Then use a bevel gage to capture the bevel angle (Fig. 3), and record it on a bevel board (Fig. 4; station 31).

Fig. 3

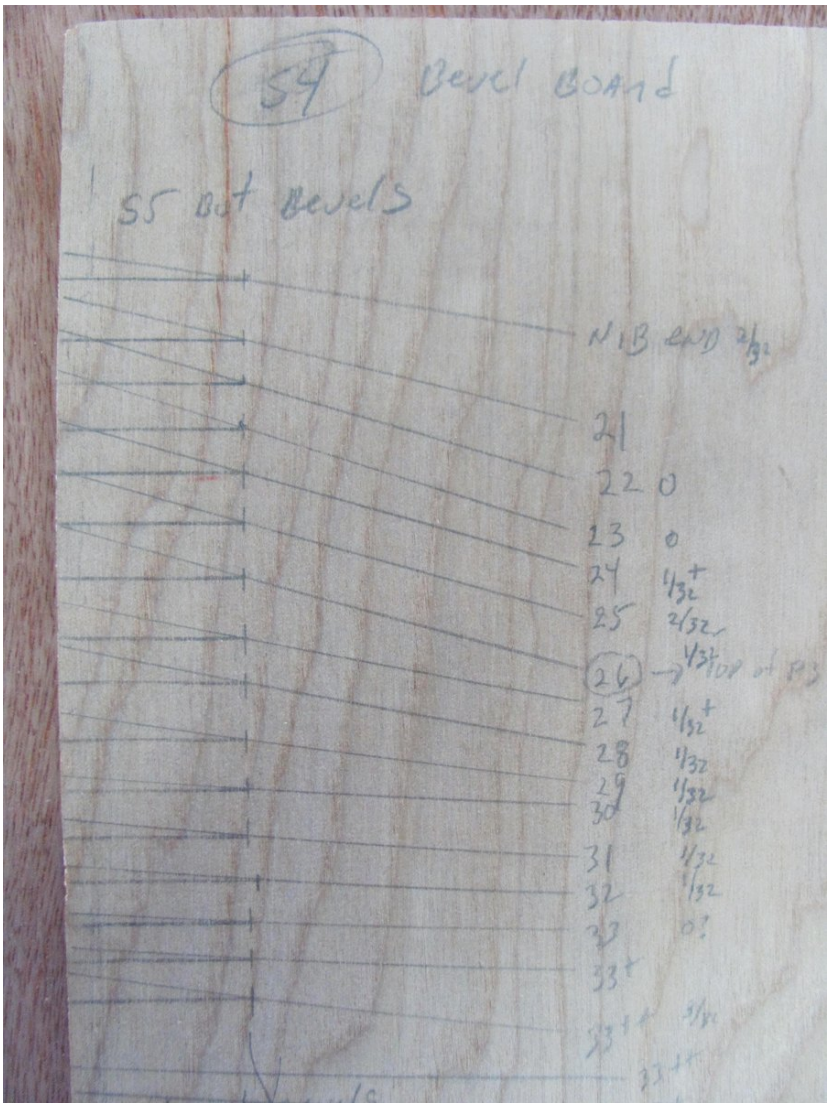
54
Bevel Board
55 Bot Bevels
NIB END 2/32
21
22 0
23 0
24 1/32+
25 2/32
26 → 1/32 TOP of P3
27 1/32+
28 1/32
29 1/32
30 1/32
31 1/32
32 1/32
33 0?
33+
33++ 1/32
33++

Fig. 4a

Fig. 4b

I then removed S5 and completed the remaining preparatory steps, such as defining stations at every frame and at regular intervals elsewhere, making the scrubbing templates for every station (sample shown in Fig. 5; outside template on the bottom, inside template on the top),

Fig. 5

and measuring the bottom-edge bevel angles (from the outside scrubbing templates, Fig. 6),

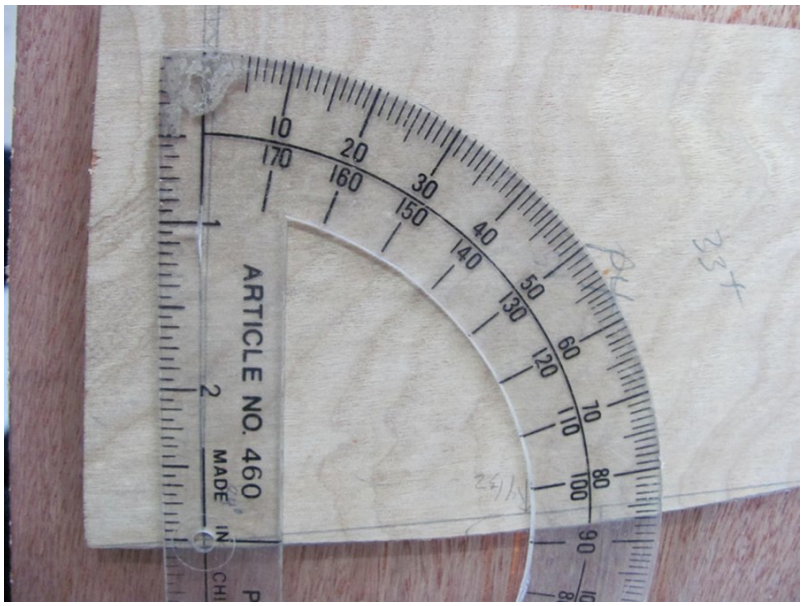

Fig. 6

and recording them on a bevel board (Fig. 7).

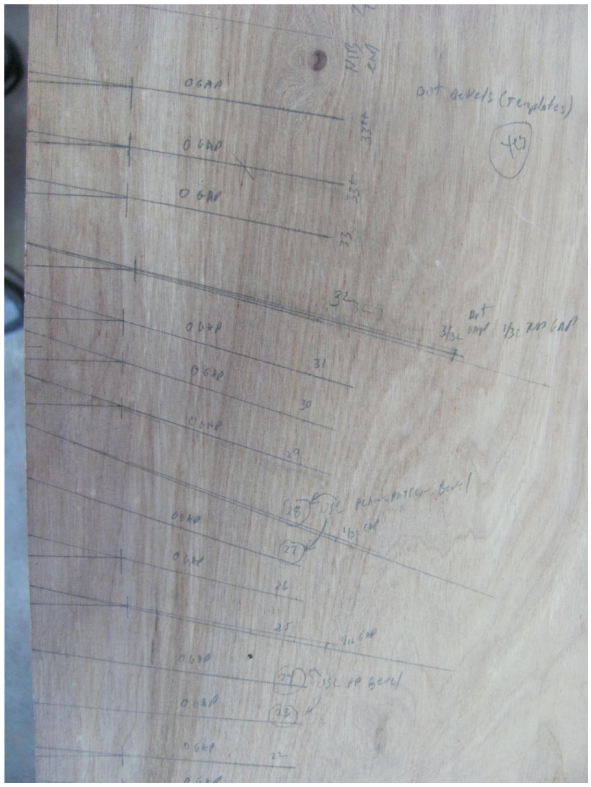

Fig. 7

When making the outside scrubbing templates for P4, I tried to make sure that the bottom edge of the template was parallel to the top edge of P3. This did not work well. Trying to keep the edge parallel while shaping the template to the curvature of the frame was just too difficult. So for S4 I just concentrated on getting the shape right. Afterwards I used a straight edge to draw a line parallel to S3, similar to what I did with the top bevel templates. Unfortunately with this approach, I no longer had a reference edge on my template for my bevel gage, so I had to resort to a protractor (Fig. 6).

With the preliminary measurements done, the spiling batten was clamped in place on the boat. In consideration of the problems I had with P4, I tried to use a thicker spiling batten to avoid introducing edge set. At first, I tried to glue two thicknesses of Luan underlayment using overlapping butt joints. This did not work well at all. The butt joints introduced stress concentrations at the joint. It was enlightening to see how fragile the thicker batten was compared to the thinner one. The thinner one would just bow under load but not break, whereas the thicker one broke right at the butt joint under very little flexure loading.

Before breaking the batten, I was able to test it on the boat. After some experimenting it was easy to see how edge set could creep in. With the middle of the batten clamped in place, it was easy to inadvertently edge set even this thicker batten.

My next attempt was to use ¼” fir plywood. Although only 0.050” thicker than the Luan, it’s considerably stiffer. Using the stiffer batten, I was careful to avoid edge setting the batten. I did this by clamping the batten to the boat at its midpoint and carefully bending the batten into position, first forward then aft. If either end would contact the keel rabbet or the top edge of S3, I would raise the midpoint clamping position and try again. Ultimately, I had to trim the batten a bit to accomplish the goal. The idea is to clamp the midpoint of the batten just below the marked bottom edge of S5, then bend the batten into position without flexing the batten edge-wise. Fig. 8 shows the stiffer spiling batten next to the finished plank S4.

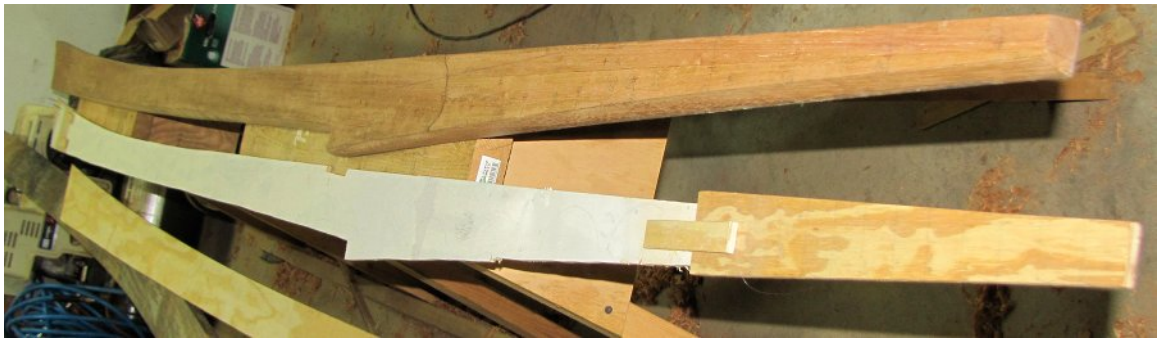

Fig. 8

Figs. 9 & 10 provide some additional detail at the ends.

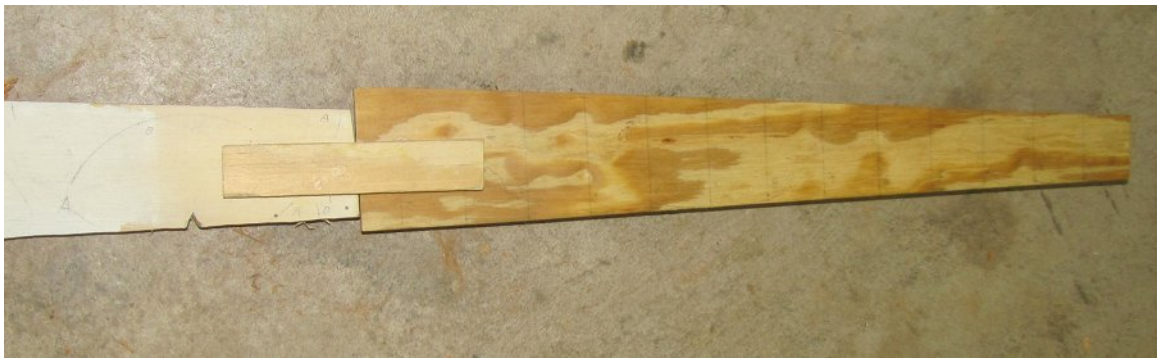

Fig. 9

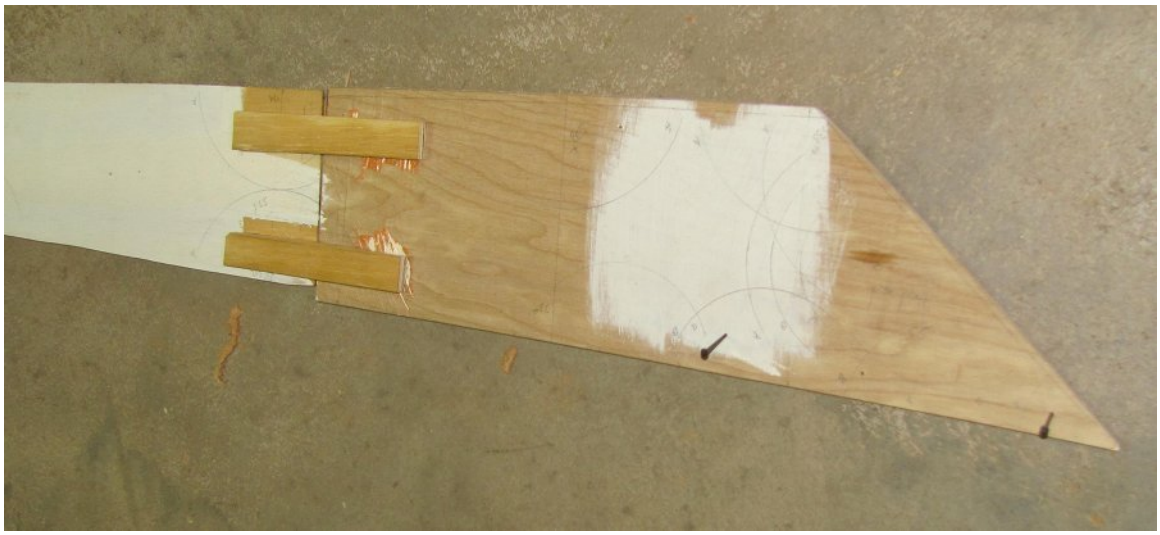

Fig. 10

As with P4, the ends of the spiling batten are templates having the exact shape of the finished plank (inside face). These templates are bonded to the body of the batten with hot melt adhesive.

In Fig. 9, notice the small notch cut in the batten towards the left. This notch was made to allow the point of the spiling compass room to fit into the keel rabbet.

After positioning the batten, I used a compass to record the shape of S4 onto the batten at every station. Now instead of reverse spiling to our planking stock, we reverse spile to a piece of ¼" plywood creating a plank pattern – an exact replica (except for thickness) of the new plank. Although this step is time consuming (professionals could not justify the time), the plank pattern offers several advantages:

- It's easier to fit the pattern to the boat than a full size plank. In some cases the plank must be steamed to conform to it's final shape. The pattern needs no such treatment.
- The plank pattern provides some insurance against spiling mistakes.
- The pattern can be useful for determining bevel angles.
- The pattern provides an accurate means of measuring gaps.

I cut the pattern to size at its bottom edge (the top edge just rough cut at this point), and beveled the edge to the proper (rolling) angle. I cut the bevel only 2/3 the way across (avoiding a feather edge on the inside). I also trimmed the hood end to size, but cutting the bevel was not done since the bevel angles are obtuse; i.e., the back edge is already correct. I then checked the fit to S3.

This first attempt at a pattern for S4 did not fit particularly well (especially forward of the notch), not sure why. Evidently the compass point slipped during spiling (this was before I cut notches for clearance) or I didn't interpolate between data points properly. So I painted the face of the spiling batten to remove the old marks and respiled. This time I recorded extra data points where the plank fits the keel rabbet and was careful to connect ALL the points when interpolating.

This second attempt fit much better, but there were still a few gaps of as much as 1/16". I was able to reduce these gaps to less than 1/32" through a series of trial fits. For each trial, I would measure the clearance along the bottom edge of the pattern using feeling gages and write this info onto the pattern. I would then remove the pattern the plane down the high spots.

Although I eventually achieved a good fit for the pattern, I was curious as to why I was still getting 1/16" errors in fit, even after being so careful. So, I decided to check the reproducibility of my spiling process. So I clamped my spiling batten to a new piece of plywood and recreated the bottom edge of the plank. I then compared this line to my well-fitting pattern. The new line was off by at least 1/32" in several locations.

I conclude from this experiment that reproducibility of +/- 1/32" is probably the best that one can expect. I suppose it's possible to improve this number by making spiling measurements at more frequent intervals (not easy to do), but I have my doubts. Consider that an edge set in the batten at its midpoint of 1/32" is not very much over a length of 12 feet.

At this point I've achieved a good fit for the bottom edge of the plank pattern, but the top edge is just a rough cut. So I planed the top edge down to the pencil line (removing the line). If you just plane down to the line, the pattern will tend to be a bit to wide when you go to trace its shape onto the planking stock.

Now we clamp the pattern back on the boat and check the top edge against the marks on the boat, making notations where the pattern is lower than the mark. (If it's too high in spots, we haven't planed enough.) We make similar notations about the amount of clearance on the bottom edge.

Before removing the pattern, we want to measure the bevel angles at the bottom edge. We've already measured these angles using the scrubbing templates, but that measurement didn't take into account any gaps (spacing between pattern and frame/backbone). Measuring the bevels directly using the plank pattern takes care of the gaps automatically.

We also want to measure the gaps. Top gaps are clearly visible and you can measure these directly. Bottom gaps are more difficult. The most reliable method is to cut a small notch in the bottom edge of the pattern at each station. Then inserting a small diameter dowel into the notch, you can determine the distance D from the front of the pattern to the frame/backbone behind it. D minus the pattern thickness is the gap. At stations where the pattern rests only against a frame, you can estimate the gap by simply pushing the pattern against the frame. The gap is how much it moves. This doesn't work for locations where part of the backbone near the frame might limit the motion.

This plank had very few gaps. One 1/16" bottom gap located at station 25 just aft of the nib. A nib always produces a gap. One 1/32" bottom gap located at station 28, and a 3/32" bottom gap + a 1/32" top gap at station 32. This location was a trouble spot where the frame was not fair with the adjacent frames. I did add a filler piece at this location, but evidently I removed a bit too much wood when shaping it (Fig. 11).

Fig. 11

One other filler piece was added to station 26 (Fig. 12) but this did not result in any gaps.

Fig. 12

After recording all the necessary data, we are ready to transfer the shape of the pattern to the planking stock. (As with P4, I had to scarf on an extension to get the length I needed.) Clamp the pattern to the stock, and trace around the pattern using a ½" spacer between the plank edge and the pencil. Remove the pattern and cut to the line using a circular saw. The extra ½" is in anticipation of any stress relief that might occur.

Clamp the pattern back on the stock and trace around the pattern. Now using the notations on the pattern, make any adjustments to your lines, including any adjustments for obtuse bevels. For this plank, the hood end aft is the only place where obtuse bevels occur.

At this point you cut just outside the line and then plane to the line. Removing the lines would have been better at achieving the correct width, but I was reluctant to do so because once you do, you lose your reference. This resulted in a bit more planing on the top edge to achieve the proper plank width, but the top edge is less critical since corrections can be made when fitting the next plank.

I also left a little extra length at both ends of the plank for final fitting.

The next step was to layout and cut the bevels. The bottom bevels are first, since they must be cut before the plank can be fitted. We have two techniques for measuring the

bevels. I used both and compared the results. The first method extracts the bevel from the scrubbing templates. These bevels must then be adjusted for any gaps. The adjustment is made on the bevel board. The second method measures the bevel angles on the boat with the plank pattern in place. These angles require no further adjustment. Unfortunately, both methods are subject to some error, most of which is related to the narrow plank edge that we must use as a reference. In comparing the two measurements, I found differences of up to 2 degrees, which translates into about 0.040" of opening in the seam; however, the seam will go through several fitting cycles which tend to correct this error. Also, eventually the seam will receive a caulking bevel, so the net effect is not significant.

Next we scrub the inside face of the plank, using our inside scrubbing templates as guides.

We now clamp the plank on the boat to check the fit. As with P4, S4 is too stiff to clamp it firmly against the frame fore and aft. In particular the hood end aft needs about 1" more rotation to close it up, so we have to do the best we can. Once the plank is steamed, it should be fine, but this causes a bit of guess work with the fitting.

We start by clamping the plank near the notch for the nib, making sure the notch is tight against the nip of S3. We then work fore and aft adding clamps at every station and wedges (for down pressure) at every other station. For S4, I took the time to make custom wedges for each location, so that they would be easier to install and more effective. The following pics (Fig. 13) show the clamping arrangement.

Fig. 13a

Fig. 13b

Fig. 13c

Fig. 13d

Fig. 13e

Once the clamps are in place, we can assess the fit at the hood end. We trim the hood end until it fits tight (as best that I can tell) with the notch tight against the nib of S3.

I then used feeler gages to measure the clearance in the seams, writing the clearances on the plank. I then removed the plank and planed down the high spots (small clearances). After about 3 cycles of this, the maximum clearance was only 0.030” in two locations and less than that elsewhere.

When the fit of the bottom edge was satisfactory, I marked the location of the top edge of the plank on the frames/backbone (fine red pen). After removing the plank, I could measure the difference between the red pen and the scribe marks on the frames/backbone. I recorded these differences on the bevel board (1/32” notations at each station). I transferred these differences to the top edge of the plank and drew a fair curve through them. Then planed to the line. The resulting fit was very good.

So next we scrub the outside face of the plank, cut the caulking bevel, trim the plank to length, layout the fastener locations, and paint the inside face with two coats of Primocon (1st coat thinned with 10% xylene). Then when the outside temperature finally moderated, I was able to set up my steam box, steam the plank for 75 minutes, and with the help of my neighbor Ken, hang the plank.

S4 was an improvement over P4, primarily in the fit to the plank below – much less edge set and fewer fitting cycles. S4 was not without it’s own set of problems, however.

As you can see in Fig. 14, the nib end of s4 did not pull up tight to keel rabbet. I believe that the problem is that the last inch or so was planed down too far. In any case, this will not be noticeable when S5 is installed.

Fig. 14

Fig. 15 shows the notch in S4 that mates with the nib end of S3. Note the small hole just to the right of the bung. In that hole about ¼” below the surface is a broken drill bit! I suppose I could try to remove it, but I might end up making of mess of things, so I’m inclined to leave it. I believe it’s far enough below the surface to not interfere with planing. I’ll eventually fill the hole with epoxy.

Fig. 15

Fig. 16 shows the nib end of S4. The bung on the left covers a broken screw – tried to hard to pull the end up tight against the keel rabbet. I’ll worry about extracting it if I ever have to remove the plank.

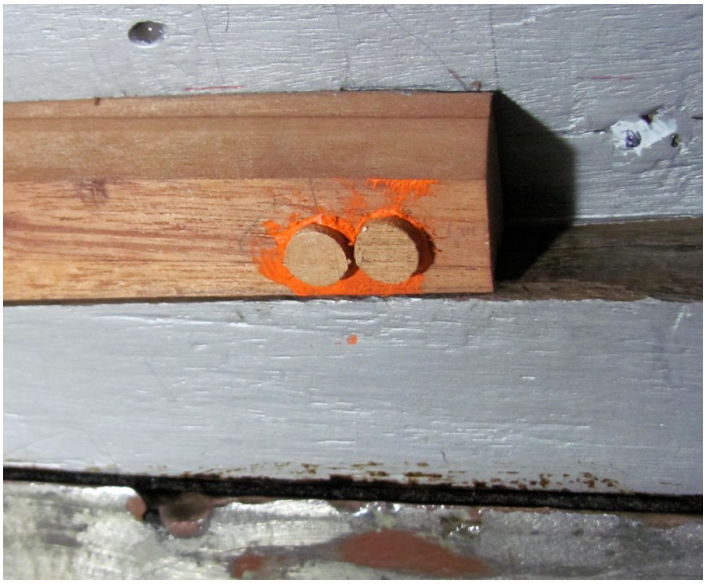

Fig. 16

Fig. 17 shows the hood end aft of s4. As the picture shows, the caulking bevel is too large (1/8-3/16”). This occurred because I was unable to clamp this end of the plank in place

without steaming. So I had to guess a bit at the fit. had the same problem with p4 but that fit is better. I did a better job of guessing then.

Fig. 17

Fig. 18 shows the two locations where the gap between s4 and s3 is .030”. All other locations have smaller gaps or no gap.

Fig. 18a

Fig. 18b