

THE FIRST KEEL LAID AT HOG ISLAND

THE RUDDER

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No. 4

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How to Build a Canvas-Covered Canoe

By Wm. Richards

THIS article on "How to Build a Canvas-Covered Canoe" is going to deal with actual and practical construction more than with the designing and theory of yacht designing—the laying down of a yacht's lines has been given careful and intelligent handling in pages of THE RUDDER in past issues, and these same theories (?) and laying-down instruction are equally applicable to the same operation in conjunction with the building of a canvas-covered canoe, assuming, of course, that reasonable common sense be used also.

Govern your design by the uses to which your canoe will be put, such as nature of water to be traversed and load to be carried. Whether small streams or rivers, where there may be portages. General cruising: large rivers, bays or other open water, or for racing. A few suggestions as to dimensions suitable for the different waters for the benefit of those of you who have not already decided upon what you want or require, may help a little. Small streams and rivers for two men with 150 lb for food and outfit: Slightly rounded model in section. Ends a little higher than midship section along the keel line or "rockered" keel. This gives a canoe that will turn fast in fast water and one also, by the same token, that cannot be turned easily by the same fast water.



Three Designs For Different Waters

The deck line should show rather narrow sharp ends for speed; the width 34 inches and the total depth 12 inches. For a single person a canoe of the same design, 13 to 14 feet in length, 27 to 29 inches in width and 12 inches in depth; keel $\frac{1}{2}$ inch thick by 3 inches wide.

General cruising, sail and paddle, would call for a canoe 16 to 17 feet in length, 34 to 35 inches wide and 12 to 13 inches deep with full lines to be carried well toward ends, not too much sheer and to have a straight keel line. For single paddles a canoe 14 feet long with 30 inches breadth and 12 inches deep will be found good; keel 1 inch square.

Large rivers, bays and open water; it would be well to use a canoe 17 to 18 feet long with 36 inches breadth and 14 inches deep of very full lines, running well to ends; a good tumblehome and large wales for extra strength are desirable.

A rocker of more than 2 inches in the keel is not desirable or necessary and will be found ample for all ordinary work.

The sheer also should not be over great, as too much sheer makes for windage, and handling is hard enough in a blow without adding any more than necessary to the canoe height above water. A fairly good table is set down here for the height of canoe ends above the deck line at amidships.

The sections of these various types of canoes could be carried out as in sketch, using the flattened floor with rather round ends for the small stream model, the very flat floor and full ends for the general cruising model, and a more rounding floor but very full-lined model for open waters.

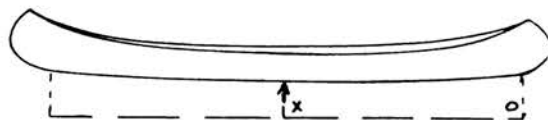
Developing a half-model from the lines you decide to use is not by any means a waste of time and will serve to bring out the good and bad points to a remarkable extent; also as a means of checking the displacement required in your canoe the half-model is well worth your time. Should you build a canoe each year or several in a period of years, the half-model as a means of comparison is worth more than the price of admission.

As many of you no doubt know the half and the whole model bear a definite and proportional relation to the full-size boat, or in this instance the canoe, so that a block for the half-model can be made one-twelfth the actual size of your canoe.

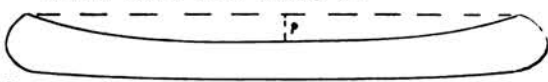
An object floating in water will sink until it displaces a weight of water equal to its own weight and the easiest way to determine whether your designed canoe will carry the desired weight at the desired water-line, will be to make up a rectangular block the size you want the half-model, emerge this whole block in water up to the proposed water-line and carefully weigh the water which will run out of a receptacle which you have previously filled level full. Then cut the block to form, emerge again in same receptacle after again filling level full and again carefully weigh the water which runs over—the difference or ratio will be the coefficient of the displacement, and, as you see, expresses the proportion between the canoe below the water-line and a solid whose length is the load water-line, whose breadth is the width at the load water-line, and whose depth is the distance between the load water-line and the bottom of the canoe next to keel.

The difference in the two weights of water, if expressed decimally, will represent the exact figure which can be used to figure down from the weights you expect to float in your full-size canoe.

Further study of this interesting subject may be had through pages of THE RUDDER for the past year.

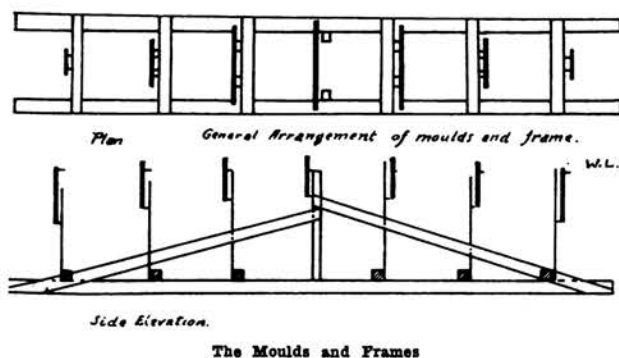


2 inches of "rocker" in keel is enough, i.e. the keel at x is 2" lower than at o.



Sheer line could be 5" lower at p for small streams
5 to 6" - - - - general cruising
7" - - - - open water.

Sheer Lines and Rocker in Keels



With the design determined and laid down it will now be necessary to cut a little wood.

Assure yourself of an even, level floor. If you have not this kind of a floor, lay down two pieces of 3-inch by 4-inch "studding" parallel about 2 feet apart and longer than your canoe is to be. Make them level one with the other by wedging or blocking them up properly. In the meantime, from some old box board or any soft lumber you can get out the moulds. Be sure that they will be as much smaller than your full-size section as the difference between the outside finished surface and the inside of the ribs. These moulds should be set up on the two long floor strips at the distances shown on your drawing—being careful to note that the moulds are placed aft of your mould center line for all moulds forward of mid-ships, and that all moulds aft of midships be placed forward of your mould center line—in so doing you will have wood enough to make the bevel.

A center line should be placed on both sides of these moulds showing the center of keel, and water-line should be marked in plainly on both sides of the mould also.

Uprights nailed to the long floor pieces will take the moulds, and when you determine the best height from the floor pieces to set the moulds be sure to take this height by measuring to the water-line. Then each mould will be exactly true in the horizontal plane, if this same measurement is applied to each mould water-line in turn. If your canoe is to have a straight keel then you could, of course, use a distance measured from the floor pieces to the extreme bottom of the keel; but if you want the keel to have even a slight rocker, you can readily see that you must use the water-lines.

The two end moulds should be at least 2 feet from the stems, as the battens which will be notched into the moulds need not run to stems, but may be cut off between the end moulds and stems, saving a lot of time and careful fitting.

If, however, you would rather run the battens to stems there is no real reason why you should not; but do not lose sight of the fact that the temporary building mould which we are now putting together is to be taken out only after all the woodwork is completed.

At least ten battens $\frac{7}{8}$ inch or 1 inch square should be used, arranged about as shown in sketch. These battens should be "let in" to moulds so as to be flush when finished, as it is necessary that the moulds should be beveled to meet the line of battens. When the battens are let in to the moulds you will find that one edge will protrude as you try to make the batten meet the other edge. It is, of course, the edge that stands out that is to be beveled; the other edge should remain intact so as to keep the original line of your section.

It is sometimes necessary to tie in the battens as they

are being sprung into place with a piece of light rope, especially if you cannot obtain spruce or white pine for the battens.

One good long nail, or better a flat head screw, in each batten at each mould, with head set down flush with the wood, will hold the battens in shape.

Shores should be run to floor to steady the whole building mould if found necessary and angular braces and cross braces used on the uprights quite freely, so as to prevent twisting or sagging.

Go over the whole work now and fair up, line up fore and aft, see that the keel is plumb with center line on floor. See that water-lines on both sides of each mould check up the same height from the floor pieces; see also if the whole mould checks up with the model or drawings, or both. Care here will produce a straight canoe, and a straight canoe is "a consummation devoutly to be wished".

Now as to stock for ribs, planking and gunwales, fender wales and stems.

Ribs and planking should be cedar and the planking should be in one-length pieces. Perhaps you live in a locality where long length clear cedar grows; otherwise Oregon cedar is about the only thing obtainable that is clear and long. Basswood is good and other woods can be used, but cedar will be found the easiest to work and handle and will last almost indefinitely. A great many woods will not last long with a piece of heavy canvas around one side, which is made waterproof. In keeping the water out the water and dampness are also kept in—inside the canoe—between canvas and planks. This alone makes the use of cedar almost imperative.

The rib stock should be dressed to $\frac{1}{4}$ inch thick by 2 inches wide, and long enough to go well beyond the gunwales on each side—two edges should be rounded and two edges left square. The two round edges are laid next the mould; they are on the inside when the canoe is finished.

There are two methods of laying the ribs. One uses the rib the full 2-inch width for its entire length and, therefore, the rib will slant off at an angle to the section moulds when steamed and bent into place, giving the appearance of having been spaced closer together, along the gunwales than at the keel, except amidships, when they will be at right angles to the keel lines, because of no bevel there.

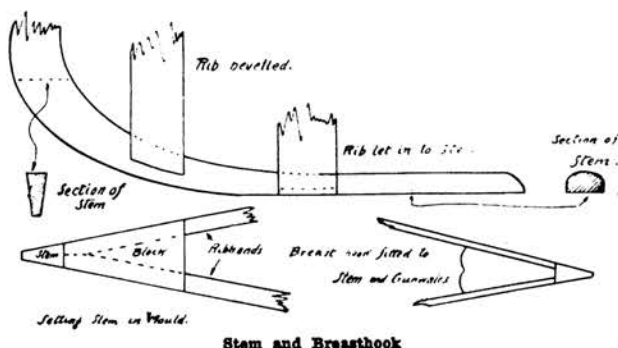
The other method tapers the ribs near the center line of the keel on each side to the gunwales so that from $\frac{1}{4}$ -inch by 2-inch the rib becomes at each gunwale $\frac{1}{4}$ -inch by 1-inch or $\frac{1}{4}$ -inch by $\frac{3}{4}$ -inch. In so doing the rib will bend around square or at right angles with keel for the entire length of canoe, irrespective of bevels.

The latter method is more work but makes a nicer job. The straight rib, however, is stronger, but is a little heavier and looks not quite so well.

With the mould ready, properly lined up and stayed in place, the next move is to produce two stems of oak 1-inch square 4 feet long, steamed and bent to the shape you have designed. After steaming and bending, allowing plenty of time for these pieces to "set", so they will hold their shape after being taken from form, the bevel should be cut to take planking leaving not over $\frac{1}{8}$ inch at forward end. As you work from the stem proper into the keel line, the face of stem should broaden out as the stems lay on several of the forward ribs and are inside the canoe—not partly outside and partly inside as in ordinary boat construction. A study of the sketch will show how this idea is worked out. The first pair of ribs and the second pair sometimes are beveled to meet the

side of stem; the other pairs that come in way of the stem are "let in" to stem so that they are flush with bottom of stem and at the same time allow the ribs to remain one continuous piece from wale to wale.

When setting these stems into place they may be tacked at the forward ends of the sheer ribbands and again at the other ribbands, providing the ribbands are brought together so that they are not wider than the after end of stem. The sketch will show how this may be done.



That part of stem that will show on the inside of canoe should be nicely rounded and the end rounded off also.

The stems being in place should be carefully lined up and battens should be bent around the ribbands to fair up the proper bevel for the planks to lay on the stem.

The gunwales should be gotten out of clear spruce 1 inch by 1½ inches, the length necessary to meet stem heads, and should be left the full size for about 6 feet amidships, then gradually tapered to ½-inch square at each end.

Moulds can be notched to take these gunwales, but the notch must not be deeper than that amount which the wales are thicker than the ribbands if any.

If wales are let in too far, the fairness of the curve of the ribs will be lost.

After wales are in place they are to be fastened to stemheads only temporarily—the permanent fastening and the breasthooks will be taken care of after the canoe is planked and turned right-side up.

Space off the location of each rib at the keel line, getting the centers first, then lay out the ribs full width, beginning at amidships and working toward each end. If tapered ribs are used the same spacing should be used on each gunwale. If ribs are not tapered the ends must come as they will at each gunwale; care should be used to keep the ribs as nearly at a right angle to the keel line as possible though the ribs must lie flat on the ribbands at any event. A light nail may be used at each ribband, and just now the rib may be tacked lightly at gunwale and allowed to extend past the gunwale until you are ready to cut and bevel them later on.

Steaming the ribs is necessary to a good job; the lots of hot water in a trough in which the ribs may be laid will do wonders. Still an old teakettle, a rubber hose and a box large enough to take a dozen ribs set on edge and spaced a little way apart from each other, is simple enough and is well worth the time to get together.

Ribs should be taken from steam one at a time and put on at once, beginning at amidships again and working toward each end.

The planking, which should be dressed on both sides and is ⅛ inch thick by 4 to 5 inches wide, should be

started along the keel line, the seam or edges of the first two planks coming at center of keel line. A little steam will help the ends of these planks to be bent up to meet the stems.

At least two other planks may be laid on now, fitted edge to edge against the first two; these planks should be tapered to 3 inches wide at the stems, and the better way would be to take a spiling of the edges of the plank already on, so that the next plank will meet this edge and fit tightly.

Fasten with copper nails ½ inch long, and as the nail end comes through the rib a solid, weighty piece of iron can be held against the rib and nail point, and as the nail continues in it will turn against the iron and clinch in the rib.

Several straight planks may now be put on up near the gunwale, but leave at least one plank off right at the gunwale so that the ribs may be cut off and beveled to rest on the gunwale.

The space now open between the two different courses of planks may be measured at every three frames, then divide this measurement at every place the measurement is taken into as many equal parts as the number of planks you intend to use in this space. The resultant figure will be the width the balance of planks are to be at that particular rib where your measurements were taken.

The shutter, or closing-in plank, will be found hard to fit, but if you are patient and careful it will be found to go in nicely.

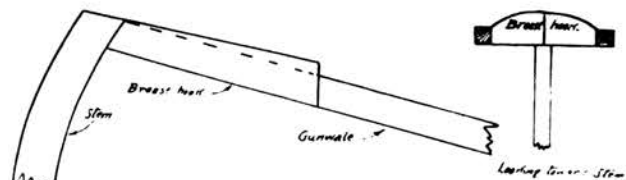
All seams should be made perfectly square and tight.

After all is fastened up well, the mould and canoe may be turned right-side up, the plank ends cut off flush with stem, care being taken to see that plank ends and stem are trued up square or at a right angle with keel line.

At the gunwales the ribs may be chiseled off on a bevel, in order that they lay perfectly fair, and then the ribs can be nailed to wales; the sheer planks are then put on, and if there is a space at each end still unplanked, as there should be, the stem and gunwales can be brought together by mahogany or oak breasthooks. These may be from 8 to 12 inches long cut to fit inside the gunwales—the gunwales may be screwed to these blocks and a long thin screw should be run through stem into the block also. It may be necessary to use 2 or 3-inch stock in order to get the proper sheer curve and crown in these blocks, depending, of course, upon your design, and they should finish about 1 inch in thickness. The face side of deck of these blocks can be given a long curve and the inboard end or widest part can be something like sketch.

Balance of planks may be fastened up and some fairly coarse sandpaper or very light planing may be done to smooth out the flat spots in the planking—the whole finished surface should be one unbroken curve each and every way you look at it, no flat spots or hollow places.

There is no need of any smooth or particularly nice surface on the outside; as it is, when you are through work, the fairly coarse sandpaper will be all that is neces-



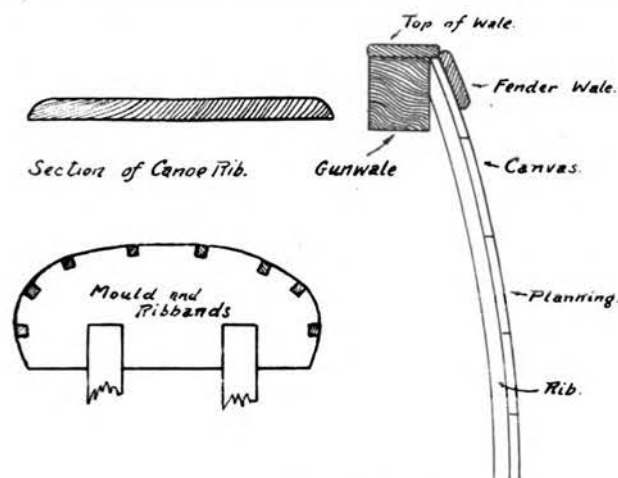
The Breasthook

sary. A good coat of raw linseed oil on the outside will come on now and, when dry, another may be applied. If your seams are well made this will not run through much, but wipe off all that does, as the inside will be varnished and the oil will make dark spots if left to soak into the wood on the inside.

You have no doubt turned the mould and canoe over again in order to paint on the raw oil, and while in this position the canvas may be put on.

Personally, I like No. 12 duck; 6 inches wider than the distance from gunwale to gunwale around the outside or bottom of canoe, and the piece may be the same length as canoe because it will be sewed up a little shorter anyway; in fact, sew the canvas at one end the shape of stem, which of itself will fold that end in the middle, then just carry this fold the full length of canvas and measure back 9 inches so that the sewing on this second end of the canvas will come 9 inches shorter than the canoe length. Then sew up as on the first stem, but do not on the second sewing sew up beyond the point of longest length of canoe, which means that from where you start to sew at the keel line, and follow the shape of stem until you come to the point of fullest curve of stem.

Put the canvas over canoe with the first sewed end over the stem, then stretch, lengthways until the last sewed



Ribs, Wale and Planking

—the partly sewed—end pulls over the other stem. This means some stretching, but as sometimes these canvases are sewed up a full foot short and then stretched over, you will know that it can be done; but everything must be dry—bone dry—including the weather and the atmosphere.

Start at one stem, give a long, hard pull and work toward the other stem—pulling at intervals of about a foot; several trips may have to be made and means will have to be found to hold what you gain each time.

Finally, you will be able to slip the other end of canvas over the stem, then tack about 2 inches apart all along one side of stems, then the same for the other side, spacing this second bunch of tacks in between the first

lot so that one straight row of tacks runs down the center of stems; then beginning at amidships tack each side toward each end, placing tacks 3 inches apart; now pull some more and place tacks in between so that on the top-side of gunwale the tacks will be about $1\frac{1}{2}$ inches apart all the way around, and pull—stretch all you and the gang know how. Canvas may then be cut away close up to tack heads, which should bring both edges of canvas edge to edge, or nearly so, on the stems.

Plenty of good white lead along these edges and stems is next in order and let it dry well after each coat.

A suitable filler can now be applied all over the canvas until the surface is free from any fuzz; use plenty of filler in as many coats as may be necessary, but let each coat dry well and hard before applying another. A little light sanding toward the last coat will help some to produce a smooth surface, but don't try the sanding too early, because you want that fuzz in the filler—it's like hair in the plaster or the steel reinforcing in concrete, it binds things into one piece.

When you do finally get that surface that reminds one of a sheet of plate glass, your favorite or a suitable color may be applied either as a flat color to be varnished over, or as an enamel, which is color and varnish too.

The fender rails are either spruce in one length or mahogany $\frac{1}{4}$ inch by 1 inch, tapered to $\frac{1}{4}$ inch by $\frac{1}{2}$ inch at ends. The top rails may be the same.

One set of these is placed upon the canvas flush with the gunwale edge when canvas is turned over. The other or top wales are laid over the tacked portion of canvas and brought to the edge of the wales—these two pieces do not overlap nor does one "set" over on the other—the inside or lower edges meet as in sketch.

A brass stem band, half-round in section, is now fastened down each stem, covering tacks and canvas edges. This stem band can be bent over so as to start at breasthook, and if keel is used should be run along keel a foot or more. A 6-foot length of half-round brass will be found to do well for both stems.

Thwarts can be made to suit and placed to suit, but should be ready for bolting just as soon as you have cut away the mould.

Sand inside well and use for first coat a good spar varnish thinned at least half with turpentine—this will allow this application to soak into all seams well. If one used varnish only it would just gloss over the seams, and at the first strain these seams would break the varnish and not only look poorly but allow a great deal of dampness to collect where dampness is not at all needed. Three or four good coats of the straight spar varnish will be about right, after the first coat mentioned.

A great many deviations from this "How to Build" article may be in various minds, but the main object has been to convey at least some sensible method which follows closely the best commercial methods today as used in the big canoe-building centers.

A canoe used by the writer for the past twelve years was built and finished in the foregoing manner and speaks its own story. Any difficult problem not entirely clear will gladly be given my careful attention, if such inquiries are sent care of The Rudder Publishing Company.

