Ernest L. Cordes.

"MOSS ROSE" UNDER RACING CANVAS

Frontispiece. *Page* 337.

YACHTS, BOATS

AND

CANOES

WITH SPECIAL CHAPTERS ON MODEL YACHTS AND SINGLE-HANDED SAILING

BY

C. STANSFELD-HICKS

AUTHOR OF "OUR BOYS, AND WHAT TO DO WITH THEM"

NUMEROUS ILLUSTRATIONS AND DIAGRAMS

AND

WORKING DRAWINGS OF MODEL YACHTS AND VARIOUS SMALL CRAFT SUITABLE FOR AMATEURS

London

SAMPSON LOW, MARSTON, SEARLE, & RIVINGTON

CROWN BUILDINGS, 188, FLEET STREET

1887

V

PREFACE.

OF late many excellent works have appeared on yachting and naval architecture. The book which these lines preface has no pretensions to be a scientific treatise on these subjects, but is addressed to that section of the yachting world which is interested in those craft which can be constructed and handled by an amateur.

Design, construction, and sails, with some of the principles which underlie them, are touched on, but practical hints and details of craft likely to be of use to the amateur, form the bulk of the contents.

Model yachting and the principles that govern it is treated at some length, and lines are given of typical boats.

The writer would take this opportunity of expressing his indebtedness and thanks to those gentlemen who have contributed drawings of, and information as to their respective craft; and also to G. W. Hutchinson, Esq., by whose permission some illustrations appear in these pages.

C. STANSFELD-HICKS.

CONTENTS.

CHAPTER I.

PAGE

Design 1

CHAPTER II.

Model Yachting 34

CHAPTER III.

On Sails 54

CHAPTER IV.

Spars and Rigging (Models) 70

CHAPTER V.

Model Sailing 82

CHAPTER VI.

Sails of Boats, Canoes, &c. 91

CHAPTER VII.

Construction 111

CHAPTER VIII.

Mechanical Contrivances 171

CHAPTER IX.

PAGE
CANOES 176

CHAPTER X.

THE AMERICAN FLAT-BOTTOMED CANOE OR SHARPIE . 223

CHAPTER XI.

ON CENTREBOARDS 232

CHAPTER XII.

SAILING CANOES 243

CHAPTER XIII.

THE DESIGNS 262

CHAPTER XIV.

SINGLE-HANDED SAILING 300

APPENDIX.

COST OF "DABCHICK," "UNA," &c. 363
CALCULATIONS 364
DISPLACEMENT SHEET . . . . *To face* 365
CALCULATION FOR CENTRE OF LATERAL RESISTANCE.
THREE-TON DESIGN 366
MODE OF COVERING CANOE WITH WILLESDEN CANVAS . 367
THE "ROB ROY" CUISINE 367
SAILING RULES, LIVERPOOL MODEL-YACHT CLUB . . 371

INDEX 377

LIST OF ILLUSTRATIONS.

		PAGE
Moss Rose under racing canvas	*Frontispiece*	
Design for model yacht under length rules .	*To face*	9
Manual screw canoe	,,	172
American flat-bottomed canoe or sharpie . .	,,	223
Plan (sheer and half-breadth) of sea or Mersey canoe	,,	259
Una—18 ft. sailing-boat	,,	283
Longitudinal section of *Puffin*, showing interior arrangements	,,	287
Rob Roy yawl	,,	303
Undine running through the Swatch Channel, off Poole	,,	321

LIST OF DIAGRAMS, &c.

	PAGE
Spline and weights	3
Half-model divided into lifts, showing water-lines, &c.	4
Half-model divided, showing vertical cross-sections, diagonals, and buttock-lines	4
Emersed portion of half-model, showing deck-line, &c.	5
Immersed portion of half-model, showing lower water-lines	6
Body plan, 3 ft. model	10
Lines of immersion and emersion and diagonals of 3 ft. model	17
Wave-line method of construction	19
English type yacht, midship section	25
American type yacht, midship section	25
Sheer plan, showing certain faults	28
Sheer plan, showing faults remedied	29
Diagram showing rough mode of finding C.L.R. and centre of gravity of model	30
Diagram showing deadwood section in model	51
Diagram showing disposition of fore-body and after-body (models)	51
Diagram of real and apparent motion of wind	56
Diagram showing resolution of wind forces (effective and non-effective)	56
Diagram showing rough method of finding centre of effort of sails	59
Diagram of mainsail, showing method of finding centre of a trapezium	61
Diagram showing method of cutting mainsail for model boats	64
Topsail (model), showing tack cut low	65
Leg-of-mutton rig	67

PAGE
"Mohican" sail, an adaptation of 67
Fittings of mast, &c., for leg-of-mutton rig 68
Diagram of rigging, &c., of model yacht 71
Diagram of masthead fittings (model) 73
Euphroe (for model rigging) 74
Boom fittings (model) 74, 75
Gaff fittings (model) 75
Diagram of bowsprit and fittings (model) 76
Diagram showing positions of vessels with relation to the wind, in reaching, tacking, and running 83
Diagram showing effect of raking stern-post 86
Sails, Standing lug 91
" Lateen 92
Sail-plan (lug) 93
Yard for lug and fittings 95
Sheave, how fitted 95
Cleat on mast 96
Sprit-rigged boat, with mizen 96
The sprit and grommet 97
Balance lug with Chinese battens 99
Revolving boom for reefing, and reefing-roller . . . 100
Batswing-sail 101
Snotter for sprit 102
Diagram showing mode of shifting mast for batswing rig . 103
Diagram showing reefing gear for canoe 104
Diagram showing topping lift 105
Sliding gunter, and modification of 106
Diagram showing mizen-sheet working from rudder, &c. . 108
Boat with Chinese battened sails 109
Curved wood-rasp 115
Section showing mode of strengthening models built in bread-and-butter fashion 116, 117
Diagram showing sheer to be taken out of wood block for model 118
Construction of stem 126
Construction of stern-post 127
Stern-post fitted with deadwood-piece (model) . . . 128

PAGE

Rabbet for garboard 128, 129
Diagram showing method of fastening transome (model) . 129
Diagram of model in frame, showing shadows and ribands 130, 131
Diagram of mode of plumbing the stern-post . . . 131
Diagram showing rise of floor in different models . . 132
The garboard, diagrams illustrating its fitting . . 132, 133
The turn of the bilge 133, 134
Rooving 134
The counter and its construction 135
Ribs for clinker-building 135
Diagram showing timbers and planking (clinker) . . 136
Diagram of model, showing stringer or covering-board for securing the deck to 137
Timber for knees and hooks 138
Sections showing how timbers should be cut . . . 139
Diagram of keel, showing method of fastening timbers . 139
Diagrams showing riband-carvel construction . . . 141
Diagrams showing diagonal method of construction . 142, 143
Diagram showing air-cases as a method of strengthening . 144
Deck-beams, how fitted 145
Diagrams of deck of model, showing fittings . . 146, 148
Diagrams of various deck-fittings—horses, bowsprit-bitts, hatches, &c. . . . . 146—149
Rudders, diagrams of 151, 152
Diagrams showing modes of ballasting 154, 155
Diagram of moulds for boat-building 158
Diagram of half-section of frame set up and stayed . . 161
Diagrams showing scarf-joint and arrangement of keel, garboard, and timbers 164
Section of double-keeled canoe with hollow bottom . . 174
Feathering paddle 175
Eskimo kayak 179
Canadian canoe 181
Flying proa 184
Double canoe, South Sea Islands 185
Norwegian präam 187
Irish corragh 187

LIST OF PLANS AND DESIGNS.

Model Yachts:

The *Defiance*, twenty-tonner, lines of.

„ „ sail-plan (*separate sheet*).

The *Isolde*, lines of.

„ sail-plan (*separate sheet*).

A Liverpool ten-tonner.

The *Bonny Jean*.

Canoes:

North American Indian birch-bark canoe.

Mersey paddling canoe.

L'Hirondelle, type C.B. sailing canoe.

Small craft:

Dabchick, two-tonner, lines, sail-plan, and diagram of keel construction.

Wideawake, 16 ft. single-handed decked sailing-boat, M.C.Y.C., lines of.

„ „ sail-plan (*separate sheet*).

Myosotis and *Wren* (same design).

Una, 18 ft. open sailing-boat, W.Y.C., lines and sail-plan of (W. Fife, Jun.).

Design and sail-plan for small cruiser (C. P. Clayton).

Puffin, three-ton cruiser, specially arranged for fishing.

Design for a three-ton racer.

Design for a three-ton fast cruiser (H. Wynne Fairbrass, N.A.).

Lines, sail-plan and machinery of a 24 ft. Itchen ferry fishing-boat, fitted with auxiliary steam-power.

PAGE
Coracle 188
Chinese sampan 189
" Dolce far niente " 193
Sections of *Rob Roy* canoe, showing sheer-plan and deck-plan 195
Diagrams showing body-plan, stretcher, &c., *Rob Roy* canoe 196, 197
Diagrams showing construction of backboard and floor-boards, *Rob Roy* canoe 199
Diagrams showing construction of apron, *Rob Roy* canoe . 201
Mast-step, *Rob Roy* canoe 204
Canadian canoe, diagrams showing mode of construction 208—219
Canadian batteau, diagrams of 221
American flat-bottomed canoe or "sharpie" 223
Sail-plan "sharpie," diagram of 228
Boom with double jaws for reefing 228
Plans of canoe of yacht model 234, 235
Centreboard and fittings, diagrams of 236, 237
Self-righting canoe 239
Yawl rig for sailing-canoe 240
Diagram illustrating value of occupant as shifting ballast in sailing-canoes 245
Tabernacles and fittings, diagrams of 251
Rudder fitted with lowering plate 253
Foot-yoke, diagram of 254
Sea canoe (body-plan) 259
Sail-plan, Mr. Fairbrass' three-ton design 290
"The cabin," *Rob Roy* yawl 304
Cooking under cover 306
Prepared for squalls 311
Undine, section of, showing internal fittings and deck-plan 322, 323
Tit-Willow, plan of 326
Viper, showing internal fittings 328
Viper, sail-plan, sheer-plan, and midship section . . . 330
Inexpensive spirit-lamp, diagram of 353
Floating ballast, diagram of 361
Rob Roy cuisine, diagrams of 368

YACHTS, BOATS, AND CANOES.

CHAPTER I.

DESIGN.

THE element of Design is a most important factor in all good work, and nothing is more essential in all Construction than that there shall first be Design, which simply means that every necessary detail shall be reviewed, put on paper, and approved before the materials necessary for the contemplated work are touched. Design is especially necessary even in the most elementary forms of Naval architecture, as when the lines of a boat are laid down on paper, not only is the form of the intended craft more clearly seen, but an opportunity is afforded for correcting and altering any details which are shown by the drawings to be detrimental to the success of the boat designed.

It might appear at first sight, so far as yachts and boats are concerned, that it would only be necessary to prepare drawings for "practical" craft, i.e. not models. But it is just the fact that the element of design is of as much importance relatively in model building as with regard to the larger craft, that has caused the extreme interest which has for some time been taken in model yachts.

The same care and knowledge is required in either case up to a certain point; when, however, we come to the distribution of weights, the necessary structural arrangements, and other such points, the large boat necessarily requires technical knowledge and experience which is not needed to complete the model.

Design being therefore common to all such structures, it will be as well to deal with its elementary features before proceeding to touch on other matters which have in them to a great extent this governing principle.

To commence a drawing-board is requisite, some drawing-pins, a T rule, and a scale divided from, say, half an inch to the foot up to two inches; a two-foot rule will also be necessary, divided to eighths and sixteenths of an inch, and a good pair of dividers to measure off the distances. You may either use common or continuous cartridge-paper; this will depend on the size of your plans, which should not be on too small a scale—if of canoes or larger boats at least one inch to a foot, and if of smaller craft, such as model yachts, it will generally be found simpler to draw the lines to the full working size. Pear-shaped and French curves are generally used to get in certain sections in the various plans. The former are made in sets and are rather expensive; the latter, though not so good, may be made to do if such curves are selected as are likely to be useful;

their cost is very trifling. You will also require some splines; these are long thin battens made of lancewood, and are used to get in the water-lines; penning-battens are used for inking in these lines, but they can be done without; in conjunction with these you will want some weights, which are generally made of lead with a wooden sole, and are used to keep the spline to the curve you desire: you will, however, find it less expensive to make these yourself, or use miniature flat-irons or pins. They are used thus:—

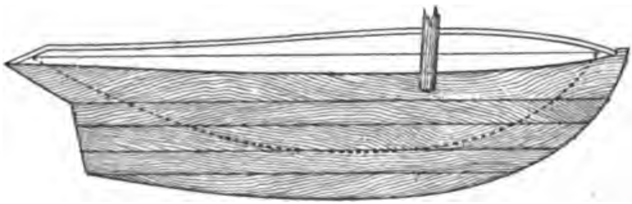
A A is the spline, and B B B the weights. Ordinary flat-irons could be made to do for

weights. The spline is chiefly used for getting in the water-lines, and when a proper curve is obtained the line is traced in.

In London any of the required appliances can be obtained from Mr. Stanley, Great Turnstile, Holborn.

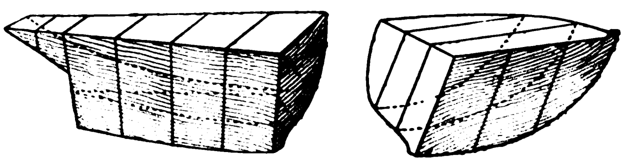
The drawings which show the lines of any particular vessel or boat are composed of three separate plans, each of which depends on the others and must be worked in conjunction with them, and each of the plans must be so constructed that they shall correspond in every essential particular. This correspondence is usually arrived at by a process of fairing, which will be touched on later on. The three necessary plans are the Sheer plan, the Body plan, and the Half-breadth plan.

The Sheer plan shows the outline of the longitudinal vertical section of the boat, that is to say, if a model were taken and cut in half in the fore and aft line of the keel and longitudinal centre-line of



Half-model divided into lifts at the water-lines, and showing bow and buttock lines, and sheer plan.

the deck, each half would, when separated, show the sheer plan of the boat; while if the half model were again operated on in a similar way at any given interval from the centre, the section so cut off would show the respective bow and buttock lines of the model (in the latter case the deck-lines would be disregarded, the longitudinal vertical form of the immersed body of the vessel being only under consideration); and if the other half were cut into layers at



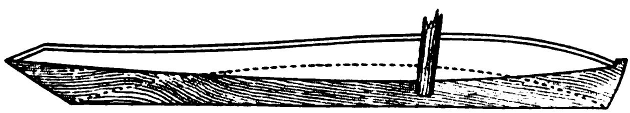
Half-model divided to show vertical cross-sections.

After-part of half-model, showing the sections and diagonals.

Fore-part of half-model, showing sections and part of bow and buttock lines.

any given distances from the centre-line, but diagonally instead of vertically, these sections (disregarding the deck-line) would show the line constructed from the diagonals, or that along which the water would pass.

The body plan shows the vertical cross-sections of the boat at various stations along her sheer plan, and the same result would be obtained if a model were taken, and stations or distances, which might or might not be even, were marked across the deck at right angles to the keel, and the model was sawn across at these various stations. The first separation at the bow would show the shape of the boat at No. 1 bow section, and so on until the largest section was reached, which would be the midship section (unless the boat had a raking midship section); after that would come, in their several orders, the stern or after-body sections. To show the greatest section of a model having a raking midship section it

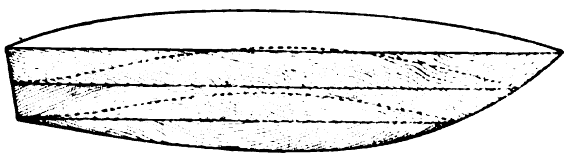


Upper part of the half-model, showing the emersed half-body, deck-line, and load water-line.

would be necessary to saw her across diagonally where that section happened to fall.

The Half-breadth plan shows the longitudinal transverse sections of the vessel at the deck-line, the water-line, and at other stations on the same plane as the water-line. If a vessel was afloat and only lightly ballasted, that part of her hull above water could be cut away on the plane of the water, and her longitudinal transverse section at that part of flotation would be shown; and this might be done at any depth of immersion, showing her sections at different water-lines, while her deck-line could be easily taken by measurement. As each half of the vessel longitudinally is supposed to be of the same size and displacement, it is only requisite to show one half to construct the full dimensions, and for this reason and to save space, the half-breadth plan is used instead of the whole plan, and a similar method is in force as regards the body plan, of which only the half-sections at the bow and stern are given, the outermost of all being the largest or midship section.

Load water-line.



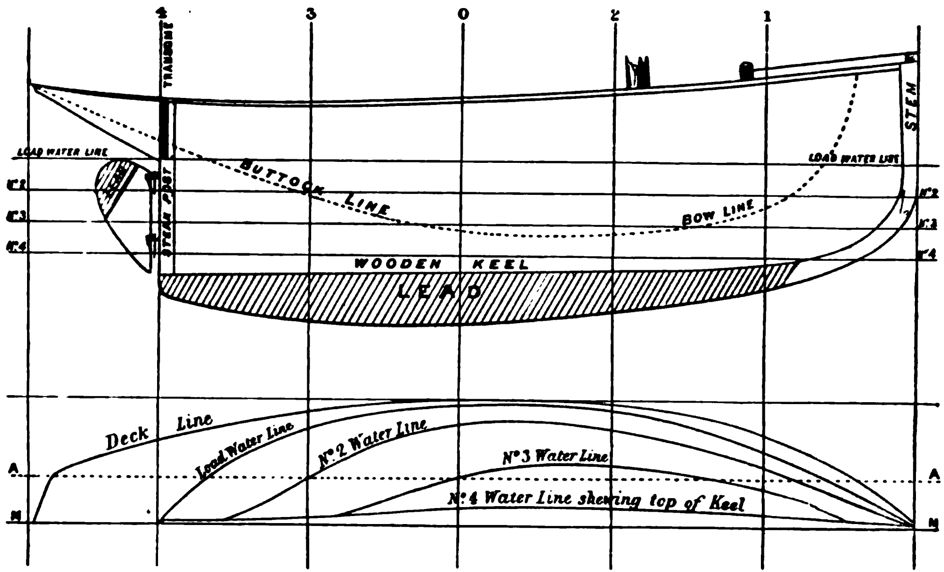
Lower portion of half-model, showing the immersed body and lower water-lines.

If we again take the half-model as illustrative, the half-breadth or water-line section can be obtained from it by cutting it in parts longitudinally and transversely at stated intervals, when each separation will show a water-line if the model be in the vertical to the plane of the water when so separated into parts. If the model is similarly separated at different stations diagonally, the separations will show the line along which the water flows, which line can be obtained from diagonals constructed on the body plans or by inclined water-lines.

By having a clear conception of the general form and distinctive differences of these plans, it will be a comparatively easy matter to commence the drawings themselves. But it would perhaps help those who have had no prior experience in such work if the several plans were first constructed from any of the lines given in this book, not by mere copying, but by taking the drawings and the explanatory details together, and making the one elucidate the other; but before taking the other drawings into consideration, it will be well to examine the design for a 3ft. model facing page 9, in which several details are shown in a way to be more easily understood by one having no previous knowledge of designing. The drawing represents the sheer plan and half-breadth plan of a model boat to be sailed under length rules; the beam being therefore untaxed, it has been made use of as much as possible, consistently with securing a fair proportion of immersed body; it would of course be possible to design a boat having far more beam on the length, but in such a case the immersed body would have to be proportionately less deep, producing a bôat of the "skimming-dish" type, and needing either a centreboard (which is not allowed in model racing) or a deep fixed keel to give the requisite lateral resistance. A deep keel, though it would secure sufficient hold of the water, would, however, involve a large amount of frictional resistance without any compensating displacement, which would be a serious detriment to the boat's speed, and a very unscientific method of construction. To avoid this, and at the same time to produce as large a boat as possible on the given length, possessing fair lines, a beam has been given of rather less than one-third of the length on the load water-line. Shallow centreboard boats (not models) have generally considerably more beam than this, and many types of open or half-decked fishing craft have quite one-third beam. In the design the body of the boat is fairly distributed, no excessive volume being allowed in any one place, and the model would be "all boat," the water-lines having no hollow, and no deadwood being allowed except what is absolutely needed to make the craft keep a straight course. This is a matter which must always be kept in view in a model, and far more deadwood and a greater length of keel is necessary, than in a real craft with a helmsman on board; a length model, too, needs all the length of keel that can be given her, while it is possible on the longer model, designed under tonnage rules, to shorten the keel to a certain extent. The design must be considered as a whole, the body plan, diagonals, and inclined water-lines being all integral parts, and by comparison of the one with the others, the fairness of the design may be checked and its faults seen and corrected. This design would produce a boat which many would consider ungraceful, too beamy, and certainly unyachtlike; but she is not a yacht, and has no pretensions to being one, but is simply a craft intended to carry a

DESIGN FOR THREE-FOOT MODEL YACHT UNDER LENGTH RULES.

For Body-plan, Diagonals, &c., see pages 10 and 17.

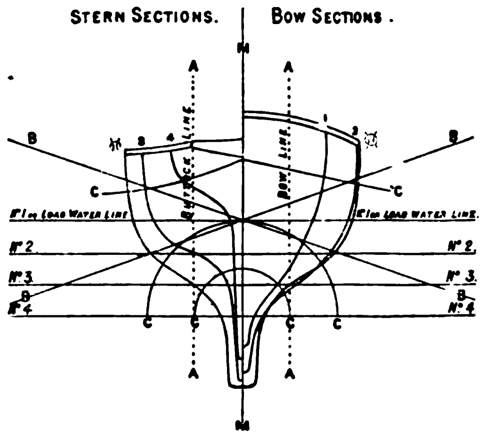


To face p. 9.

large amount of canvas and to overpower by sheer weight and size competitors on the same length, but of less displacement. And the lines are given more to illustrate the text than for any other purpose. It is very possible to construct a faster boat on the length of less extreme type, but a model on the lines of the design, sailing under length rules, would be found to be a troublesome one to beat, particularly in a breeze. The water-lines, especially the lower ones and at the bow, are exceedingly full, far too full for a real yacht, which with such a bow would be considered a regular tub; but the only reply to this must be, once for all, that a model is not a yacht, and the conditions under which she is sailed are altogether dissimilar.

In commencing the drawings the sheer plan is the first to start on; in it you determine the length, sheer, depth, and general contour of the intended vessel. As a commencement it will be well to draw the load water-line marked L.W.L. on the plan, and having determined what length your boat is to be on this water-line, you mark this length off to scale on the L.W.L. You can now mark off the freeboard you intend giving the boat amidships or at the lowest point, and also at the stem and stern (at the transome); you can then sweep in the sheer by a spline touching these three points. If you give the boat a counter, this of course will have first to be marked in, and the sheer taken from the end of the counter. If there is to be a rail to the boat, the deck-line should be measured off and marked in by a dotted line; if the deck is over all, this of course is unnecessary. Having decided what depth you intend giving the boat, you now mark this off from the underside of the deck (if undecked from the top of the gunwale) to the top of the keel, and another line is drawn to represent the full draught of water at

BODY PLAN.



B B, inclined water-lines; C C, diagonals; A A, bow and buttock lines; M M, centre line dividing the two half-bodies; ⊗ midship section; 1 and 2, bow, or fore-body, sections; 3 and 4, after-body sections.

the bottom line of the keel. This line can either be put in with a spline, or with a curve and rule. The different water-lines can now be marked off in such numbers and at such distances as may be found convenient.

Room having been left on one side of the sheer plan for the body plan, this may now be put in, first draw a perpendicular, which will be the dividing line of this plan, mark off the extreme draught from the sheer plan, and also mark the intended thickness of the keel and line it in; the midship section will now have to be settled if the boat has one. A midship section is a section which has the largest area, and is situated about amidships, but it is not at all necessary that there should be any section which has the largest area at or about midships; the areas of the sections may be so disposed that one forward of midships may have a large area under water, and another aft may have the greater area on and from the water-line; this would give a raking midship section, as the cross-section, including the greatest area, would necessarily lie in a diagonal instead of a vertical direction. Still, many boats have some one determined section termed midship section at or about the centre of the water-line which includes the greatest area; we will therefore suppose you are dealing with such a boat. You must first settle the beam on the water-line and the beam on deck. You can then either use curves or splines to put in such a section as you think proper, and having got the section lined in for one half, unless you are using curves, you will find it necessary to mark off with the dividers the distances from the perpendicular on the different water-lines, so as to get the other half in correctly.

This being done, you can turn your attention to the half-breadth plan. Draw two perpendiculars marking off the length of the boat over all from the sheer plan, directly under which the half-breadth plan is put. The position of your midship section on the sheer plan must now be determined. It is generally advisable to place this section slightly aft of midships. With the straight-edge draw this line right through the sheer plan down to the middle or base line of the half-breadth plan, and mark in as many other sections as you deem requisite; it is not necessary that these should be at equal spaces, though it is generally found desirable, but if it is intended to work out a displacement sheet it is absolutely necessary that there should be an odd number of sections and an equal number of spaces. The base or middle line of the half-breadth plan having now been lined in, the deck-line can be put in with a spline, the beam amidships being taken from the body plan. It is as well to let the beam come some way fore and aft of the midship section, but this will be dealt with later on.

When you have got a nice deck-line, the next thing will be to mark off on the body plan the distances of the various sections at the deck-line from the middle line (the middle line of the body plan corresponds with the middle line of the half-breadth plan, one plan giving the vertical and the other the horizontal cross-sections. With the dividers, starting with the first bow section, measure off the distance at that section between the middle line and the deck-line. Mark off this distance on the body plan, then take the next section (No. 2 bow), and mark it off also on the body plan, and proceed in the same manner until you have all the bow sections marked off, as far as regards distances of the deck-line. You can now, by means of curves or splines, indicate the form you wish the bow sections to take, starting from the points showing the distances from the middle line. It will be advisable, before doing this and after you have settled the greatest beam, to mark off from the sheer plan the freeboard at the stem and stern (these are marked on the middle perpendicular line), and at the greatest beam mark off the lowest freeboard (if it should happen to fall there), and from these points you can put in the line of the deck on the body plan, which line will show the freeboard of the different sections as they are put in.

Having got in the bow sections to your satisfaction, you will next proceed to deal with those of the after body, and taking the distances on the deck-line in the same way as you proceeded with those of the bow, you by means of curves or splines indicate on the body plan such lines as you think suitable.

When you have got in all the sections, the next step is to construct the L.W.L. on the half-breadth plan. Mark off on this plan from the middle line the distances at each section, which that section on the body plan at the L.W.L. is from the middle line, and having these points all indicated, apply a spline, and, seeing that it touches all the points, sweep in the curve.

It will very likely happen that the spline will not touch all the points without assuming an unfair curve, one or more of the distances from the middle line being too far or too near to it to be in the same curve as the others. In this case you will have to look at the sections on the body plan and fair them, i.e. by bringing some portions of the section nearer to the middle line and others farther out, but only very slightly, until they are altered so as to give a fair water-line on the half-breadth plan.

It may be the case that both plans will have to be slightly altered before you can get the desired result; but whatever steps you may take it is absolutely necessary that wherever you use the spline it should take in all the points you are working from, and that it should at the same time make a fair curve.

When you have got all the water-lines marked in on the half-breadth plan, which must correspond in number with those shown on the sheer and body plans, the bow and buttock lines have to be considered. These lines are used to ascertain whether the other lines are fair, and they also show the form of the boat at various longitudinal lateral sections; to construct them you mark off perpendiculars on each side of the middle line of the body plan and at any convenient distance from it, one perpendicular on either side for each buttock-line. The distances between the base line (top of keel) on the body plan and those points where the perpendiculars cut the sections, are then marked off from the base line of the sheer plan (common to both plans) on each section that is so cut, commencing from the first section forward.

By applying a spline to the points so marked in on the sections, it will be seen if the curve is a fair one, and if it is, it can be lined in; if not, the plans must be altered until they give fair buttock-lines. Although the buttock-line is a very useful one, it is a mistake to take it, as some do, as giving the line in which the water passes, it might do so if the boat were continually on an even keel, but this is seldom the case in sailing-vessels—and as it is an essential point to know what form your lines assume when the boat is careened, it will be most desirable to construct diagonal lines, which give as nearly as possible the true course of the water as it is displaced by the vessel in her onward course.

As the particles of water are assumed to disperse a right angles to the plane of the vessel's skin or planking, it is necessary when drawing the diagonals to see that they cut the sections at right angles, or as nearly so as possible. This is a point frequently overlooked or not properly understood, and the result is that diagonals are often to be seen drawn at all sorts of angles to the sections, and the lines taken from them are therefore practically useless. Having drawn your diagonals, the distances are taken from the point where they start from the middle line to that where each section is cut by them, giving the distance at each section. A line is then run in through the points by means of a spline, and if the line is unfair or unsuitable the various plans must be altered until the desired result is obtained.

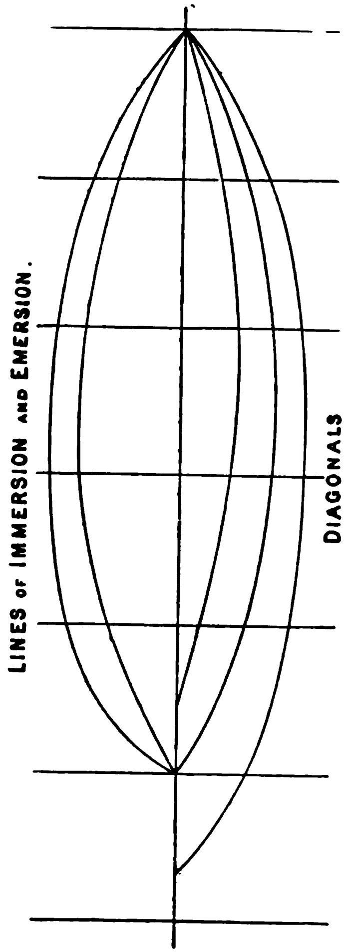
This line, constructed from the diagonals, is a most important means of checking the other lines and determining whether the form of the boat is one likely to be successful, as it shows very nearly the course the water will take as it is displaced, and is therefore a better guide as to the fairness of the drawings than the buttock-lines, which, however, afford an additional check, and should therefore always be constructed as well as the diagonals. These lines are of the greatest importance as indicating the fairness of the boat's body and its wave-making tendencies; the diagonals also show how the displacement is disposed at different angles of heel, which may differ considerably from that as shown by the ordinary water-lines.

The latter only give the form of the under-water body in a state of repose, and many appear extremely satisfactory until the diagonals show that the form of the boat which is above water when at rest, and which under canvas is partially immersed, does not harmonize with the under-water sections, but develops some features likely to have a retarding influence on the speed of the vessel.

This especially applies to the shoulder at the bow and the form of those after sections at and about the transome, which until the vessel is heeled over are above water.

It would seem almost supererogatory to direct attention to the fact that a sailing-vessel under way must be more or less out of the vertical, but yet many who are fairly well up in designing are quite satisfied to check the cross sections by bow and buttock lines, which though they show the relative fairness of these sections, only show the form of the vessel when in a vertical position to the plane of the water.

It is evident that to give practical and valuable results it is required to ascertain what the character of the longitudinal sections are, along which the water will pass when the vessel is under sail, and this can only be done by taking diagonals, or by proceeding in a similar direction in some other way.



Part of Design, page 9.

One other method of obtaining information on this point is to take the body plan at any given angle of heel and construct inclined water-lines; this may be done by constructing water-lines on the body plan as it appears in a vertical position, in which case the water-lines must be placed in such a diagonal direction or inclination as will indicate the required angle of heel which the vessel is supposed to assume. It is then only necessary to measure off the sections at any given water-line to find the immersed and emersed form of the boat at that water-line.

To still further check the fairness of the lines it will be advisable to construct a curve of displacement, which is done by taking the areas of the different cross sections and treating them as ordinates in the curve (see next page,) to be constructed. The curve must be taken along the ordinates, and if the ordinates are disproportionate the curve will be an unfair one, which will show that the areas are unequally distributed, and they must be adjusted until their ordinates produce a fair curve.

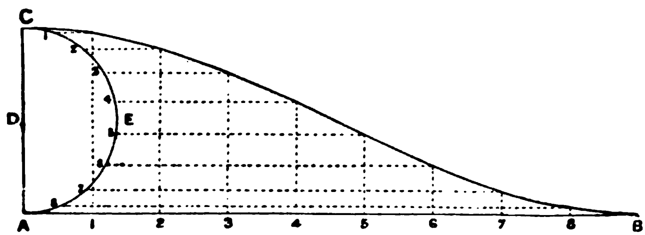
Now although one may be fairly well acquainted with the principles of drawing and fairing the lines of a boat, it is necessary, in order to produce good lines, to know something as to different types of craft, and those causes which produce bad vessels, as well as the general qualities which are desirable.

The question of the fineness or fullness of a vessel's lines, and how they are disposed, is a most important one, but it is impossible here to do more than glance at such questions. The old wave-line theory introduced by Scott Russell, shows graphically the character of water-lines with a considerable hollow forward. The wave-line is constructed as follows:—

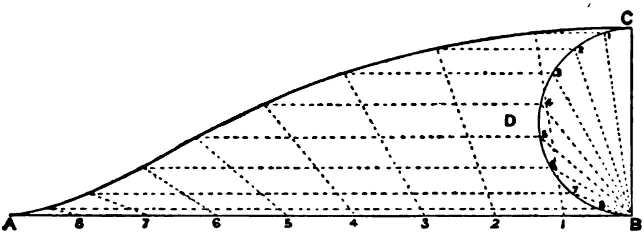
It is first laid down that the length of entrance shall be to the run as 3 to 2, and that for given speedsa certain length of entrance and run is required, as, say, at:—

	Entrance.	Run.
1 knot per hour	·562 feet.	·375 feet.
2 ,, ,,	2·24 ,,	1·50 ,,
3 ,, ,,	5·05 ,,	3·37 ,,
4 ,, ,,	8·99 ,,	6·00 ,,

then let A B be the length of the entrance fixed upon. Construct the perpendicular A C = the half



Fore Body. Wave-line construction.
(1, 2, 3, &c. are ordinates in the curve.)



After Body. Wave-line construction.

breadth of the intended vessel and from the point D, at the distance D E describe the semicircle A E C. Divide the line A B and the semicircle A E C into the same number of equal parts, and construct perpendiculars (ordinates) in the line A B at the stations as 6, 5, 4, &c., and from the points in the semicircle A E C construct the horizontal lines 1, 2, 3, &c., then through the points where the horizontal lines cut the ordinates, draw the curve C B, which will show the required wave-line for the entrance.

In the run a similar method is employed, with the exception that chords are used. Let A B be the determined length of run, and C B the perpendicular = to the half-breadth of the vessel, construct the half-circle B D C, and divide it into equal parts, to correspond in number with those of the fore body. Then draw the chords 1, 2, 3, &c., in the semicircle, and on the stations marked on the line A B, which correspond in number with those in the entrance, draw lines parallel to the chords in the semicircle, then the points where these lines are intersected by the horizontal lines drawn from the point in the semicircle, and parallel with the base A B, will give points in the curve A C.

One of the principal features in this method of designing is the proportion between the entrance and run, and the determined length of either for different speeds; the addition of a certain length of midships body will not affect the speed to any perceptible degree.

The wave-line theory has been successful as applied to large vessels, with certain modifications but Mr. Scott Russell's yacht *Titania*, which was built on his principles, was never remarkable for speed, and in a match with the celebrated *America*, made a wretched exhibition, hardly seeing the way the Yankee went when sheets were hauled in.

There is no doubt but that, generally speaking, a long easy bow is a good thing, but so is a long run; and though the Americans mostly design their vessels with long entrances, having a great flare aloft, and a short run, with the after-sections tucked well up at and about the water-line, English yachts and vessels usually have a long easy run, as well as a long bow.

This is more necessary in the case of a vessel having a considerable amount of immersed body, than in craft of the "skimming-dish" type, the lines of which may be "clubbed" or suddenly terminated, without much ill effect. This would give a very short run.

But perhaps the points in which there has been the widest departure with the best result have been in the disposition of the longitudinal immersed area of the vessel, and the dislike to forms giving hollow water-lines.

The longitudinal area of the vessel used generally to be so disposed as to give a great gripe forward, from the immoderate length of the fore-foot.

This naturally gave the boat strong weather helm, and to sail her an enormous jib had to be carried on a proportionately large and weighty bowsprit, and the vessel being short in proportion to her beam, mainsail area had frequently to be given by hoist, creating such a high centre of effort as to make the boat pitch heavily in a sea-way.

Such craft bruised along in a smother of foam, making tremendous fuss but doing little profitable work; the form of the vessel, the weight of the bowsprit, and the arrangement of sail area, being all against her success even as a good sea boat. But all this has been altered of late years; the same size, if we can use the expression, has been put into a better form. With less beam and more depth, extra length has been given, and the fore-foot rounded well up, while the drag aft is greatly done away with. In fact all the useless deadwood that can be spared is cut away and the requisite lateral resistance given by the disposal of the area of the parts cut away somewhere towards the midship portion (or slightly aft of midship) of the immersed longitudinal body. The weights are thus carried more in the centre of the hull, and the ends proportionately relieved, while the whole improved form of the under-water longitudinal section is disposed in the most favourable way for producing a vessel handy and quick on her helm.

The gripe forward being so much reduced, a shorter bowsprit can be carried, and smaller jibs, while the boat being longer, the mainsail can be longer on the foot and set as much canvas with less hoist, giving a lower centre of effort, which together with the various other improvements effected, gives much greater ease in a sea-way, and enables the vessel to make better progress under snug canvas than the old type would do under a press.

Now in the old type you will find, as a rule, hollow water-lines, very often exceedingly pronounced, with a large midship section; but the newer vessels have all the dead-wood sections cut away as much as possible, and so fuller lines are given, showing no hollow either fore or aft; and this is an important point. If, for instance, we take any semicircle and use it for, say, a midship section and lines approaching it in shape for the other sections, all being more or less convex, the result will be that a boat of a certain displacement will result; and if we use the same length of lines again for another craft, but dispose them in a concave form, it is evident that a smaller displacement will result; but it will be found that the wetted area will be about the same in either case, so that while the same, or about the same, skin resistance has to be overcome, the one type has considerably less displacement, i.e., sail-carrying power to overcome such resistance than the other type, and provided there is no undue fulness to produce excessive wave-making tendencies, the more displacement that can be got on a given wetted surface with fair lines, the better result will be obtained.

There are many other points which it is necessary to keep in view in designing. For a canoe or small cruising boat, it is necessary to know what weights she is to carry, and how they are disposed, the water she is to be used in, if rough or smooth; and, if a canoe, whether she is to be sailed or paddled, or both.

In a racing-boat or model yacht, the first thing to look at is the nature of the rules under which she has to compete, and how far you are able to take advantage of them; for instance, if a length rule, it is obvious that one point, "length," being settled, you have two to deal with as you like, viz. beam and depth; but, as it is impossible to get a good boat on a certain limited length, with an undue proportion of beam and depth, or indeed of either, which means displacement, you are limited here not by the rule, but practically by the necessity of producing good lines. If, for instance, you decide on great beam, you must reduce depth, or *vice versa*, though perhaps, for an all-round boat, it would be better to give a medium amount of both.

But in length classes *beam should never be reduced to anything like the proportion adopted in yachts raced under tonnage rules;* which, in fact, would be only throwing the size of the boat away for no practical purpose.

Under tonnage rules you will have to consider how they affect the forms of boats, and what is the best to adopt so as to get the full benefit of the rule.

If the rule taxes beam and length only, it is well to sacrifice beam and go in for length, giving stability by depth and lead, building a boat of large displacement. In any case, it may be taken as a general axiom that length means speed, beam initial stability or great sail-carrying power at small angles of heel, and depth lateral resistance and sail-carrying power at large angles of heel, given by ballast carried in or on the vessel. The present English type of racing yacht, Fig. 1, which is produced by the tonnage rule taxing length and beam and allowing unlimited depth, though far superior to the shallow class of boat, has probably been carried to the extreme, as far as a

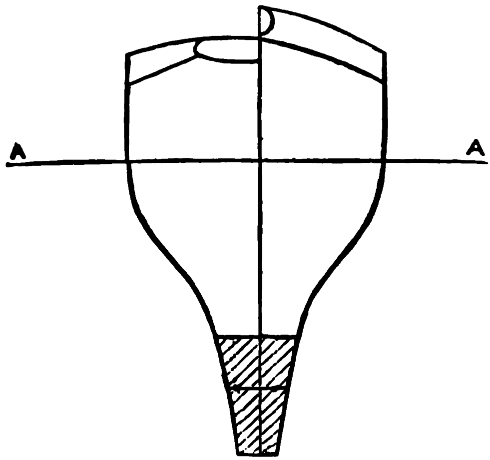


Fig 1.
Midship section.

good all-round form of vessel is concerned, apart from tonnage rules. The contests between the *Genesta* and *Puritan*, *Galatea* and *Mayflower*, and especially

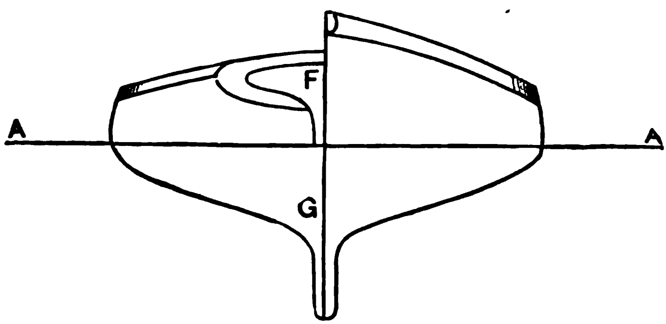


Fig. 2.
Midship section.

the *Miranda* and the American schooners, show that beamy vessels of small proportionate displacement and large sail area are not to be despised, especially in smooth water and light winds. The *Puritan* and *Mayflower*, however, differ considerably from the *America* or the ordinary American type, shown at Fig. 2, as they are vessels, as compared with them, of large displacement, and draw considerably more than the generality of American yachts of their size, while, like the English boats, they have nearly all their ballast outside; and though the *Genesta* draws 13 ft. and *Galatea* 13 ft. 6 in., the centreboards of the Americans must not be forgotten, the *Mayflower* with her board down drawing 18 ft. The respective dimensions are:—

	Genesta.	*Galatea.*	*Puritan.*	*Priscilla.*	*Mayflower.*
Length on L.W.L.	81 ft.	87 ft.	81 ft.	85 ft.	85 ft. 8 in.
Beam . . .	15 „	15 „	23 „	22 ft. 5 in.	25 „ 6 „
Draught of water .	13 „	13 ft. 6 in.	8 ft. 3 in.	7 „ 9 „	9 „ 7 „
Displacement .	141 tons.	157.63 tons.	115 tons.		110 tons.
Lead keel . .	70 „	81.50 „	27 „		42 „
Ballast . . .	2 „		17 „		6 „
Mast deck to hounds . .	52 ft.	53 ft.	59 ft.	62 ft.	63 ft.
Topmast . .	47 ft. 6 in.	45 ft. 6 in.	42 „	41 „	46 „
Main boom . .	70 ft.	73 ft.	76 „	78 „	80 „
Gaff . . .	45 „	45 „	48 „	45 „	50 „
Bowsprit outboard	35 „	36 ft. 6 in.	40 „	38 „	38 „
Spinnaker boom .	63 „	65 „ 6 „	64 „	69 „	74 „
Topsail yard .	42 „		46 „	47 „	
Sail area by New York Yacht Club rules .		7146			9000

The midship sections of the *Puritan* and *Mayflower* may be roughly said to be a compromise between Figs. 1 and 2.

Vessels of the type shown at Fig. 1 rely on what is called artificial stability, which is obtained by a heavy lead keel and depth of immersed body, which allow of a low centre of gravity. The second type rely on their great initial stability, which arises from the excessive beam. The first are impossible to capsize, as, the greater the angle they are careened to, the greater the righting moment caused by the elevation of the heavy lead keel and ballast at the end of the lever (i.e., the depth of immersed body), and at the same time, the sails being at an acute angle, allow the wind to pass over them, opposing less and less resistance as the vessel heels more and more. The other class of vessel are fast in light winds, and stand well up to their canvas in a blow, as long as they do not heel more than a certain angle. This point (which exists in all such vessels, and is called the "vanishing point") reached, the vessel capsizes without any possibility of righting, and it is not long ago that a large American schooner yacht was lost in this manner. The ill-fated *Captain*, lost in the Bay of Biscay, is another instance.

It is therefore highly necessary that care should be used in sailing-vessels of this type, and for all racing purposes, outside ballast, and plenty of it, is the safest plan. The thirty foot class of racing boats or small yachts, offer some very good examples of craft with considerable beam and yet sufficient depth to make them perfectly safe and able boats in a sea way. The dimensions of the *Curtsy*, one of the latest and fastest additions to this class, are—

36 ft. × 11 ft. × 7·4

One of the fastest three-foot models at Victoria Park

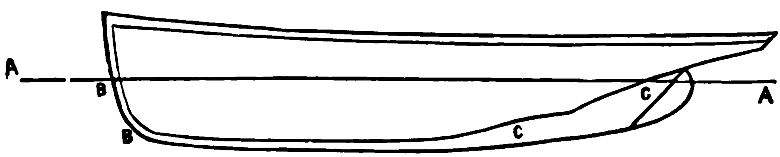
Club under length rules measuring 36 inches × 11 × 8. The *Curtsy*, however, has considerable rise of floor giving a sharper bottom and less displacement than is advisable in a model.

A very important question is the sheer plan you intend giving the boat, and the draught you intend her to have.

No boat will sail to windward unless she has sufficient hold of the water, and the draught must be distributed according to the result you wish to obtain, thus :—

Fig. A is a sheer plan of a craft with a great deal of

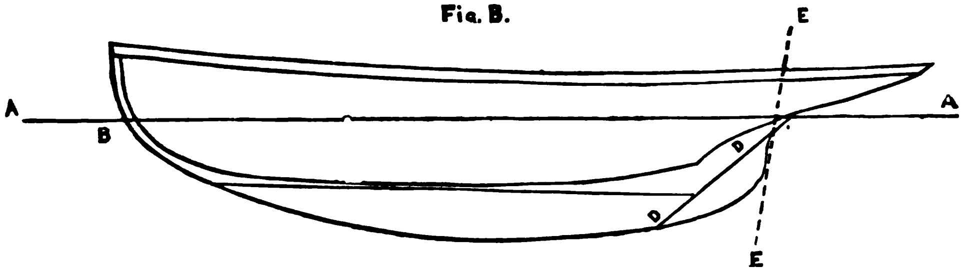
Fig. A.



gripe or forefoot (B B) as compared with the dead-wood aft (C C). Such a boat would need a very long bowsprit and large head-sails, and, in fact, her whole sail-plan would have to be entirely different from Fig. B, in which the forefoot is cut away, greatly reducing the gripe, while the area of deadwood aft is much greater.

Fig. B is after the type of a modern cutter. The line of the stern-post at D D has a considerable amount of rake; this makes the vessel quick in stays, and answers well in a sea-going vessel which can be steered by men on board, but in a model it is indispensable to give more deadwood ; in fact, the stern-post of a model had better come at E E in order that she shall carry her mainsail without luffing up into the wind. Of course, it is possible to sail a model boat cut away as at D D, by carefully balancing her sails (carrying a small mainsail and good-sized head-

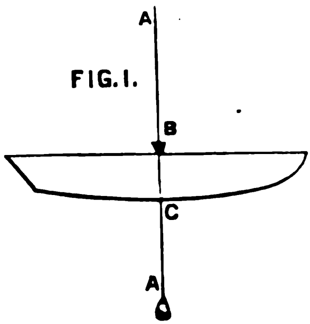
Fig. B.

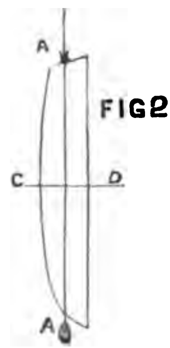


sails), but such a boat would probably be beaten by one of the same length with keel prolonged to E E, if both were equally well designed. In fact, in a model it is best to give as much length as possible along the keel, taking care that the stern-post draws about twice as much water as the bow, in order that she may steer steadily when close hauled without a rudder.

From the sheer plan you can find the area of lateral resistance, and also its centre, which you must ascertain in order to place the masts and to draft the sail plan by.

Lateral resistance is the resistance offered by the water to a vessel when pushed sideways through it. The centre of lateral resistance is that point in the area of the longitudinal vertical immersed plane of the boat where the whole force of the resistance offered laterally by the water is supposed to be concentrated. It is generally considered sufficient to take the centre of the load water-line as marking this point; such a mode of procedure is, however, most misleading. In most boats it would probably be rather aft of the centre, and as the immersed portion of the vessel under consideration varies in form, so the centre of lateral resistance must vary in position, and it must be remembered that the body of the boat offers curves and not plane surfaces





to the water, and also that the area and character of the longitudinal immersed body varies as the vessel careens or pitches.

There are many ways of approximately finding the centre of lateral resistance: the simplest, as applied to a model, is to fasten the ends of a piece of string of sufficient length to the stem and stern at the water-line, another piece of string is then secured on the bight by a slip-knot, and the boat, being placed in the water, is pulled towards the shore sideways, and the hauling part of the string is shifted until you get a point where the boat comes laterally towards the shore, neither bow nor stern first. It is much the same operation as properly fixing the string on the belly-band of a kite.

Another way is to cut out a thin piece of wood to the shape of the under-water portion of the boat, as shown from the L.W.L. downward on the sheer plan; the centre of gravity of this is found by suspending it from two points, and marking by a plumb-line where these points bisect. See Figs. 1 and 2.

By taking the under-water section from the sheer plan, you can also find the area by triangles quite closely enough for any ordinary purpose.

The way in which this method is worked out is fully explained in the chapter on Sails. If, however, you wish to calculate the centre of lateral resistance with greater accuracy, the mode of doing so is given in the Appendix.

Besides the centre of lateral resistance it is useful and in most cases necessary to determine the displacement and centre of buoyancy of the intended boat (see displacement sheet in Appendix). Displacement simply means the amount of water which the boat pushes away or displaces to substitute so much of her body as is requisite to support the whole fabric, with masts, sails, rigging, and stores. In fact it is the hole in the water made by and corresponding to the form of the immersed body of the vessel. In order to compare different forms of vessels with regard to the immersed portion of their hull, a fraction termed a co-efficient is employed, which is determined in the following way,—

If we imagine a parallelopipedon constructed in the form of a box, the dimensions of which in length, breadth, and depth just allow of the reception of the immersed body of the vessel, it is apparent that there will be considerable difference between its cubic contents and those of that part of the body of the boat which is contained in it, and that proportion of the latter to the former is termed the co-efficient of fineness or displacement of the boat.

This may, perhaps, be more readily understood if we take a block of wood, say, sufficiently large to make a 3 foot model, as far as her immersed body is concerned.

Let it be 3 feet × 10 × 6. It will contain 2160 cubic inches, and if the model, when cut out, only contains 720 cubic inches the co-efficient will be $\frac{1}{3}$, or ·333, being the proportion the model bears to the original block.

Now it is obvious that as the lines of vessels differ, so the co-efficient must alter, and that it is impossible to take any one, as arbitrary. It is, no doubt, true that men of experience, by seeing the lines of some particular boat, can form a pretty good idea as to the co-efficient that should be employed, but this cannot be done by one without such experience, and in any case it is only guess-work.

From 0·35 to 0·4 would, perhaps, give the range of most yachts, but this is too wide for any accurate calculation. The total displacement or weight of a boat when floating at any given load-line can be obtained by taking her length and breadth at such load-line, and multiplying them together, the product being multiplied by the mean depth. The sum is again multiplied by the co-efficient of the boat, or that you may decide to employ, say, ·4; this will give the bulk of that portion of the body of the boat which is immersed in cubic feet, and if any remainder it will be fractions of a cubic foot.

To find the weight displaced in tons, it is necessary to divide by 35 or 36—the division depending on whether the boat is in salt or fresh water; 35 cubic feet of salt water going to a ton, and 36 cubic feet of fresh water.

A rough and ready way of finding how the displacement is disposed, is to cut out a half or whole (either will do) model, to scale, of the immersed body of the boat, and suspend it in the same way as was described for lateral resistance, the only difference being that for the latter a thin section was used, while for the former it must be a whole or half model, but only of the under-water body of the boat. By operating in this way what is really found is the centre of gravity of the section employed, and any deductions made from the experiment entirely depend on how far the model represents the actual body. The centre of effort of sails may be found in a similar manner by cutting a piece of card to scale, representing the sail plan (lower sails) and finding its centre of gravity, which will correspond to the centre of effort of the sail plan.

CHAPTER II.

MODEL YACHTING.

As a scientific and interesting pastime suited to men of all ages, combining the pleasure of designing and building with the exhilarating and healthy excitement of match-sailing, carried on, too, at a minimum of expense, Model Yachting stands pre-eminent; and though the model racing yacht in its present advanced type is but of comparatively recent date, the number of model clubs which have been formed both in this country and America, shows conclusively the popularity of the amusement.

Model yachting is one of the few pastimes in which all classes of society join in courteous rivalry. The man of high scientific attainments competing with the artisan, and the well-known yachtsman and perhaps member of the Y.R.A. with the tradesman (knowing, perhaps, nothing at all of real yachting) as to who shall produce the "crack" model which will give all the others of the fleet the go-by. And one of the peculiar features of model racing is, that the race is not always to the swift, or the battle to the strong, for the yachtman's craft is not unfrequently beaten by the production of one whose only yacht is a model one; and sometimes all the theory of the scientist cannot avail against the more practical knowledge of the artisan.

Still the importance of design cannot be overlooked in model-building, and proper drawings are generally prepared, and some calculations entered into before the model itself is commenced; and it is this element of design that gives the great interest to models, and distinguishes them from the mere toy boats with which they are frequently confounded by those unable to appreciate the wide distinction between them.

Our American cousins must be complimented as being the first to use models with a view to find how the vessel itself was likely to answer; and there is no doubt but that by working the drawings and models together a great deal can be learnt; but it must be distinctly seen that for any purpose of comparison, or to enable a fair judgment to be made as to the capabilities of a real vessel, as deduced from the performance of the model, a representative model must be used, which is constructed on entirely different principles from a model yacht; the end of the latter being speed under certain rules of measurement, and no regard being necessarily paid to the form of any other boat.

The "representative model," however, must follow not only the lines of the drawings of the real one it is intended to produce, but her stability must bear an exact relation to the calculated stability of the larger craft as yet in embryo; this effectually prevents the sides being scooped out to the utmost limit, and the greatest amount of lead put on the model that she can profitably carry.

For an ordinary racing model such a mode of procedure is perfectly correct, but for the other it is necessary to proceed differently, or the ratio it bears to the yacht herself would be destroyed, as a model simply designed for speed has ability to carry ballast out of all comparison with that possessed by a real vessel of proportionate dimensions. For this reason the proportionate amount of ballast which the representative model is to have, must be calculated from that which the real yacht is intended to carry, and whatever line this brings the *yacht* down to, the *model* must be brought to a similar bearing, by leaving sufficient thickness of wood inside to allow it to be scooped away until the right plane of flotation is reached. This scooping should be fairly done so as to leave an equal thickness of wood at all parts of the boat, as, if all the thickness is left at the bottom, it will act as ballast and add to the stability of the model. The model is not yet down to her load water-line, as a certain allowance has to be made in the calculation for the weight of masts, spars, &c.; these must be taken in the proper proportion from the weights of the yacht's spars, sails, gear, &c., and the model's spars and sails must be made of sufficient size and weight to bear the proper ratio to the actual weight.

Such a model it is evident could not compete as to speed with the ordinary model yacht, but she would be of much greater value as the means of checking theoretical calculations and ideas as to types of craft. It is related that the celebrated *America* was tried in this manner, and however that may be, it is certain that the practice is far more common amongst American ship-builders than English, and it must not be forgotten that America at a time when sail power was the only one used on the seas, built vessels, particularly schooners, which our fastest craft could not touch, while the celebrated Baltimore clipper was certainly the beginning of fast merchant-vessels, and though since then we have somewhat turned the tables as far as merchant shipping is concerned, and considerably astonished the American sloops by the advent of *Madge* in 1881, from which date may be traced distinct modifications in their type of yacht, (The two finest and most recent, *Puritan* and *Mayflower*, being a considerable advance in draft and displacement on the ordinary shallow type, which will now probably be dismissed in favour of yachts of moderate displacement and outside ballast,) still the Americans showed us how to build, and with *Puritan* and *Mayflower* have kept up the idea that they are able to put something together that will get through the water. Leaving *Galatea* out of the question, there is no doubt but that *Genesta* was a fairly representative boat when she went over to America, and though *Irex* has since proved herself to be the faster vessel, and *Marjorie* for her size perhaps the fastest of all amongst the big ones, yet it is extremely questionable if either would have had any chance against the Yankee sloops.

Each nation has produced the type of yacht most suited to its own waters, and it is not fair to suppose that vessels of heavy displacement, designed to contend with the short, choppy seas and heavy weather to be met with in the Channel and elsewhere round the English coast, are likely to be successful in the comparatively smooth water and light airs of the States against specially designed native C.B. craft of relatively small displacement and large sail area.

As to the amount of practical information to be obtained from experimenting with models, naval architects are greatly divided in opinion. The late Mr. Wm. Froude, who with Scott Russell, Rankine, and others devoted a great deal of time to investigation of the performance of proportionate models as compared with vessels themselves, has handed down certain "constants" which can be applied to such models. The law of comparison thus formulated is that the speed of a vessel and the speed of the model vary as the square root, and the resistance is as the cube, of the scale of comparison, or in other words, the speed of the ship is to the speed of the model as the square root of the scale of comparison is to 1, and the resistance as the cube of the scale of comparison.

For instance if we take a real yacht of 50 feet in length on L.W.L. with, say, a speed of 9 knots, and a model is constructed following her in all respects as to lines, weights, spars and gear, and sail area.

This model shall be 3 feet long on L.W.L., then the scale of comparison will be $\frac{50}{3} = 16\frac{2}{3} = 16{\cdot}666$ of which the square root is 4·082; therefore 9 knots, the speed of the ship, divided by the square root of the scale of comparison $\frac{9}{4{\cdot}082}$ gives the required speed, 2·2048, that should be attained by the model.

In considering the above it must not be forgotten that the law of comparison given only applies to vessels of identically the same type, in fact, reproductions in different sizes of the same vessel. Then let *A* represent a yacht 80 feet on the L.W.L., and let her speed be 11 knots an hour; and *A* 1, a yacht on the same lines, and with all gear, sails, and rigging in exact proportion, but only 40 feet on L.W.L.; her speed by the formula will be 8 knots; and if *A* 2 is a model constructed proportionately as the others in all respects, but only 4 feet on L.W.L., she will have a speed of 2·46 knots. To find out the complementary speed of a large vessel from a model, the operation is reversed; as *A* 2, 4 feet on L.W.L., with a speed of 2·46, what speed will *A* have with 80 feet L.W.L.?

$$\sqrt{\frac{L}{l}} \times \text{speed } l = 4{\cdot}47 \times 2{\cdot}46 = 10{\cdot}9962 \text{ or } 11 \text{ knots.}$$

It will be observed that eight knots are only given for the 40 feet length, and it shows no flaw in the law of comparison if it is adduced that yachts have attained higher rates of speed on that length; if they did, their type 80 feet in length would have a proportionately higher speed, as also the 4 feet model. For using this formula the sail area must be as carefully in proportion as all the other parts of the models. In comparing vessels of different type, it is very commonly received that their speed varies approximately as the square root of the length, so that if *A*, 64 feet on L.W.L., has a speed of 10 knots; *B* with 4 feet on L.W.L. should have a speed of 2·5 knots. This formula, however useful for purposes of comparison of varying types, has none of the absolute accuracy of the formula of the law of comparison as applied to exactly similar models.

The resistance to be overcome by vessels, is roughly considered to vary as the square of the speed, and this formula is generally used for purposes of comparison. While the resistance offered by similar models may be taken, as before stated, as varying as the cube of the scale of comparison. Thus, if we take a yacht 64 feet long, and a model 8 feet in length, the scale being as 8 to 1, the yacht will have a resistance of $^{3}8 = 512$ times the resistance of the model.

There are, however, other factors to be taken into consideration before it is possible to arrive at correct comparisons. One important part is frictional, or skin resistance, which in some forms is excessively large, and is always greater as the vessel diminishes in length from 100 feet, which may be taken as a standard, and at over which length the constant resistance may be reckoned as 0·23 lbs. per square foot of wetted surface; under the length of 100 feet the resistance increases in inverse ratio to the length; for 20 feet it would be 0·278 lbs.; for 8 feet, 0·325, and for 2 feet, 0·41, at a speed of 6 knots; while for speeds other than 6 knots the resistance varies as 1·86, to the 1·8 of the speed to be considered. Small models have therefore proportionately greater resistance than larger vessels of the same class, and with a proportionate sail area would attain a less rate of speed than they would have by the formula of comparison; but in ordinary racing models the increased resistance is far outbalanced by their enormous sail area, as compared with real vessels. It is now well understood that it is quite possible to give a vessel of certain proportions greater length by lengthening her amidships without reducing her speed (the same power being used), and in some cases increased speed has resulted from the alteration. Mr. Scott Russell went as far as to proportion the length of the after-body to that of the fore-body, and gave constants to determine this ratio for any given degree of speed (see Designing).

The practical meaning of this is that the longer a vessel is, the finer her lines can be, and without abrupt curves, and with the displacement evenly distributed along the vessel, the resistance is greatly diminished. It is comparatively easy to design long and narrow vessels so as to produce easy lines, the very form of the vessel naturally giving this result; for instance, if we take the often quoted "plank on edge," the resistance offered by it to the water is almost entirely skin or frictional resistance; and the chief objective in designing long and narrow craft is to give the required displacement with the least possible wetted surface, by cutting away all deadwood possible, and obtaining the requisite lateral resistance from the form of the immersed body of the boat. With beamy short boats, it is far more difficult to get good lines—such craft are frequently all middle and ends, the bow and stern giving away suddenly from an excessive midship section, and producing abrupt curves, and pronounced wave-making tendencies. Such boats, although they may be fast in light winds, do badly when pressed, and cannot be regarded as good models; for all-round purposes it is far better to reduce the extreme beam, and distribute the displacement over the boat. Let *A* represent the first form of beamy model, and be 3 feet on L.W.L., by 13½ in. beam. It is obvious that it is an impossibility to give such a boat the easy lines which a long narrow boat has, and moreover most of the displacement of such a boat will necessarily come about amidships. The boat alluded to is not a very shallow one, say seven inches from top of keel to deck. This craft carries an enormous amount of sail and is decidedly fast; but as the wind increases in power, her sail area must be rapidly reduced, as from her form she will do nothing if sailed at any large angle of heel. With just as much sail as will slightly careen her, she goes well; but if pressed, will knock off to leeward and generally behave badly; while another model, B, of the same length, with only eleven inches beam, and with the same or less displacement, but distributed more evenly over the boat, shows far better qualities, and even when considerably over-canvassed, will struggle away to windward, though half her mainsail be under water at times; and with suitable sail area for each boat, the more beamy one cannot hold with the other when it blows hard.

In all models it is a nice operation to get them in such trim as to put them to windward in the best possible form, and the slightest alteration in trim will make a considerable difference in the performance of a model. The sheets should be marked for a close haul, and the hole in the boom, that the vessel likes when pinned in for a dead beat, should also be marked, while the foresheet must be carefully looked to, and the hook seen to travel easily and without any chance of jamming on the horse, as if this occurs the foresail is often hove aweather and runs the model clean off the wind. The jib-sheets, too, need most careful attention, as the jib, far out from the centre of lateral resistance of the vessel, has great power in paying her head off, if hauled in too flat. It is a great and very common mistake not to give sufficient jib-sheet, and the lead of the sheet is another point that requires attention; it should be led in such a manner that while the jib is allowed to describe a sufficient angle with the fore-and-aft line of the vessel, the clew is hauled down by the sheet; this can be done by a horse on the bowsprit, or by self-working jib-sheets as described in the chapter on rigging, &c. One difficulty which sometimes occurs with models is their liability to run off the wind, and few things are more annoying than this, as after working up several boards, possibly in keen competition with a rival boat against a heavy sea and strong wind, just as your model is hauling free of the other, and you are congratulating yourself on her superior speed, she suddenly heads off and continues falling away to leeward until she has lost almost all that she made to windward.

There are several reasons for this troublesome fault, one has been alluded to, the jamming of the fore-sheet on the horse, another is the jib being hauled in too flat, particularly when blowing hard, when it requires more sheet than in light winds; again the centre of effort of the sails may be wrong, in which case the only thing to do is to put it right; the mode of doing this is given in the chapter on sails. The centre of buoyancy may be too far forward, in which case when the boat is pressed she squats by the stern and lifts her bows, immediately running off the wind.

There was a fast little model schooner about 2 feet in length, that was very cleverly sailed some years ago by her owner, an old naval man, and he adopted the dodge of putting a small piece of lead at the bowsprit end when it blew hard—it was in general a small strip of sheet-lead long enough to meet round the spar, and of hardly any weight; but although the weight was so infinitesimal, the little vessel showed by her behaviour how she felt it, for though even without it she never ran right off the wind when close hauled, even in its strongest puffs, directly it was added she looked right up to windward, and moreover went where she pointed, and though knocked off by a sea or a puff, would be up again in a second and pegging away to windward.

She was a curious little boat, having been a model of an old gun-brig, but her ports were filled up, and she was decked over all, and a false keel given her. She had bluff, flaring bows, cod's head and mackerel tail, her counter being only about an inch wide, great beam on the water-line, and considerable tumble home—a long flat floor, and great straight of breadth, but though the bow of this boat looked so full, it was only so on deck, the greatest beam on the water-line being aft, almost at the mainmast. She was perhaps as fine a little sea-boat for her size as could be built, and was exceedingly fast in all weathers. The object of having the little bit of lead out on the bowsprit end was to give more gripe, and as a rough-and-ready plan it answered well.

There are some causes, however, which make a boat run off the wind, that are not so easily dealt with; one of the worst of these is too full an after-body, particularly just at the transome. Models that have this fault often sail very well in light breezes, as long as the hump is kept out of the water, but directly it is immersed by the vessel lying over to a breeze, she is steered off the wind by it, just as if her rudder was on. If the diagonals are run out in the drawings they will soon show if there is any unfair fullness when the boat is careened. It is as well in making models always to leave a considerable thickness of wood at this part, to allow the run and buttock to be fined off if necessary, and for this reason, too, the counter should not exceed in width half the greatest beam of the boat. A long deep heel is another cause of a model running off the wind, for if deflected from her course by a puff, she cannot luff easily, and frequently keeps on the altered course considerably off the wind. A radical fault that cannot be cured, and yet which is not so infrequent as might be imagined, is that the sides of the model are unequal; if this is the case, she will very likely go to windward in splendid style on one tack, and on the other, run right off to leeward. Such models had best be condemned and broken up, though in some cases the owners prefer trying to cure the fault. If the sternpost and deadwood only is slightly out, and the boat is otherwise fair, the whole of the deadwood aft may be removed, and a fresh piece inserted and properly faired, or just so much of the deadwood as is over the square can be cut away, and a piece fixed in with marine glue to the other side, and planed down true. If the boat is only slightly out, and yet there is a perceptible difference on each tack, she can be sailed by putting the horse slightly over to the side which is aweather, when she is on the tack on which she runs off her helm. If the horses are properly adjusted, she can then be made to sail equally on each tack. A simpler plan, and one that had better be adopted until the right position for a time is found, is to put a piece of cork under the side of the horse (the leeward side on the tack she falls off on), blocking up about half an inch or so; this will keep the sheet to windward. Of course the same result might be attained by altering the mainsheet on each tack, but with much greater trouble.

By a careful use of templates when building, so as to ensure the various sections being correctly taken from the drawings, all such unfairness may be avoided, though of course any inherent fault that may exist in the drawings themselves will be reproduced in the model, and for this reason it is imperative if a successful model is desired, to thoroughly fair all the drawings by means of diagonal and buttock lines. To sum up, running off the wind or heaving up in it, if the boat is not otherwise faulty, may be put down to the fact that the centre of effort of the sails, and the centre of lateral resistance of the boat, are relatively not in the proper positions.

It will be readily admitted that, to get the best result in any form of production, it is first of all requisite to exactly know the requirements under which it will be used and for which, therefore, it must be fitted. Now the English racing Yacht (I am alluding to the real thing and not the model boat) of the present day is the outcome of a good many contending influences. One important factor is the tonnage rule, and another, lead ballast. The result is the production of an extremely narrow, long decision. Under some circumstances, and in some waters, the one type might be most successful, and under other conditions the result might be reversed. But this only holds good when both classes are designed for model sailing. Under no circumstances, will a model, being an exact reproduction on a small scale of a real yacht, successfully compete with one of the same length designed simply for model sailing—it is of course taken for granted that the lines of the latter shall be fairly good. Should, however, the end of the builder be to produce a handsome model, there can be little doubt but that he will be successful if he reproduces some well-known racing yacht. But in boats which are intended for match sailing, the great end is not to produce a craft which is merely pretty, but to build one which is able to beat her competitors, to obtain which it may be necessary to sacrifice some beauty in form in order to gain displacement combined with great sail-carrying power, giving momentum, and creating a fast and powerful boat. But although, as has been stated, it would appear more in accordonce with correct principles to design the model on fuller lines than a large racing yacht, it must not be forgotten that models travel at high (proportionate) speed. This is greatly owing to the amount of canvas they are able to carry being, in proportion, far in excess of the sail area of a racing yacht. Now, though it would appear that a model should have full lines forward, she cannot below the water-line have too fine a run. The deadwood section aft, shown in the triangle B C A, should be only about the thickness of the keel, just enough wood being left where it merges into the body of the boat, to round the juncture off and escape having a sharp knuckle, and as long as this is done the body cannot be tucked up too closely aft.

For models the fore-body (2) should displace more than the after-body (3). The former is disposed in the form of a vertical wedge, dispersing the water,

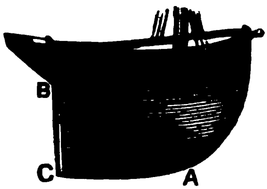
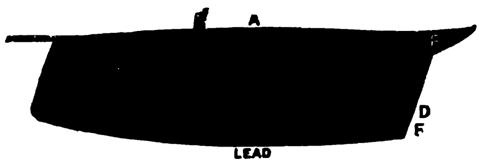


Fig. 1.



F, false keel (wood).

Fig. 2.

which immediately closes in and rushes aft. If the after-body be disposed in the form of a horizontal wedge the greater capacity of which is on and just about the water-line, it will leave a free passage under it for the escape of the water, which by its pressure will assist in pushing the vessel on her way ; but if the after-sections are disposed in V forms, carrying the displacement almost or completely down to the keel, it will be found that such a design is not so successful in model racing as the other, nor so steady on her helm. This last is of vital importance in model sailing, and from experimental sailing there is little doubt but that the full boats, with their form disposed as described and with an actual deadwood lateral section aft instead of the V-shaped stern sections, will give better results for model sailing, and especially when length is limited. In extremely long and narrow boats, the full section can be carried below the load-line, giving water-lines without a hollow aft, but this will not do for short boats, which with such an after-body are frequently disposed to run off the wind.

In figure 2 the line E C shows a raking stern-post, and E D the stern-post almost vertical. In length classes it is better to adopt the latter form, as greater length is obtained on the keel, which greatly steadies the model when sailing, and the increased lateral resistance aft is needed to carry the large mainsail without having recourse to a huge jib.

While on the subject of model racing, it may not be out of place to draw attention to the fact that if inter-club races could be arranged under some rule which would admit of models of all classes and types competing on a fair basis of measurement, it is extremely probable that a good deal of light might be thrown on the vexed question of type—such a rule might be displacement + sail area. If, for instance, it were found that a 4-foot model of the length classes weighs approximately 40 lbs., and a 20-tonner, under tonnage rules, about the same, a class might be arranged for boats weighing (displacing) 40 lbs., and the sail area of, say, half a dozen cracks of both classes being taken, a mean sail area could be found. It would be necessary to add sail area, as, under a simple displacement or weight rule, boats of small displacement and large initial stability would immediately be constructed, and the sail area should be proportionate to the displacement, so that if a yacht of 20 lbs. weight was entered, she could only have a proportionate sail area of her class. The varying amount of sail area might either be taken from a mean of boats in actual use, or the rule that sail area varies as the square of the length of the boat on the water-line might be adopted as a basis. Amongst the many scientific men who are members of model yacht clubs, it should not be difficult to find those capable of formulating a rule which would be generally accepted, and any races in which boats representing widely different ideas could meet on equal terms, as far as measurement was concerned, would not fail to be highly interesting, and probably instructive, as it would give wide latitude for the production and testing of different theories as to what the best type of yacht really is.

CHAPTER III.

ON SAILS.

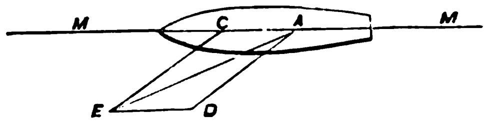
SAILS are quite as important, and require as much care and skill in designing and fitting, as the boat itself. Without them the vessel would be a mere lifeless log, and with ill-made and badly-fitting canvas, the finest yacht that ever was produced would have little or no chance against a far inferior craft whose sails were well made and properly bent and fitted.

It was at one time supposed that baggy sails held the wind, and were therefore the correct thing, but this was at last discovered to be a fallacy.

Perhaps nothing attracted more attention in yachting circles in '54, than the admirable fit and texture of the sails of the *America*, and it is probable that it was quite as much to the careful manner in which she was sparred and canvassed that she owed her speed, as to the form of her hull. It is now, however, a recognized truth, that to be effective a vessel's sails should be as flat as possible. Baggy sails, particularly when close hauled, cannot compare in value with a flat standing sail, for the parts bagging out are scarcely struck at all by the wind, but are filled with eddies from the adjoining parts, which eddies are useless as propelling power; besides which, it frequently happens that the after part of a baggy sail, when the sheets are hauled in, becomes a regular back sail, greatly retarding the vessel's speed, and in any case the flatter the sail the less lee-way a boat will make, even though, as is the case, the flat sail actually offers more effective surface to the wind than the other, for the wind strikes fairly on all the parts of the former, while on the baggy sail only a pressure in proportion to the angles is given; so that, should the wind strike such a sail obliquely, it will have little or no effect in driving the vessel forward, its greatest force, owing to the form of the sail, being utilized in driving the boat off to leeward. This will be better understood if we consider the reason why a vessel is propelled towards a desired point by a wind which is almost directly opposed to her course. Before looking at the amount and character of the force exercised by the wind on sails, it is necessary to define the expression "wind," which is rather carelessly used.

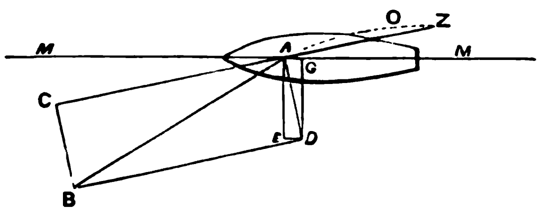
When considering the wind with relation to sailing vessels, we generally speak of its apparent motion. The real motion of the wind is its direction relatively to the earth; the apparent motion, that relatively to the ship when sailing. The apparent motion being the resultant of the real motion of the wind and of a motion equal and directly opposite to that of the vessel.

Let E C represent the real direction and power of the wind, and A C the direction and velocity of the motion of the vessel; then E A will represent in



magnitude and direction, the apparent motion of the wind. By the use of a diagram, as above, which is termed a parallelogram of forces, any one force can be resolved into two, and any two into one, and as the lines representing forces vary in length, so the forces they represent vary in value.

To find the effective impulse of the wind on the sail, two parallelograms must be constructed: the first resolving wind force into two forces, one parallel to the sail and the other at right angles to it; and the second resolving the force at right angles



to the sail obtained by the first into two forces, one acting at right angles and the other parallel to the vessel, which last is that part of the whole force of the wind directly useful in propelling the ship on her course.

Let B A be the direction and power of the wind on the sail A Z; construct the parallelogram

A C B D, of which the sides A C, D B are parallel and D A, C B at right angles to the sail A Z. D A will be the effective impulse of the wind. Construct the smaller parallelogram A E D G—G A being in the same plane as the direction of the vessel and G D at right angles to it; then D G, perpendicular to M M, is the component of D A, which produces heel and lee-way, and G A is the component of D A which propels the vessel along.

With a baggy sail, as shown by the dotted line, it is evident that that portion of the wind not effective in propelling the vessel forward, would be caught somewhere at O, and retard the speed of the vessel, while with a flat sail it could only cause friction.

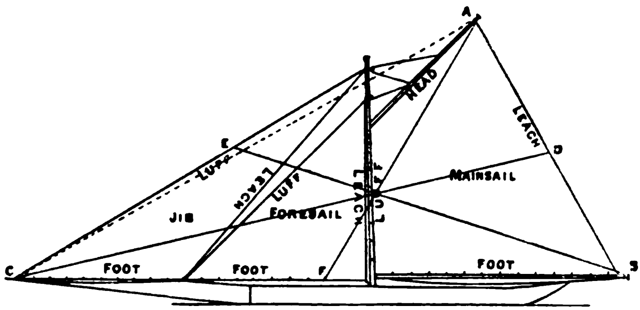
There is always a certain amount of difficulty in getting a really flat standing mainsail, as the gaff describes a greater angle with the hull of the vessel than the boom. Steamers and large vessels having fore-and-aft sails generally use vangs to haul in the gaff to the proper angle, and in this way are able to utilize their sail power, which otherwise would be to a great extent lost. But perhaps the best contrivance for making a flat standing sail, is the principle of Chinese battens, each batten being fitted with a sheet, all these sheets terminating in one or two hauling parts, which are led through an outrigger from the stern, to give sufficient drift to set the sail smart; by this means the sail can be hauled out as flat as a board, and the upper part remains very much at the same angle as the lower.

It is obvious that when a vessel is close hauled, only a small percentage of the wind is directly available; but against this, it must be remembered that when on a wind, the force of the apparent wind increases, while in sailing off the wind it diminishes; and therefore, although only a small portion of the wind when close hauled may be effective, its power is proportionately greater than if the vessel were off the wind.

The centre of effort of the sails, which is the point in which the whole force of the wind is supposed to be concentrated, is a most important matter for consideration, and it is as necessary to make proper sail plans as it was to prepare drawings before constructing the hull of the vessel. The principal points in connection with which it is necessary to consider the centre of effort of the sails is, firstly, with relation to the centre of lateral resistance (either before or abaft), and secondly, with relation to its height above the water-line.

A rough-and-ready rule of finding the centre of effort is given in the diagram, which shows a cutter's lower sails (the topsail does not affect the steering of the boat if properly cut).

A triangle is constructed the sides of which are the leach of the mainsail, A B; the dotted line from the peak of the mainsail to the tack of the jib, A C; and the base the foot of the mainsail, foresail, and jib, B C. From D, the centre of the line A B, draw the line D C; and from E, the centre of the line A C, draw the line E B; where the lines D C and E B bisect one another, marked O, is the centre of effort of the sails. You can also construct the line F A from F, the centre of the base C B, to the peak of the mainsail at A, which should bisect the lines C D and E B at the point O, as in the diagram.



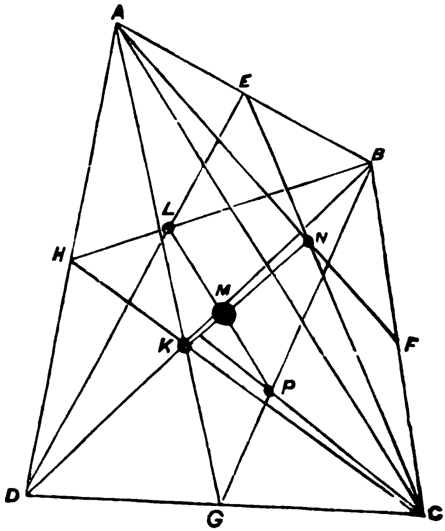
The sail-plan is roughly correct for a model built under length rules; but the headsails and bowsprit are far too large in proportion for a seagoing craft, or for most models built under tonnage rules.

Having found the centre of effort of your sail-plan, you must alter it, if necessary (by reducing or increasing one or other of the sails, probably jib or mainsail), until it (the centre of effort) is a little forward of the centre of lateral resistance. To one who has some experience these calculations are unnecessary for a model yacht, as your eye will generally guide you as to the proper place for the mast, and in what proportion to cut the sails; but yet some men with a great deal of experience are unsuccessful in this matter, and so their boats never sail properly, now luffing up into the wind, and then falling right off, but without making any real progress.

The above plan gives sufficiently accurate results for ordinary purposes, and to work out the centre of effort of the sails more correctly, it is necessary first to take the area of each of the ordinary working sails (lower canvas in cutters, &c.). The area of sails is more readily found by treating them as triangles, if triangular, as jibs, &c., or if trapeziums, dividing them into triangles, and dealing with them as such. To find the area of a triangle multiply the base by half the height. It is also necessary to find the centre of gravity of each sail. To do this, if the sail be triangular, as a jib, bisect the sides, and from these points draw lines to the opposite angles—the point where the lines cut one another will be the centre of gravity.

Let the trapezium A B C D represent a mainsail. Draw the diagonal A C, dividing the figure into the two triangles A C B, A C D. Bisect A B at E, draw E C. Bisect B C at F, draw F A, the point N where E C and F A cut one another will be the centre of gravity of the triangle A C B. Find the centre of gravity of the triangle A C D at K in a similar manner. Join N-K, draw the diagonal B D, and find the centre of gravity of the two triangles B D C, B D A at L P; join L P, intersecting K N, the point of intersection M being the centre of gravity of the whole sail.

Another way to determine the common centre of two or more sails is to draw a vertical line just ahead of the forward sail, and multiply the distance of the centre of each sail from this line by the area of the



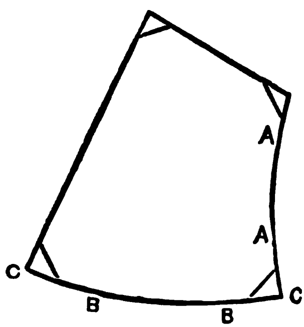
sail. Add the products together, and divide by the total area of the sails, which will give the distance of the centre of effort from the *vertical* line.

The next step is to find the moment of each sail, which is obtained by multiplying the height of the centre of gravity of each sail above the water-line into the area—the sum of the moments of all the sails divided by the sum of the areas gives the height of the centre of effort. To obtain the distance of the centre of effort from the middle of the length of the water-line or of the centre of lateral resistance, multiply the distances of the centres of those sails that are before it into their areas, which will give the position of the centre of effort either before or about the required point, according to which has the moments in excess of the other.

The centre of effort should be rather forward of the centre of lateral resistance, particularly in a model which has to steer itself, and therefore cannot sail quite so close to the wind as a real vessel.

The vertical height of the centre of effort of the sails above the L.W.L. has a great deal to do with the sailing qualities of a vessel. It is evident that the greater the distance between the load water-line and this point, the greater will be the leverage and heeling pressure exerted by the wind; while, when running before or off the wind, if the centre of effort is too high, it will cause the vessel to pitch and 'scend heavily, or to depress her bows under and lift her stern, while with the sails properly balanced, she should lift her bow slightly and depress her after-body when running. It is generally considered that those vessels which are full at the L.W.L. and clean below require the centre of effort higher than those which are more cut away at the water-line, and it is given by men of considerable experience that the proportion in which the moments of the sails of the fore-body of the vessel should exceed those of the after-body in relation to the centre of lateral resistance, is about 1 to ·75.

In making your sail plan, the character of the under-water longitudinal section of the vessel must be carefully considered. If she has little draft forward, she will need little head-sail, unless the light draft is compensated for by a raking stern-post and short keel, in which case a longer bowsprit will be necessary; but if your sail plan when completed, shows the centre of effort fairly low and slightly forward of the centre of lateral resistance marked in your sheer plan, you can proceed to cut out the sails with the assurance that they will not be far wrong. A model has generally, at least three suits of sails, dimensions of which are given (page 69): a large suit for fine weather, a second suit, and a storm suit. The sails should be made of fine close calico, without much dressing in it; linen is better, but of course more expensive. The topsails, at all events the larger ones, should be of lighter cloth than the lower sails; both the foresail and jib had better be cut in such a manner as to leave the selvedge of the cloth on the after-leach, while the luff should be strongly bound with narrow tape, to take the strain, as the foresail is frequently set flying (i.e. without a stay). Some model yachtsmen cut their sails with the selvedge up and down the luff, but I do not think the sail stands well. It will be better if the foresail and jib are fitted with a stout line running along the luff, and to which they are secured by small rings, just large enough to travel. One end of this line takes the hook for the bowsprit eye, and is sewed on to the tack of the sail, the other end passes up through the rings, and is made fast to the head of the sail, the halyards being hooked to the bight: this takes a great deal of strain off the sail and sets it well. In some boats which race under length rules, the head-sails are very large, the foresail coming half-way out on the bowsprit; while in others built under tonnage rules, the sheer-plan of the boat allows the head-sails to come more inboard, and the foresail is therefore carried as in real vessels, to the stemhead. The luff of all the sails should be slightly hollowed, as shown in the figure, as at

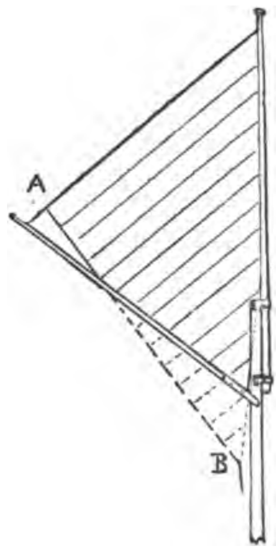


A A, as the strain on the sail soon pulls it straight, and the foot cut with a sole falling below the boom, as at B B. This applies to all the sails. The corners must be strengthened with extra pieces sewn in, and the tack at C should be rounded off—not as shown above.

The reason for hollowing the luff is to get the sail to stand flat; this plan does not answer with large sails, which in fact are made just the reverse, as the great strain at the head and foot of the mainsail, and the sheets of the foresail and jib pulls that part of the sail out more than the middle, but in models it answers well enough. At all events, however you cut your sails, see that they are flat. If you have a sewing-machine, it is not a bad plan to run diagonals up the sails from the clue, which plan helps to strengthen the sail at that point, where all the strain of the sheet comes.

The topsail is a very difficult sail to cut so as to stand well, and a square-header is the most difficult of any form of topsail. The jib-headers should be laced properly to their respective topmasts, and be thus kept ready for instant use. In planning a square-headed topsail it is best to let the yard come as nearly up and down the mast as possible; the greater the angle it describes with the topmast, the worse it will set.

The tack (B) of the jib-headed topsail comes below the jaws of the gaff, and therefore the foot of the topsail (A B) is longer than the head of the mainsail, though it comes out no farther on the gaff—in fact, it ought not to come out quite as far; and it also should be cut slightly lifting, as at A, leaving a little space between the clew of the topsail and the gaff end.

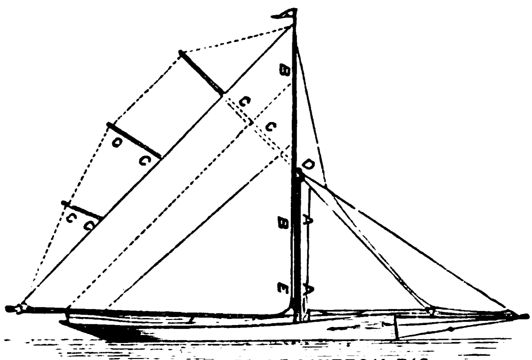


Square topsails with jack-yards are frequently used in racing. The jack-yard is a short spar used to extend the foot of the topsail beyond the gaff, so as to carry a larger topsail than could otherwise be set. The jack-yard comes in a little way along the sail, far enough that when the sheet is seized to the middle of the yard it is a fair lead for the block or sheave in the gaff end, and sufficient drift is given to sheet the topsail well out.

In model yachts the foot of the foresail and jib are laced to booms, and it must be seen that while these booms clear everything so as to swing freely, they are sufficiently long to extend the foot of the sail properly. It will be found after the sail has been some time in use, that the foot will stretch a good deal; on the main boom there will be a proper traveller, so that the foot of the mainsail can be hauled out as required, and when the boat is put up after sailing the traveller should be eased off, or the mainsail will, as it dries, take an unfair strain which will probably spoil it.

With sailing models, and also with canoes, it is much better if the sails can be left all standing, each suit having its own mast, spars, and appurtenances, with the exception of those which can be common to all. Models so fitted, particularly those boats which are kept with their gear standing, have a great advantage over others which are rigged and unrigged each time of sailing, as the latter lose some little time in finding the exact trim, and their sails do not stand so well. If, however, it is necessary that the boat should be rigged each time, it will be desirable to have separate bags—something of the shape of those in which fishing-rods are kept—for each suit of sails, with the respective spars and gear, and let each bag be marked with the number of the suit. It certainly gives some trouble to get all the suits complete in every detail, but once this is accomplished, your boat is always ready, blow high, blow low, while those who do not care to sit down and complete these minor details are generally in trouble at every little blow, finding it necessary to make out all kinds of jury rigs and temporary devices, not doing the boat justice, and taking up time which might be more enjoyably passed in sailing.

A good many years ago I had a rather narrow model that did not like a long gaff, though under suitable canvas she was there or thereabouts with those of her own size; advantage was taken of this to rig her in a fashion I never saw before or since in a model, though I recently observed a similar contri-



LEG OF MUTTON RIG.

vance fitted to the American "Mohican" sail. My method was as follows: The boat was first fitted with a good lower mast, not very long, and a good stout boom, which was always left standing even with the storm-suit, as it was useful to handle the boat by when turning her, though there is no doubt but that when it blew hard she would have gone easier with a lighter boom. The sails were all leg-of-mutton shape, fitted with one batten C C almost where the gaff would be in an ordinary sail (as in the diagram), as this form, giving a very low centre of effort, suited the boat; but if the rig were used for a stiffer craft, it would be advisable to bring the sail out as shown in the dotted line, and fit more battens, as shown C C, C C.

The mast is shown at A A and the yard to which the sail is lashed at B B. At E there is an eye-bolt

in the mast, or better still a metal band round it with an eye aft, to receive a strong pin in the heel of the yard B B, which is secured to the upper part of the mast by a metal band on the yard, which slips over the masthead. If this masthead is squared, and that part of the band which is slipped over it is made also square to fit, it will prevent the yard slipping round the mast, as it sometimes does if masthead and band are round.

The great advantage of this rig is the ease with which the mainsail is shifted when necessary, there being no topsail or topmast. The yard is best made of bamboo.

When drafting the sail plan of a model the following may be found useful. They are the dimensions of the various suits (three in number) of a three-foot boat under length rules, of rather smaller displacement (about 20 lbs. *lead* being 17 lbs.) than the design given, which would require larger canvas. The dimensions of the boat to which the sails belong are 36 × 10¾ × 5½, length and beam taken on L.W.L. extreme beam on deck being 11¼ in. and depth taken to top of keel, extreme draught being 8 in. The suits are, No. 1 for light weather; No. 2, strong breeze, equal to single reef in real yachting, and No. 3, storm suit. Some boats have an extra set of very small storm canvas, making four suits, and this boat's No. 3 suit would be too much for any but a stiff craft of the same class.

		No. 1.	No. 2.	No. 3.
Mainsail	luff	32 inches.	24 inches.	21 inches.
	head	18 "	16 "	14 "
	foot	32 "	32 "	29 "
	leach	45 "	40 "	36 "
Topsail (jibheaded)	luff	32 "	29 "	27 "
	leach	21 "	20 "	18 "
	foot	21 "	18 "	16 "
Foresail	luff	36 "	33 "	30 "
	leach	29 "	27 "	24 "
	foot	19 "	19 "	18 "
Jib	luff	45 "	42 "	36 "
	leach	31 "	30½ "	28 "
	foot	20 "	17 "	13 "

The above, as far as the proportionate size of the headsail is concerned, would not do for most models constructed under tonnage rules, and in any case it is advisable to draft out a sail plan for the individual boat, and see that the centre of effort of the sail plan is in the right place with relation to the centre of lateral resistance of the boat, and also as to its vertical height.

CHAPTER IV.

SPARS AND RIGGING (MODELS).

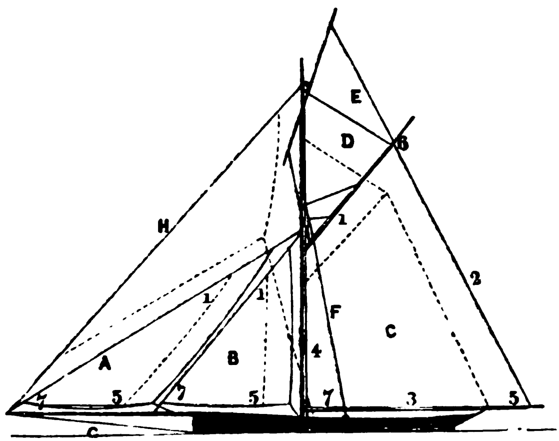
ALTHOUGH the hull of the model yacht may differ in form from the real one in some points, such as the rake of the stern-post, the length of the keel, etc., it is in the spars and sails that the small vessel departs to the greatest extent from her big sister.

The length of the spars and the amount of canvas carried by a model, is out of all proportion to that which a real yacht is able to stand up to. And then, besides this, the length of the bowsprit and the size of the head-sails carried by the one, are absurdly large if compared with the other. The reason for this is that the model, when sailing on a wind, has to be steered by her sails alone, and this necessitates large head-sails.

Some few models, however, have their sail plan on a similar scale to real yachts, and are sailed to windward by means of a small balance rudder, but they cannot compete with the regular racing models.

The spars of a model should be as light as possible, consistently with the requisite strength, and the rigging cannot be too simple. The sketch given will show the rigging necessary for a model cutter.

F is a light shroud—in large models it is as well to have two of these; G, bobstay; H, topmast stay—these comprise all the needful standing rigging,



no forestay being required, as the foresail is set flying—backstays or runners can be fitted, but if they lead much aft they are in the way when the boom is eased off. A the jib, B the foresail, 1 head, 7 tack, 5 clue; C is the mainsail, 1 the head, 2 the leach, 3 the foot, and 4 the luff, 5 the clue, 6 earing, 7 tack; E shows the square-headed topsail; D the jib-header.

The dotted line from H shows the jib topsail or staysail, only used in very light winds. The above are the largest suit of sails for fine weather.

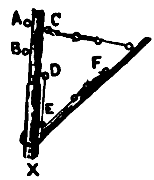
The dotted lines on the respective sails show the approximate size of the smaller suit; but the head-sails of this suit would be set in on the bowsprit, so that the foresail would just clear the mast, and the jib just has room to clear the foresail.

The position of the mast is an important element in the success of the model; as to this, you must be guided by the character of the model requirements of your sail plan. It is, however, not a bad plan to cut a slot in the deck, a couple of inches fore and aft of the ordinary position of the mast; over this slot, which is just wide enough to take the mast-casing, is fitted a piece of brass plate with a corresponding slot cut in it, about six inches long and two inches wide (this is for, say, a three-foot model), the sides of which are turned up to receive another piece of sheet brass, cut to fit over the slot and travelling between the turned-over edges of the plate. This second piece need only be about three inches in length, and is pierced in the centre by a hole large enough to take the mast-casing, which is a tube made of brass, with a flange round the top edge.

The casing is fitted at the lower end with a strong steel or brass pin, which may be secured by lead run in, or a wooden plug.

The mast-step for this arrangement is made as follows: a piece of wood about eight inches long and two broad, is shaped to fit the boat's bottom, and on this is fastened by screws at each end a piece of brass plate, drilled at intervals of about a quarter of an inch, with holes large enough to take the pin at the bottom of the mast-casing; these holes also go through the wood, which may be an inch thick.

If your boat is fitted in this way, it is very easy to shift the mast slightly forward or aft, as occasion may require; and, at the same time, if all the parts are properly made, no water can get below. In any case, it is desirable to have a mast-tube, which keeps out the water, and allows the mast to be shifted with ease, which is not always the case when no casing being used, the mast and deck are swollen by the wet. The head of the lower mast is fitted with a short piece of brass tube, half of which is housed by the mast, and the other half receives the heel of the topmast, and by filing this tube slightly you can bore holes with a bradawl to screw in eyes for the halyards, thus:—



X is the brass tube.

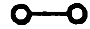
A, ring for jib halyards.

B, „ foresail ditto.

C, „ peak halyards for mainsail.

D, „ throat ditto ditto.

A square brass case is better than the tube, as it prevents the topmast shifting its position.

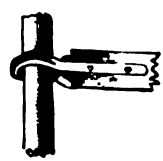
The throat or main halyards have a hook at D, the standing part is then led through the ring at E on the gaff, and passed through the ring F on the upper part of the gaff, and a euphroe having been previously slipped on the standing part, the hauling part of the halyard is brought back through F and made fast to the upper ring of the euphroe, by sliding which up or down, the halyard is eased off or hauled on. The euphroe is an important feature in the rigging of model yachts. It is the same in principle, though perhaps not in form, as those which are used to tighten tent ropes. You can make them either of wood or wire (copper wire is the easier to work), bending the two eyes, thus: 

To use them pass the end of the halyard through *both* eyes of the euphroe, then through the eye of the hook, and then back to the lower eye of the euphroe, and make fast, thus: 
By sliding the euphroe up and down the halyard you can slacken it or make it taut, as you like.

A better form is that with three rings, the standing part being made fast to the middle one, the running part passing through those at the ends.

The mast, bowsprit, and boom should be, for a three-foot model, about five-eighths of an inch in diameter, tapered towards the end very slightly from about the middle. The gaff may be three-eighths of an inch at the jaws to a quarter of an inch at the gaff end. The boom must be fitted with a piece of copper wire bent round the mast, and with ends riveted or otherwise secured to the boom, thus: 
The jaws of the gaff can be fitted the same way, only in two pieces, not joining in a ring round the mast.

Or you can take a piece of stout copper wire as for the horse, and beat out the ends and bore them; you can then bend the wire, pass a short piece of copper wire through the holes into the gaff, and rivet on, thus:



The gaff-ring had best be bent at an angle, to prevent it jamming on the mast, thus:

The boom ought to be fitted with a traveller and outhaul to hook on the clew, thus:

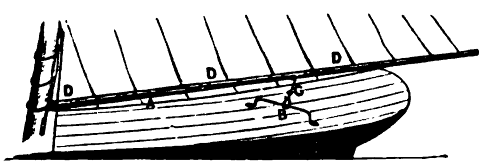
C is the boom.

A, the hook to the clew of mainsail.

B, traveller ring on the boom.

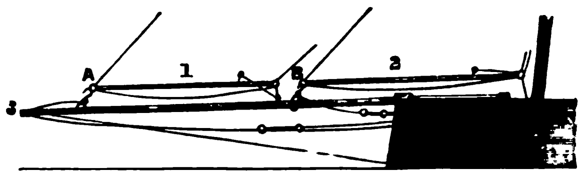
D is the outhaul which you pass through a hole in the end of the boom, and fit with a euphroe and hook somewhere at E, so as to haul the slack of the mainsail out.

Small holes must be bored along the boom to fit a pin in with an eye; the holes should be just large enough to receive the pin, to which one end of the sheet is attached. The holes after being bored should be burnt out with a hot wire, as otherwise they are liable to close up if wetted. A neater way is to fix a cleat of hard wood on the side of the boom and bore the requisite holes in the cleat. The pin may be of brass, and must have an eye at one end. The end of the main sheet is passed through the eye, and made fast; you can then shift the pin from one hole to another, and adjust your sail, thus:—



A is the pin. B, the horse on deck. C, the main sheet. D, the boom.

By-the-bye, all the *ropes* that you let out the sails by are called sheets, and not the *sails* themselves; you pass the main sheet, at C, through a ring in the boom before putting the pin on; fasten the end of the sheet to a clip-hook (see p. 147), which you can slip on or off the horse. The bowsprit is also fitted with travellers, thus;—



A B, jib and foresail travellers; the outhauls lead inboard and are hooked to a ring-bolt on deck; with the euphroe fitted to the outhauls you can haul the travellers in or out on the bowsprit and thus set storm sails, or by having a long bowsprit alter the position of the larger ones if necessary. A distinctive feature in models is that the headsails (jib and foresail) are fitted with booms; this is absolutely necessary to work these sails with proper effect.

Besides the standing rigging already mentioned, a couple of bowsprit shrouds are requisite as shown in the sketch just over the bobstay; these are fitted with euphroes, the end of the standing part made fast at the bowsprit end and the fall hooked to an eye-bolt at the side of the vessel in the bow.

The end of the bowsprit is fitted with a brass band which carries four eye-bolts; the lower one carries the bobstay, the upper the topmast stay and the fair lead for the jib traveller outhaul, while the bowsprit shrouds are hooked on to those at either side.

One end of the standing part of the halyards of the jib is made fast to the head of the sail, and the other end passed through the eye of a brass hook, and made fast to a euphroe which has been first rove on the halyard; another hook with an eye is now fitted above the euphroe so as to travel on the halyard; this hook is hooked on to a ring in the masthead (see A, masthead fittings, and the fall led down to a ringbolt on deck, or in the mast), where it is hooked on, and the halyard taughtened up by the euphroe. The foresail can be fitted in the same way.

If there is enough drift between the head of these sails and the masthead bolts, another way is to have a short halyard fitted with a euphroe and hook, the fall being hooked to the eye in the masthead.

The jib sheets can be long, in which case they are double, the ends being made fast inboard, the sheet being first rove through an eye in the boom of the jib; but they are usually short, one end being fast to the boom, and a pin being secured to the other end. This pin is passed, with the sheet attached, through an eye in the bowsprit, as shown at B in bowsprit fittings, the pin being then placed in one of the holes in the boom. Both jib and foresail booms are fitted with holes in the same manner as the main boom.

It makes a better lead if, after the sheet is fast to the ring in the boom, you pull the bight through this ring, and fit a hook on the bight, to hook on to the eye-bolt in the bowsprit; in this case the eye at the head of the pin must be sufficiently large to prevent it passing through the ring in the boom. Some models are fitted with a wire horse across the bowsprit for the jib sheets to travel on, each end of this horse being steadied by the bowsprit shrouds passing through a ring which is placed at the ends of the horse for the purpose.

Long jib sheets can also be worked by the main boom. For this four eye-bolts are necessary, two being fitted opposite each other forward, so as to give a fair lead, and two aft about midway between the mast and the taffrail. The port sheet is led through the port forward eye-bolt, and then across to the starboard after one, thence to the boom and the starboard sheet leads in the same way, so that when the mainsail fills, the lee jib sheet is hauled taut, and the weather one paid out; and if the boat comes up in the wind the jib sheets are flattened in, and the jib pays her head off.

The sheets may be in one piece, the ends being led through the fair lead on the bowsprit, and secured to a hook, which is hooked to the ring in the boom of the jib; and the bight having another hook clear of the after eye-bolts, by which the sheet is made fast to an eye in the boom.

The peak and main halyards can be short, as shown in masthead fittings, or long, as described for the jib halyard leading down to the deck.

The topsail sheet may lead through an eye at the gaff end with a hook (big enough to prevent it coming through the eye) to make fast the clew of the topsail; the halyard is fitted with a euphroe below the eye, and the fall hooked some way down the gaff, far enough to give sufficient drift to sheet home the topsail.

The tack of the topsail is fitted with the euphroe and the fall led down on deck, or, at all events, far enough down the mast to give drift enough to set the sail smart.

Topsail halyards may be used, leading through a small ring or sheave at the masthead; but this is only needed to set the square topsail, in which case a traveller on the topmast is useful. Jib-headed topsails are nearly always laced to their respective topmasts, which are stepped "all standing" into the tube or cap at the masthead.

It is not at all necessary to carry a topmast stay, which only holds the wind; a better plan is to have a short stay, one end of which is fitted to the top-mast head, and the other rove through a euphroe and fitted with a hook. The jib halyards are so led that when they are hauled taut, the after part of the foot of the jib towards the clew, falls below the line of the bowsprit. When all the other sails are properly set, the fall of the short topmast stay is hooked on to the head of the jib and bowsed up until the foot of the sail clears the bowsprit.

By this means everything is set smart, and the short stay close to the mast is far neater, and a great deal more useful than the ordinary one the full length.

An easy method of making hooks used in rigging is to take a brass chain of the required size and open out the links.

On the Round Pond, Kensington, and some other waters a spinnaker is used on racing models. This sail is always part of the outfit of a large racing yacht and of most cruisers, but on models it is troublesome to work. It is only used right before the wind or on a broad reach. There are two kinds, a bowsprit spinnaker and spinnaker proper.

The bowsprit spinnaker is a large triangular sail reaching from the masthead to the end of the bowsprit, and filling up all the space occupied by the jib and foresail, which of course are stowed when it is set. It is a fine sail for pulling a boat along off the wind, but is of no use in beating to windward. The spinnaker proper (the same sail is frequently used for either purpose) is of the same shape and is set on a spinnaker boom, which is secured to the side of the mast by a gooseneck almost in a line with the boom. This spinnaker boom in cruising yachts is short enough to swing under the forestay, but racers carry a long boom, which has to be unshipped and dipped under the stay when the sail has to be shifted to the other side.

When the sail is set the spinnaker boom extends out on one side of the boat and is kept in its place by a sheet leading aft, and also by a preventer guy to prevent it rising.

The main boom is carried on the opposite side with the sheet eased well off; should, however, the mainsail gybe it will smother the spinnaker and render it useless; this would not be allowed to happen on a large yacht, but might easily occur in a model.

For this reason and the trouble of setting it, I do not think it much use in model racing. The bowsprit spinnaker might, however, be used where there is a large extent of water allowing a long run to be made before hauling in the sheets to beat back, when it must be shifted for working the foresail and jib.

Another sail, which, though of great use on real vessels, is hardly suitable to models, is the balloon foresail; this sail is generally so large as to sheet considerably aft of the rigging; it holds a great deal of wind, and is a famous sail to pull the craft along, and as its hoist is only about the same as an ordinary foresail, it is a handy sail and easily managed.

CHAPTER V.

MODEL SAILING.

MODEL yachts may be roughly divided into two types, those built under length rules and those constructed to meet the requirements of a tonnage rule. There is as much diversity between these two classes of boats as there is in real yachts between the three and five tonners and the thirty foot classes.

The boats built under tonnage rules are generally long, with limited beam and great draught of water, while the others are comparatively short in proportion to their beam and have only a light draught.

Owing to the great difference in the boats, their sail plan is also very dissimilar. The "length" boat with a considerable amount of gripe forward, an enormous mainsail, and a short keel, needs a long bowsprit and large headsails; whilst the other, having a long easy bow and drawing little water forward, can carry her head canvas more inboard; besides which the model built under length rules has generally a large proportionate spread of canvas, and owing to the shortness of the boat, her sail area has to be disposed in a form that gives a high centre of effort, which, particularly when running, tends to depress the bows of the boat, and in a strong wind it is a common thing to see such a model bury herself forward to the mast every now and again, when pressed by an extra strong puff.

The longer "tonnage" craft has the great advantage of being able to spread out the area of sails longitudinally, so as to obtain a much lower centre of effort, with as much driving power.

There is no doubt but that the more lofty canvas may in some waters, surrounded with trees, have the advantage, but that is only fluking, and to get fair results, open water without any shelter is the only true means of testing the comparative speed of models.

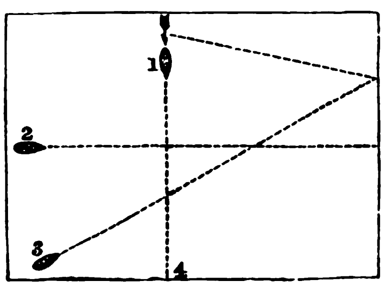
Both types, however, resemble each other in one important particular, and that is, that having no man at the helm, they require to be steered by the sails alone, and therefore it is a matter of the greatest importance that their sail plan should be so arranged that the centre of effort of the sails is in its proper position as regards the centre of lateral resistance of the boat. And now as to sailing. The diagram shows :—

1st, running before the wind, or wind abaft.

2nd, reaching, or wind abeam.

3rd, tacking, or sailing on a wind close-hauled.

The arrow shows the direction of the wind.



The bottom of the square, marked 4, is what is called a lee shore, that is, with the wind blowing dead on it.

Now any ordinary boat can cross and recross a pond with the wind abeam, as at Fig. 2; but if you take her to the lee shore and start her off, will she successfully tack up the pond against the wind? This will entirely depend on the boat's weatherly qualities, and on the trim and cut of the sails; no boat is of any value for sailing unless she will go to windward.

The first thing to do when a new boat makes her *débût* at the pond is to get her in proper trim.

It will be necessary to find out if she is ballasted to the best effect, whether she is a little too much by the head or stern, or has too little or too much lead on her.

The sails will also require close attention, and it will take some little time to find out just the right hole in the boom for going to windward, and when it is found, it should be marked so that there is no unnecessary trouble next time.

The fore sheet may perhaps give a little trouble, as it may jam every now and then, boxing the boat off the wind, and making her lose all she had gained to windward; this must be remedied.

It is not a bad plan to put a small piece of cork under each side of the fore-horse to keep the hook of the fore-sheet from jamming in the curved corner.

The jib sheets, too, will need attention; see that they have a fair lead, and remember that as large jibs are shifted for small ones, or *vice versâ*, the sheets need alteration, as the angle they describe is different, and what you want to find is the exact angle which suits the boat best, and at which the jib does the most work.

If the mainsail is new, it will do it no good to stretch it out much at first. It must be got out little by little along the gaff and boom until it sets smartly.

The topsail, which is a difficult sail to cut well, very frequently sets badly at first, and if it is badly cut there is no help for it but to make another; perhaps it is cut too low at the clew and the leach flaps about, the sail doing no good.

If a topsail sets badly it is much better off the boat, for it stops her way and she will go quicker without it. If, however, the sail seems all right but yet does not set just as you like, it is not a bad plan to ease off the peak halyards a bit and let the weight of the mainsail come on the topsail sheet. If the sail is any good at all, this ought to set it.

In sailing you must remember that the tendency of headsail is always to pay a vessel's head away from the wind, and of the mainsail or other aftersail to bring her up to windward or luff her up.

Thus, if she luffs too much, haul out your head-sails on the bowsprit, or first see if she has enough main sheet; the boom ought not to be right in the centre of the deck, but given a little room to swing.

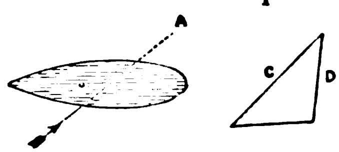
If she pays off to leeward, perhaps your main sheet is too slack, or your headsails too big. This you will have to find out, and in heavy winds you can put on a smaller jib, which, if hauled well out on the bowsprit, will steer her as well as the big one.

When blowing hard, however, you will find it necessary to give a little more jib sheet than in moderate winds.

The less water a boat draws at the bow the easier she pays off from the wind, and the more she draws aft the steadier she steers, and the better she carries her mainsail.

Although any form of hull can be made to keep its course by canvas properly planned and balanced, yet, as a rule, if a boat has much rake on her stern-post she is apt to luff up and is difficult to keep out of the wind, needing a long bowsprit.

A boat in the position shown in the diagram,



with the wind from the arrow, with a raking stern-post C, would fly up in the direction of the dotted line, her head up in the wind and her stern off to leeward at A; but the extra deadwood, C D, given by having the stern-post at D, offers a much greater amount of lateral resistance, counteracts the effect of the mainsail, and the boat goes steadily on her course.

In fitting the foresail be careful that the jib clears it so as to swing easily.

You can get little brass screw-eyes at most shops; hooks you can easily make by buying a little brass chain and opening out every other link; for the mainsheet a bootlace or gutta-percha cord will do best, as it will not kink; while fine fishing-line or whip-cord will do for the running rigging.

To run down the wind, you have to hook the stern of the boat towards you by the turning-pole and put on the balanced rudder, taking care that you use the one suitable to the sail the boat is carrying, and the power of the wind. When the rudder is on, unhook the mainsheet that is used when going to windward (which generally hooks on the horse right aft).

The sheet used for running is a standing sheet, secured to the boom rather aft of midships, and the end fast to a ring-bolt in the deck—this sheet is just long enough to let the boom almost touch the shrouds. Of course you might use only one mainsheet, or have some other system altogether, but when racing it is found convenient to be able to hook on the rudder, unhook the mainsheet, and shove the boat off at once—the second sheet being adjusted, before the race, to the required length.

This, however, is only one way of sailing, and you will probably find that each club has its own pet way. In some clubs, for instance, if the person turning a boat moves his feet whilst turning it, the boat is disqualified, and a very good rule too, as it prevents an anxious owner from helping his boat some feet up the lake with a wooden wind.

When the boat is put before the wind the pressure of wind in the mainsail forces the bows to windward, and at the same time heels the boat over, when the weighted rudder immediately falls over to leeward and the boat pays off again before the wind; and if therefore the rudder and sails are properly counter-balanced, the boat will run dead before the wind, or nearly so.

The system of gilguys attached to the main-boom, and working the jib sheets, described in Rigging, will be found very useful in keeping the boat out of the wind.

Another plan is to have a small lazy sheet to the foresail, which passes through a hole in the deck, and to the end beneath the deck is suspended a small leaden weight; this weight must, of course, be properly adjusted, so as not to prevent the foresail filling even with a light wind, but if the boat heaves up in the wind, the weight hauls the foresail in flat, and backs the yacht off.

As a general rule, in sailing models it will be found well to have the jib sheeted home to a certain point, the foresail may have a little more sheet in proportion, and the mainsail the most of all.

The reason for this is that the mainsail tends to steer the boat up in the wind and the headsails to pay her off; if, therefore, the headsheets were eased off more than the mainsheet, when the mainsail filled the headsails would be shaking and have no power until they filled again, and before they did so the vessel would probably heave about on the other tack, fill for a moment, and again fly up in the wind with the head canvas all shaking, and it may be a long time before a boat so trimmed comes to shore.

It is no uncommon thing for a craft in this position to go on backing and filling, and at the same time drifting slowly down the lake until she reaches the lee shore; while she frequently picks up several other craft to keep her company, much to the annoyance of their owners.

By, however, pursuing the system of giving the mainsail the most sheet, the headsails are full before the mainsail is, and though the mainsail presses the boat up into the wind, the headsails are in a position to counteract the tendency of the aftersail, and if the sails balance, the boat stands in no danger of getting in irons, as was the case with the other model.

To sail models with comfort to the owner and justice to the boat, it is absolutely requisite that all the gear should be thoroughly overhauled at home, or in the boat-house, when leisure can be obtained, so that the little craft is always ready to meet any contingency of wind or weather; each suit ready with all spars and gear, and plenty of spare gear, such as bobstays, runners, &c., at hand to replace those carried away, while it is not amiss to have two large bowsprits, and one or two small ones for the storm suit; for a bowsprit may carry away at any time, and if there is nothing to replace it, the afternoon's sailing is spoiled.

It is of course possible to rig up jury spars, but this takes time, and they never answer as well as those properly made and fitted.

Jury spars, scotch reefs in a jib instead of shifting for one suitable to the weather, and all tinkering-up of models at the water-side, shows a want of careful preparation and forethought that is prejudicial to the success of any boat, however well designed, and uses up valuable sailing-time for work that can be far better done in the evening at home, or on a wet afternoon at the boat-house.

The old motto is not a bad one to apply to model sailing—"A place for everything, and everything in its place"—and if a boat is well designed, carefully rigged and sparred, with well cut and flat standing sails, and above all skilfully handled, she will be generally seen to be in her rightful place, well to the front.

It is of such craft that the vanguard of every model fleet is composed, whilst the stragglers, under jury spars, jury canvas, make-shift rigging, and hulls which are always undergoing repairs, not yet completed, are very much where the little boat was in the Rabbinical legend, "a long way astern."

CHAPTER VI.

SAILS OF BOATS, CANOES, ETC.

SHOULD your boat be one intended for rowing, and you merely wish to have a sail to avail yourself of when the wind is fair, it is not of so much consequence as to the sort of sail you use. This applies equally to a canoe of the same description. For such a boat you must study convenience, in stowing the mast and sail away, and perhaps the best form of sail will be—for a boat, a lug or lateen, and for a canoe, a simple standing lug, thus:

Fig. 1.

Fig. 1 is a simple standing lug, so called because it is not shifted on each tack as an ordinary lug has to be. In the ordinary lug the luff runs in the direction of the dotted line, and the tack is made fast forward of the mast to the windward side of the boat. In the standing lug the tack comes short at the mast at A. The luff of the sail is cut very short and the head given a good deal of peak, which make the leach very much longer than the luff

The head of the sail is bent to a small yard, and the halyards, which lead through a sheave in the mast, are seized to the yard so as to set the sail smartly. It is necessary to get the yard slung just in the right place or the sail will not set. You will have to shift the seizing along the yard until you get it fairly slung—about one-fourth from forward will generally sling the yard properly. This sail is most suitable for any ordinary canoe; for racing canoes different and larger sails are used.

Fig. 2

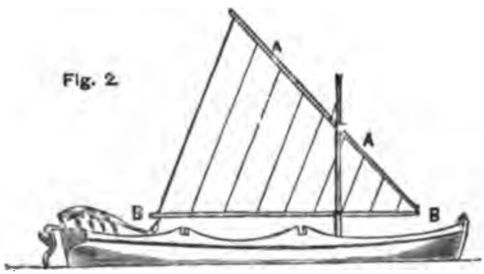
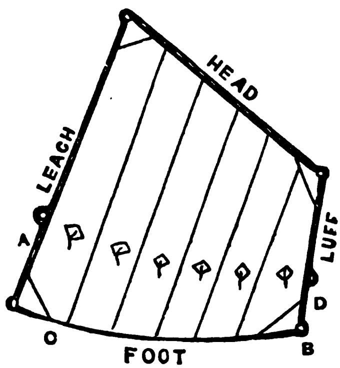


Fig. 2 is a lateen sail. This is a very handy sail for rowing-boats, particularly with a fair wind, as the sail being on a boom swings across the boat and sends her along very steadily. In a squall, however, it is more dangerous than the lug, as it has a boom, and letting go the sheet may not spill the wind out of the sail, which it will certainly do where no boom is used. The sail is laced to a yard at A A and there is a boom at B B. The halyards are bent in the same manneras the lug.

To construct the sail plan you must measure what sized spars are easily stowed away, and having determined this, mark off on a piece of paper the length of the mast, say on a scale of one inch to the foot; you must also draw a sheer plan of your boat and put the mast in the position you intend it to be. When sailing is not desired (by sailing I mean beating against the wind in contradistinction to merely putting up a sail to run before the wind, or on a reach), it is best to have the sail as small as possible, as it is more easily stowed, and, what is of the greatest importance, far safer, if your boat is not constructed or ballasted for large sails, by the use of which in such boats most of the deplorable accidents one hears of occur.

Put your mast as far forward as you can, as the boat runs better and steadier so, and you have more room aft to sit comfortably. You must next mark off the length you intend the foot of the sail to be; now mark off the luff and then the head of the sail, with the peak (i.e. angle from luff to leach) you intend giving it. Then mark the leach.



You can now see how the sail looks on your plan and alter it if required. When completed to your satisfaction, you have only to multiply your measurements by twelve to get the size in feet your sail is to be.

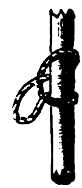
The best thing for a small sail is twilled cotton sheeting, as it is cheap, and you can get it broad enough to make a small sail without much if any joining. You will have to get stronger stuff for larger sails; light duck is the best. The breadths must be cut out, commencing with the after part of the sail, which had better be in one length, and each piece must overlap so as to allow it to be firmly sewn together. For large sails two rows of stitching are required side by side to each seam. You must have reef-points in the sail if it is a large one—either a narrow band of the same material as the sail or little tabs of canvas must be sewn each side where the reef-points come, and a small hole made in the middle of the tab through the sail, properly sewn round, and the cord for the reef-point cut long enough for each side, and then passed through the hole so as to allow an equal length each side of the sail, and sewn firmly to the sail where it passes through the hole. The sail must also be turned in and sewn at the head and foot. When finished it must be roped. A thin piece of good rope or cord, according to the size of the sail, is taken, long enough when shrunk with wetting to go round the sail, allowing for cringles at each corner and for the reef.

The roping is only continued as far as B on the foot of the sail, and tapered off there to nothing, the foot of the sail being simply turned in and sewn, and it is desirable to carry it further up the leach than the upper reef cringle. At each corner of the sail a triangular piece had best be put in on each side and firmly sewn; small pieces will do at the head, but at the tack, and especially the clew, where the sheet is made fast, the pieces must be large and strong. Along the head of the sail small holes must be made and sewn about six or nine inches apart, to lace the head of the sail to the yard.

In a small sail this may be saved by lacing with a twine-needle under the roping of the head. The roping must have the small brass cringles put at the proper places and the rope seized at the nip to secure them; the ends of the rope are then whipped and the roping placed round the sail and neatly sewn to it over and over with tarred sail twine.

The yard of a lug is fitted thus—

with two little stoppers at A A (which must be the thickest part of the yard to take the strain), to keep the sling in its place. The sling is merely a small grommet spliced and reeved so:—



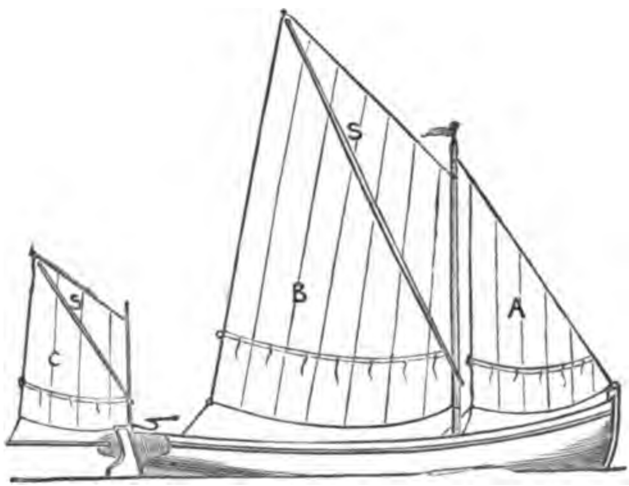
It is then pulled taut and is ready for the halyard to be made fast with a hitch. In a small sail you may make the halyard itself fast to the yard. A traveller made of galvanized iron is generally used to slide up and down the mast, to which traveller the halyards are made fast; the sling on the yard is hooked on to the traveller, which has a small hook for the purpose. The mast must be long enough to allow of sufficient drift (i.e. length of halyard) to the yard from the sheave to set the sail properly.

The sheave is put into a hole cut in the masthead to receive it, about four inches from the end of the mast, and a small hole is bored in the mast to push the pin of the sheave through, on which the sheave works, thus:—

You had best fit a small iron or wooden cleat, thus—

on the mast, to belay the halyard to, and have a small eye-bolt to lash the tack to, or pass a grommet round the mast for that purpose. In this way—all the fittings of the sail being secure to the mast, above the thwart—you can if necessary, at once lift out the mast, sail and all, which is often very desirable—for instance, when

Spritsail.



A, Foresail; B, mainsail; C, mizen or jigger; S, sprit.

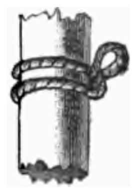
shooting a low bridge. The sheet you should never make fast, but hold it in your hand, ready to let go in case of a squall.

For boats intended for sailing there are of course many rigs suitable to different kinds of hulls.

One of the simplest for a small sailing boat is the spritsail.

The sprit is a light spar made long enough to set the sail properly; the ends are tapered down suddenly, thus:—

One end is put into the peak cringle of the sail, and the other into a snotter on the mast, which is merely a grommet passed round the mast in the same way that the sling was passed round the yard of the lug. The grommet must be of such dimensions that when passed round the mast, and the bight pulled through, there is only enough room in the bight to receive the end of the sprit; thus the strain on the bight jams the hitch and keeps it from slipping. Should, however, the grommet be too large, you have only to seize one end of the bight, leaving enough room for the end of the sprit to fit in. You have only to take out the sprit and slip the grommet up or down the mast to get it in the exact position requisite for setting the sail.



When you reef the sail the snotter must be lowered down as far as the depth of the reef taken. The luff of the spritsail must have small holes, as in the head of a lugsail, for lacing to the mast.

A mizen is very useful as a steering sail, and also a very nice little sail in an ordinary rowing boat. When rowing with a strong wind a little on the bow, it can be set close-hauled, and keeps the boat from falling off as the wind presses against her bow, and off the wind it helps the boat considerably. In carrying a mizen, if you use a tiller the mizen-mast must be stepped a little on one side, and the tiller made of iron, with a curve in it to allow it to be put over. The mizen-mast must be stepped as near the stern as possible, as the farther forward it is the greater the curve needed in the tiller. A lateen with boom makes an excellent mizen for a rowing-boat.

Manilla rope you will find about the best to use for stout rigging; for the finer running rigging any good strong woven cord that will not kink when wet, will do.

The mast may be fitted with a small truck—i.e. a round piece of wood with a square hole cut in the middle to fit the top of the mast, which is squared to receive the truck. At one side of the truck is fitted a small brass sheeve to take the signal halyard, to which you can bend your burgee.

Among the many descriptions of sails that are used by canoists, the simplest is perhaps Mr. MacGregor's lug, which is shown in the "Rob Roy" description, and with it hoisted you see on page 193, the canoe gently gliding along over the placid surface of a lake, and the owner indulging in pleasant day-dreams after hard work. This sail is a most useful one, and under the modified form of the balance lug is largely used in sailing canoes and larger sailing boats.

Fig. 1 shows a balance lug with Chinese battens. If the lug is required pure and simple, the yard

(K K) would be shorter and more peaked—that is the end at O would be raised more in the direction of P, and the luff (K A) would be shorter. When Chinese battens are fitted, a larger sail can be, carried than without, and by an arrangement of lines to bring one batten down on to the other the sail is

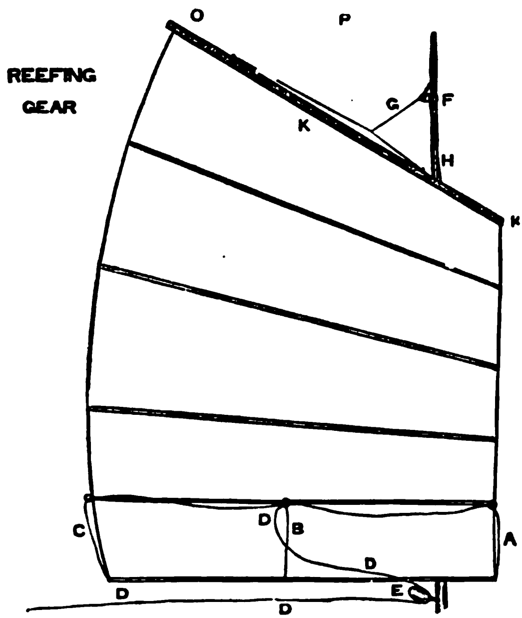


Fig. I.

very easily reefed. The battens are made of bamboo, and are inserted in pockets made by sewing broad tape across the sail. In Fig. 1, D D is the hauling-line for reefing; you will see it divides into three parts, A, B, and C. When past the leading ring on the lower batten each of these parts, A, B, and

C, passes through a ring down to the batten below, and on hauling the one line D D the three parts haul the two battens together and thus take a reef.

Note the position of the hauling-line (D D) is incorrectly drawn; it should lead from the upper batten *in a line with the mast* and down through the pulley E.

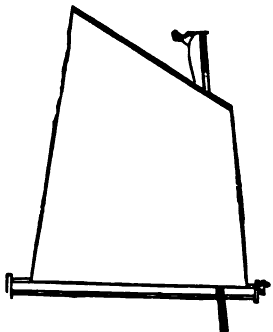


Fig. 2.

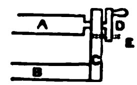


Fig. 3.

Fig. 2 shows another way of reefing. The sail is in this instance a balance lug, but the system of reefing can be applied to any form of rig, and a friend of mine uses it in a small racing cutter of about two tons. The feature in it is the roller in Fig. 3. This roller is shown more clearly at A; B being the standing part or boom proper. There is a metal cap (C), which is secured to the lower boom (B), and in which the roller revolves. The winch (D) is firmly secured to the projecting pintle of the roller through the cap (C), and as the foot of the sail is fastened to the roller, on the halyards being lowered and the winch turned the sail reefs up, and *vice versâ*. The luff must be cut at less than a right angle with the boom or the sail will jam in rolling. The pin (E), running through the lower part of the winch (D) into C, makes the roller fast where required. In some cases the roller is dispensed with, and the boom revolves on a gooseneck, the sail rolling round the boom itself.

The spritsail is a very handy one, and no sail sets flatter or can be stowed away more quickly. This rig is generally used in sailing barges, and in them you see the enormous sprit towering away far higher than the stumpy mast that supports it. The sprit is the spar that extends triangularly from the peak of the sail to the mast near to the deck. In small

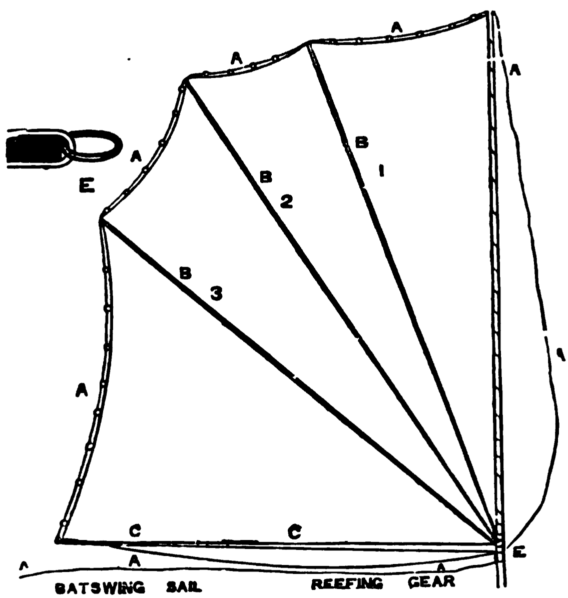
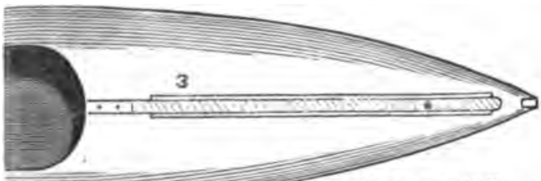


Fig 4.

boats it is kept in place by a sort of rope grommet called a snotter, but in large boats and barges there is a regular chain and purchase to secure the lower end of the sprit. In taking a sprit from the grommet in a small boat you should be careful not to let go the spar, which would in such a case, the sail being fastened to the upper end, probably drive through the bottom of the boat. As a modification of the sprit I give you a diagram of what I call the batswing-sail (Fig. 4). You will see on this sail there are three sprits (if there were only one, as in an ordinary spritsail, it would be in the position of B 2, Fig. 4), and the lower end of the sprit secured to the mast by a snotter, which can be made by a grommet large enough to go round the mast, and also to take the sprit end, which is tapered off. A seizing is passed round the grommet between the mast and sprit (see Fig. 5).

Fig. 5.

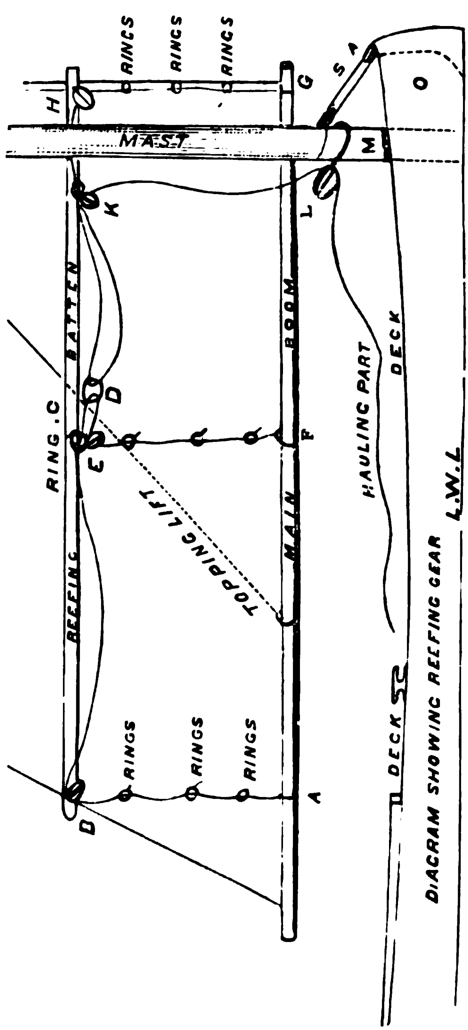
The batswing-sail (Fig. 4) is fitted with three battens, arranged diagonally as sprits; and the lower ends of the battens are secured to the mast at E by rings so fitted as to allow full play to the battens, as at E. Small rings are fastened along the leach of the sail, and a line (A A A) is led through them from the boom end, where the end is made fast, thence through the sheave at the masthead, and from there to the pulley or sheave at E, and then aft to the well. By pulling the line A A the first batten (B 1) can be drawn to the mast and the sail reduced, and further by bringing B 2 or B 3 to the mast, while by hauling the boom up to the mast the sail is stowed for paddling, and can be let fall again immediately. It will be apparent that in reefing this form of sail the boom is raised at each reef, and to meet this it would be well to fit a canoe using this sail with some means of easily shifting the position of the mast, which can be worked from the well. This can either be done by an arrangement at the heel of the mast, shifting it forward, and thus allowing the masthead to rake aft sufficiently to make up for the sharper angle caused by the reef, or by a slide on deck (Fig. 10), which slide will have to be drawn



FORE DECK SHEWING SLIDE FOR SHIFTING MAST POSITION

Fig. 10.

back as required, and thus will shift the masthead aft. With three reefs in the sail three points can be fixed necessary to bring the masthead sufficiently aft to meet the altered conditions caused by the reef; and these places being marked on the deck, a hole can be bored, say at any fixed place, through both the sides of the casing, and the slide can then be put to the required position to alter the mast for the first reef, and a hole bored through it; then shift it for the second reef, and bore another hole, and similarly for the third reef. The one hole in the casing of the slide will answer for all, and a catch at the end of the slide ought to be fixed to allow you to pull it to you easily. The pin used to secure the slide at the reef, passing through the holes, should be fitted with a chain and secured to a ring bolt. It might perhaps be better with this sail to have a couple of other lines, one on either side, from the boom about two-thirds from E, and leading through rings on the



battens fastened at about the same distance, and so through a pulley at the mast and down as the other; and the three lines could terminate in one hauling part. The object of the other two lines is to confine the sail more when reefed.

The sheet is fitted with a ring close to the lower batten or boom to which it is made fast, and on the reefing battens are fitted short lines with a toggle, which is passed through the ring of the sheet when the reef is hauled down, taking the strain of the sheet on to the last battens hauled down, and also keeping the boom and battens together.

The reefing gear shown in the yawl rig with Chinese battens is fitted in the following manner: one end of the reefing gear A is fast to the boom directly under first reef cringle, and then led up through rings which are sewn on the sail as fair-leads, to the block at B, through which it passes on through the fair-lead ring at C to the bull's-eye at D (this may be either a bull's-eye or a sisterblock); passing through this the end comes back through

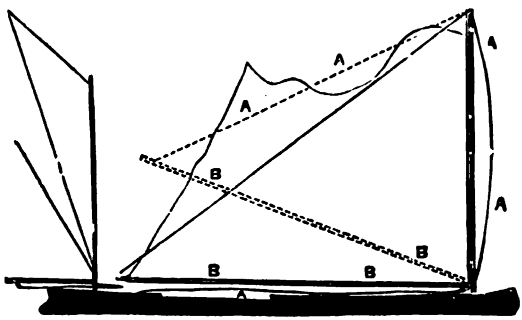


DIAGRAM .. SHOWING .. TOPPING .. LIFT

the block E, passing down through the fair-lead rings on the sail, and made fast to the boom at F. Of the other part of the gear, the end G is fast to the forward end of the boom, led up through the fair-lead rings on the sail to the block H, through which it passes on through the fair-lead ring K, through the bull's-eye at D, and back through the block K, down to the deck by the fair-lead block at L; this end now constitutes the hauling part, and on being used, brings the first reef batten down on the boom immediately, while by easing off the hauling part if reefed, and hauling in the halyards, the reef is shaken out in a second.

In any sail, either lug or gaff, or with battens, if the boom comes right aft, it is necessary to have some means of raising it over the occupant's head while tacking. (See diagram showing topping lift.) The topping lift (A A), on being hauled on, raises the boom (B B) to the position of the dotted line, sufficient to clear the occupant's head; or, if required, the boom can be hauled up to the mast. The sliding gunter (Fig. 6) is a very useful rig for a canoe or small sailing boat, particularly if fitted as at Fig. 7. In Fig. 6 the mast is A A, and the yard (D D) is fitted by rings to the mast, up and down which it slides. The halyard (B) passes through a sheave at the head of the mast, and lowers or raises the yard as required. It can either be made fast round the yard, or the upper ring can be fitted with a bolt and shackle for the halyard to be made fast to. On this yard a leg-of-mutton sail is generally set of a triangular shape, and the yard can be easily lowered for reefing; and when the reef is taken the yard is hauled into its place. By using a pintle at the foot of the yard (as at C, Fig. 7) the yard can be lowered away as indicated by the dotted line, and a triangular reef taken in at the foot of the

Fig. 6.

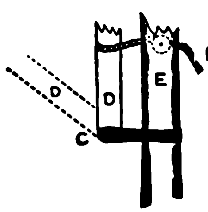


Fig. 7.

sail, converting the leg-of-mutton into a gaff sail. And further reefs can be taken by lowering the heel-rope of the yard—an extra halyard must be fitted in this rig to the upper part of the yard, acting as a peak halyard.

If complicated fittings and gear are undesirable, they can be avoided by having a main and mizen balance lug. You can reef down the main and carry the mizen as long as the canoe will bear the sail, and if it is too much for her you can strike the mainsail and set the mizen lug on the mainmast, or stow the mainmast and sail and set the mizenmast, with its sail in the step of the mainmast. For this purpose the lower part of the mizenmast—that part from the deck to the step below, which is generally square to prevent shifting—is frequently made of the same size as the foremast at the same place, though the remaining part of the mizenmast is generally slighter than the mainmast. All the mast-fitting should be watertight—and, better still, cased in; and all other openings in the deck should be so constructed that a minimum of water shall be shipped. What is taken aboard ought to be at once removed with a sponge. Many canoes are fitted with air-tight compartments at the ends, and of course such craft are far safer than those without. The air-cases may be made of zinc soldered, or of wood with the joints made watertight; or indiarubber bags inflated can be stowed in the ends of the canoe, of sufficient size to float her. In the latter case the bags must be strong enough to resist the pressure of the water in case of an upset. Too slightly made bags in such circumstances would probably burst, which would be rather awkward.

A very good way of making a canoe or sailing boat fitted with a mizen, handy, is shown in the diagram (Fig. 11) of the mizen-sheet working from the

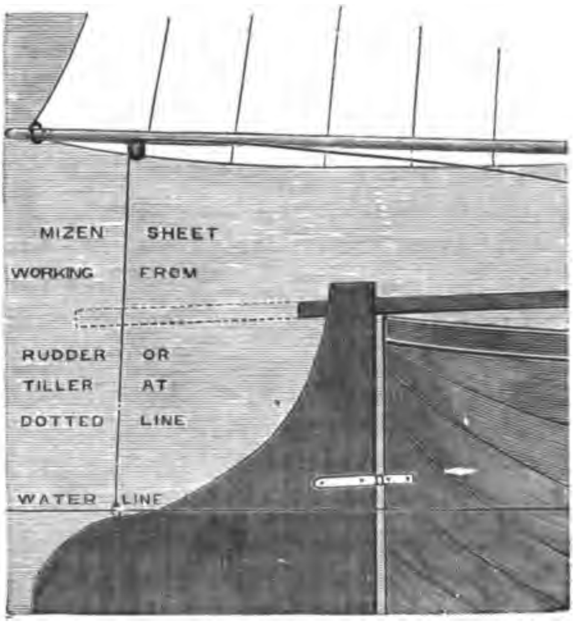
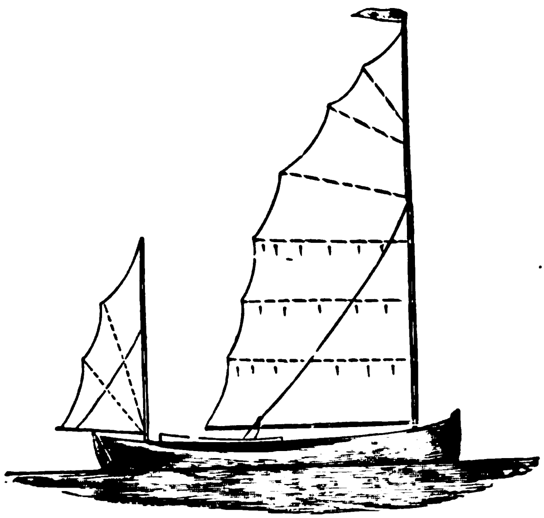


Fig. 11.

rudder; or a neater way is to work it from the outer end of the tiller, which must be made purposely, as indicated by the dotted line. The effect of this arrangement is that when the helm is put up the mizen-sheet is eased off, and the boat falls off at once. By taking the main-boom and pushing it out to windward at the same time the boat will turn in her own length like a top, particularly if the sails are battened; and if tacking, when the helm is put down, the mizen is shoved up to windward and brings the boat about directly; and this handiness of working is no small matter in narrow and crowded waters. I have seen a boat with battened lugs



Sail fitted with Chinese battens

Fig. 12.

fitted in this way work in and out of craft where there was hardly more than her own length to turn in.

Fig. 12 is a sketch of a canoe fitted with these battened sails. She has a kind of leg-of-mutton or jib-headed sail forward, and a smaller one of the same kind for a mizen aft. A sprit-mizen would perhaps be better, as it would set more canvas and keep the sail low. If such a rig were fitted with some adaptation of the principle of the sliding gunter, it would be extremely handy, as you could lower away the upper portion of the mast and take a reef in the sail with the greatest ease. Where a sliding gunter is used it must be fitted at the back of the mast, not as a topmast in front, as the sail having to be laced to it, if it were forward of the mast it would set the sail badly.

CHAPTER VII.

CONSTRUCTION.

WHEN the drawings are finished to your satisfaction, the next step will be to produce from them a half-breadth model in wood on any suitable scale.

For this work many tools are not required; a chisel or two, a couple of small gouges, a small tenon-saw, and some glass-paper will be quite sufficient to commence with.

In making these small models the great thing is accuracy, and unless the greatest care is taken, an amateur will certainly come to grief in his first attempts; it is so easy to cut away just a wee bit too much, and once that is done, the fairness and accuracy of the model is gone.

To make the half-breadth model, you will require a sufficient number of pieces of wood planed down in thickness, to correspond with the distance spaced between the water-lines; it will have a better effect if you use alternate layers of light and dark woods, such as pine and cedar for this part of the work.

A sufficient number of these pieces (which must be sufficiently long and wide to make the model on the scale you are working to) are used to make up the immersed portion of the model, i.e. that from the first water-line downwards, and another larger piece of wood is taken of sufficient size to get out the above-water portion of the model. The whole of these separate pieces are then screwed together so as to form a solid block, but in such a manner as not to interfere with your using the tools. From the reduced drawing you now mark off on the block each of the sections from the sheer plan, and on the back indicate the outline of the sheer plan you are working to, omitting the keel, which is added afterwards. You can now mark out the half-breadths on the top of the block from the deck-line of the half-breadth plan, taking the distances by means of the dividers, and when they are all in, the curve can be struck in from them, by means of a spline, and the superfluous wood cut away. The lines showing the sections must now be re-marked where cut away, and the sheer on the drawing taken off by the divider at the different sections from the base line and marked on the back of the block.

When these points are all in, the sheer line can be struck in by a spline, and the top of the block cut away to the line of sheer. When doing this, the crop (or arch) you intend giving the deck should be shown. You can then cut away all that wood outside of the sheer plan marked on the back of the block, and will have the approximate form of the boat. To finish off the model you had better secure the block by screws through the back to a bench or piece of board. You must now proceed carefully to shape the block to your drawings, working by templates cut out of wood or cardboard from the sections of the half-breadth plan, and constantly comparing them with the block, as you carefully cut away the wood little by little. When you have got the model roughly shaped to the forms of the templates at each section, you can finish it off with glasspaper until it is as accurate as you are able to make it.

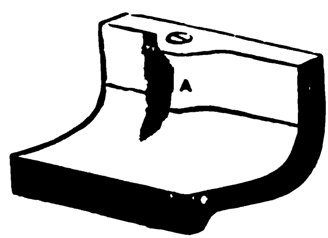
In working to templates, you must first have the block square to the board on which it is secured, and then cut the templates from thin pieces of wood, of which two sides should be properly squared, the one, showing the shape of the section, resting on the board at the ends, and the other, at right angles to it, should be in the same vertical as a perpendicular from the board to which the model is secured. When the half-breadth model is complete, by unscrewing the pieces of which it is composed, you can prove its accuracy by laying each piece on its water-line in the drawing from which you worked, and with which it should agree. Another and more simple plan is as follows. If the water-lines are, say, a quarter of an inch apart, you would take a piece of board a quarter of an inch thick (when planed down) and trace out on it the first water-line, cutting that piece away from the plank, and proceed in a similar way with the other water-lines, until they are all cut out. When they are placed one on top of the other, you will have a very near model of the immersed half body of the boat, the corners only needing to be smoothed off. To do this accurately, you must use the templates. The half-body above water you can take from the sheer plan, the deck-line on the half-breadth plan and the first water-line, fairing it by the templates. When finished, you can fasten your model to a board at the back so as to hang it up, but it is better, if you make it in separate water-lines, to have it loose, that you can at any time by lifting off any particular section or sections show any water-line you may wish to see.

You can, of course, make such a model from one piece of wood, working from moulds or templates taken from the sections in the body or plan.

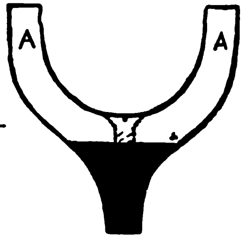
After you have got out your half-breadth model, if you like the form of the boat, the next thing will be to build or cut out a model on the scale you intend to use for sailing. For model work it is simpler to cut out the boat from a block of suitable wood. This block may be either *au naturel*, or built of various pieces—the latter is probably the plan more often pursued, as it gives a wider range in buying the wood, large blocks being difficult to obtain, free of knots and shakes. Good soft white pine, or some wood easily worked is the best to procure for the purpose of model boat-making. We will first take the method of cutting out a model from one piece of wood. You will proceed very much in the same way as when making the half-breadth model, the great difference being that in the present case the boat will be on a larger scale and complete, i.e. the whole breadth. First plane the block true and then mark a line longitudinally down the block, exactly where the keel will come; then mark a similar line the other side, which will be the middle of the deck longitudinally; then if these lines are true, and you connect them at the ends of the block, you will have a true line showing the position of the stem and stern-post. When you have got all these you must mark off the position of the sections along the boat to exactly correspond with your plan, and prepare cardboard, metal, or wood moulds or templates from the sections on the plan. You can then proceed very carefully to shape out your boat. A great deal of work can be done with a spokeshave or small plane. Be very careful how you use the gouge or chisel, as one unlucky cut deeper than you intended may spoil the shape of the boat. You may of course saw away any superabundance of wood to start with, first seeing exactly what you are doing, and carefully measuring how far you can cut away. Work carefully by your templates, trying them again and again at their respective sections, until you get the boat fairly into shape. When you have done this, you had better finish her off with a large wood rasp a little curved at the end, thus :—

If you cannot get such a one, you can bend a straight one slightly at the end yourself, by first heating it. Be very particular in the run where the body of the boat joins the deadwood, and leave no sharp knuckle there, but make all a fair curve, and go over the boat when finished with the palm of your hand to detect any lumps there may be, which, if noticed, instantly mark and smooth carefully down.

But it may easily occur that you may find it impossible to get a bit of wood large enough and good enough to make your boat. In such a case your best plan will be to build one "bread-and-butter fashion"—that is, in layers. If you want a boat six inches deep, two pieces of three-inch plank the requisite length will do, or the under one need not be so long as the upper by the length of the counter; and this class of wood you will find no difficulty in procuring. When you have got your planks you must get them planed down on all sides, particularly where you intend joining them, and when they are ready put them together with a solution, previously prepared by you, of shellac dissolved in spirits of wine. The shellac may be obtained from any oilman and the spirits of wine from an oilman or chemist. See that the shellac is thoroughly dissolved, and then apply it to the surfaces you wish to join, putting a heavy weight on top of the upper plank. Leave it to set, which will take about a day or so, and then you can proceed as with a solid block. But in scooping out the inside you must leave greater thickness in certain parts to put a long screw through from the upper to the under plank, thus :—



These thicknesses (as at A) must stand out far enough from the side of the top piece to put a screw through that will have good hold in the lower plank without going through the bottom of the boat. The stem must be left thick enough in a similar way to put a screw through, thus:—and the deadwood aft at its junction with the boat must be left thick enough to take a screw, thus:—



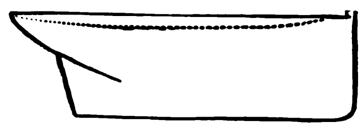
A A, sides of the boat; B, deadwood.

In this way you will be able, out of any wood, to select that most suitable in softness and freedom from knots, etc., for your purpose, and then to join it together as firmly as if it were a solid block. I have tried marine glue as a means of joining, and though it is perfectly waterproof, and unites the wood together very firmly, it is liable in hot weather to exude from the seams, coming through and forcing off the paint, which is very annoying. You will therefore probably find shellac and spirits of wine the better method. It has, at all events, been tried by several builders of models, and proved very successful.

There is another way of joining boats longitudinally; but this, in my opinion, is not a good plan to adopt. The boat should be hollowed out as thin as possible consistently with strength. A pair of callipers will show the thickness, and it is important to try and get the sides as uniform a thickness as possible—say, a quarter of an inch for a three-foot boat.

You may find it a help if, instead of merely tracing lines to show the midship section longitudinally, the position of the keel, stem, etc., you screw small quarter-inch hard-wood battens in these positions, and work from these, taking them off when you have finished. Something of the sort you must have to guide you, as, unless you work from a proper centre longitudinal line, keel and deck coinciding, you will get your keel and deadwood crooked from the body of the boat, and she will sail better on one tack than she will on the other.

Before you commence shaping the boat you had better cut her sheer, whatever it is, thus :—



The dotted line shows the sheer.

Very good model boats can be made from metal, by those who have the requisite skill, or the patience to acquire it. The great objection to such boats is that it is difficult to keep them from getting dented and bruised, and thus altering in shape; still, small models can be very readily built of metal and will be found to answer well. Tin-plate is a very good substance to use to commence with. Zinc is of almost too soft a nature for large boats, though for anything under two feet long it would do very well, and is far better in one way than tin, as it does not corrode, and always presents a smooth surface to the water. The frame must be put up as if you were building a wooden clinker-built boat, but no rabbet need be cut in either keel, stem, or stern-post. When the frame is up you will have to screw on to the keel (this can be done first, if you prefer it) a piece of wood representing the depth and thickness of the leaden keel, and plane and fit it properly on. To commence building, you first cut from good thick block tin a piece to fit on the wooden stem, lapping over it each side about an inch, and running from the top to the bottom of the stem; you will then have to fit another piece on to the stern-post in the same way, lapping over. Both pieces, stem and stern-post, must come down as far as the bottom of the false keel you have fixed on. You must tack them in their places slightly, just to hold them; then cut a piece of extra thick block tin the shape of one side of the keel, including false keel and all. You must let this piece come well up to the garboard strake. You will probably, unless the boat is very small, have to join this keel piece. Let it run in at the ends, under the lap of the tin stem and over the lap of the stern-post, and solder well together; then fit the other side. The garboard can now be cut out and soldered to the stem and stern-post, and also to the keel-piece, and if you like, a piece can be cut to fit the deadwood and soldered on, and so you can proceed till you get to the top strake, letting each plank lap the other clinker-fashion, and soldering strongly together. When completed to the top strake you will have to run a wooden stringer round the boat to screw the deck to, as before described. Screw from the outside, through holes drilled in the tin, and over all the screw-heads run a narrow strake of thin tin right round her, fore and aft, soldering along so as to cover the screw-holes.

With regard to the soldering, which is the most difficult job, you cannot do this without a soldering-iron, and whoever you buy this from will probably be able to give you some hints as to its use, and answer any difficulties that may occur to you. The best solder to use is that which is sold in long thin sticks, rather less in diameter than a penholder; they are far better than the thick ones, and easier to use. The tin is not expensive; and, indeed, I think this is the cheapest way to build a boat, but when finished she runs more risk of being knocked out of shape than a wooden boat, though, if well built, tin boats are strong enough. The more lap you give the planks the stronger the boat will be. If you please you can strengthen them by compartments inside, like shadows soldered in; this, however, binds a boat and stops her speed. As for the lead, that is put into the tin keel, which, of course, is hollow inside when you lift out the frame and wooden keels. You can either put your boat in the water and run lead into her till she is in trim (not letting the lead run right to the ends), or you can put half in that way and the rest loose, or all loose in compact fitting pieces. You can use an existing model to build off, if you like, but you must be careful not to build on a model tumbling home aloft—i.e. narrower on deck than below, or you will not be able to take the model out when the metal boat is completed.

In building models you will require a plane or two —the small iron American planes are very useful—a small saw, several bradawls, and a couple of gimlets, and a quantity of small brass screws for fastening. In larger boats copper nails with rooves are used, but these are not required for models. Of course, if you have more tools and a bench with a clamp fitted, so much the better, but you can manage with the tools before mentioned.

For building proper, as distinguished from making models, you will require more tools, and some of an expensive character are desirable, though they may be done without; and, in addition to the tools, several other accessories are desirable. The first and most necessary is the bench, on which to build the boat, which must be at a height convenient for working; this may however be simply made from a couple of planks properly nailed together and supported on trestles. Clamps, either wood or iron, are also required; for many purposes the latter are preferable, as they are smaller and lighter to use. The bench should be made of sufficient length to take the boat and to allow room at the ends and sides for working, planing up, planking, &c., unless you have a regular carpenter's bench, and a couple of horses for sawing planks on are also necessary. For tools you will require saws, a ripping saw for cutting planks, &c., and rough work, and a panel and tenon saw;

the latter should be fine, and a fine compass saw will also be found useful; these should be of the best make and kept clean and bright, and sharpened when required, as dull and rusty saws add greatly to the labour. A jack and smoothing plane will be required, and a rabbet plane is useful for certain parts of the work, while the small iron American planes will be found very handy. Chisels you will require of various sizes, according to the size and character of your work, and a gouge or two, particularly the flat ones, will be found useful. Spokeshaves are used for finishing up the spars and other work, and draw-knives are useful for quickly roughing out the forms of spars, oars, or other needed work from the rough material. But of all the handy tools for roughing out work, the adze is the best by far; it requires, however, an apprenticeship to use it properly, and any novice is just as likely to cut off his toe as to take the required shaving off the wood; it is therefore better to use for such purposes a light bench axe. Gimlets and bradawls must be regulated in size by the nails you intend using. A light mallet and two hammers, one heavy and the other light, are also wanted.

A brace fitted with the proper bits is also required; the bits should be the regular centrebit, and also the augur shape, ranging from one inch downward and also some rosebits for counter sinking, and gimlet-bits.

You will need a two-foot rule and a pair of iron compasses for measuring your work, and a T square and plumb-line for setting up the frames, &c., with; a marking guage for marking distances, a screw-driver, pincers, and cutting pliers, will also be necessary.

The woods most suited for your purpose are English and American elm, spruce, larch, cedar, teak, and mahogany; oak, English and foreign; pine, red, white, yellow, and pitch. Of these, pine, oak, mahogany, and cedar are more used for small work, and the other woods for large boats, steam launches, and yachts. Elm is excellent to use if it is to be kept under water, but if between wind and water it soon rots. Pitch-pine is a very good and cheap wood for large work, but it is heavy, and not at all suitable for small craft. Spruce, larch, or red pine is the cheapest and easiest wood to work for small boats and canoes, while cedar and mahogany are useful for deck-fitting, but are too expensive for amateur boat-building, at all events to commence with, though no doubt very handsome craft can be built of these woods.

Oak is best for travelling canoes, but is difficult to use; and except for the keel, which might be of oak or elm, and the timbers, which, unless steamed timbers are used, must be of oak, American elm, or ash, soft wood can be used for planking, except where great strength is required. As a general rule it may be laid down that soft woods are not so strong, and decay sooner than hard woods; but still, for some purposes and in some places, soft wood answers as well as hard, and costs much less.

The nails used are fully described, except French wire-nails, which are not alluded to. These answer very well for cheap boats, being inexpensive, strong, and pliable. Ordinary clout-nails, too, are very useful if good, which can be tested by bending them; they ought to bend easily without breaking. They must be just long enough to go through the wood and leave about a quarter of an inch to turn over with the hammer until buried in the wood, which must be done in the direction of the grain of the wood. If the nails project too much they should be cut with a pair of cutting nippers until only sufficient is left for a turnover. A hole should be first bored with a small bradawl before the clout-nail is driven in the wood; but the copper nail and roove, as described, is by far the best, though most expensive, fastening. Clout-nails, if used, should be galvanized.

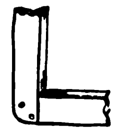
Copal varnish is best for canoes and boats, but it is expensive, the best being about eighteen shillings per gallon. There is a cheaper kind, not nearly so good, called boat varnish, at about ten or eleven shillings a gallon. Two coats of varnish will do, but the first must be given time to thoroughly dry before the second is put on. For a cheaply-built boat paint will do as well as varnish, and is far cheaper; but a well-built and handsome boat is worth varnishing, and it would be a pity to "spoil the ship for a ha'p'orth of tar."

There are three principal ways of building boats and ships—1st, clinch or clinker; 2nd, carvel; 3rd, diagonal.

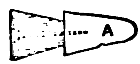
The first method is used chiefly for small craft, rowing-boats, etc., and some fishing-boats up to twenty or thirty feet long. Most ships and large craft and yachts are carvel-built. This is a stronger method of construction, and the craft so built offers less resistance to the water, the sides being perfectly smooth and equal, instead of, as in clinch-built boats, one plank lapping the other.

The diagonal plan is used chiefly for lifeboat-building, to secure great lightness with a maximum of strength. Some ships are built this way, but not many. It is a troublesome and expensive method of building, and a very bad one for any but first-class workmen to attempt. We will first take the clinch or clinker style of building.

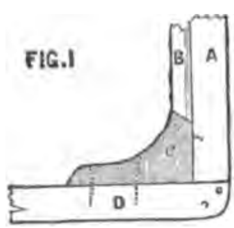
The first job is the keel. This must be the length you intend the boat to be at that part, and I will presume you are building a three-foot boat, so the keel will be three feet long. You had best use hard wood, oak or elm. You must leave it broad in the middle, and taper it off towards the ends, where the stem and stern-post are joined on. I will suppose in all the details I hereafter give that you are building a three-foot boat (i.e. three feet on the keel). The keel will be, say, one and a quarter inch amidships, tapering to half an inch at the stem and stern, and, say, one and a half inches deep. The stem and stern-post are cut out of hard wood, and are left a little longer than you actually need, as you can afterwards cut them to the exact size required. They are scarped or halved on to the keel thus: the keel being half an inch thick, you cut it away to a quarter inch as far as the stem goes; say, the stem is, at the junction with the keel, one inch deep, you will cut the keel down to a quarter inch thick, one inch from forward, aft, thus, and the stem will then fit into the recess cut in the keel, and you screw it on, seeing that it is perfectly perpendicular with the keel. This is called halving. You will then have it thus:—

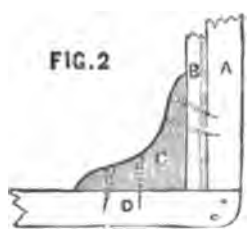


but as there will be a taper in the keel, which must not be too sudden, but gradual, the stem must be cut to fit the keel, being narrower forward than aft. When this is done you will have to cut an apron-piece like a second stem, about one inch deep and as wide aft as



the keel, but forward, where it joins the stem, it must be narrower than the after part of the stem. This piece will have to be screwed through to the stem; its use is to secure the butt ends of the planking to. Another way is to cut a groove on each side of the

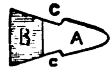




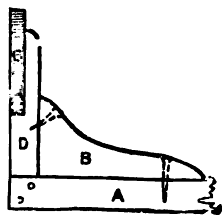
Construction of stem; A, stem; B, apron-piece; C, knee; D, keel.

stem for the same purpose, but an apron-piece is easier to work in.

In large boats, such as rowing-boats, etc., a knee or hook is introduced, as Fig. 1, which is, of course, the stronger method of construction, or you may let the apron-piece come down and butt against the keel, and then knee it as shown in Fig. 2.

In such boats the apron-piece comes flush with the stem, thus: 

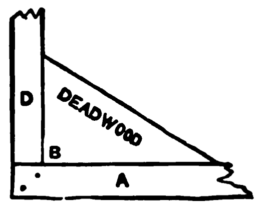
and a rabbet is cut in the stem at C C, to receive the ends of the planks, and the apron-piece comes short of the end of the stem, as in Fig. 1, where it joins the knee C. In such boats the stern-post also has a rabbet cut to receive the ends of the planks there, and also has a knee called deadwood, thus:—



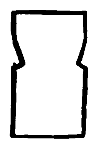
A, keel; B, knee deadwood; C, transome; D, stern-post.

(All knees used in large boats are cut from naturally-curved timber, generally oak), but no apron-piece is used for the stern-post, except in double-ended boats, i.e. boats like whaleboats and lifeboats, of which the stern is similar in shape to the stem, being sharp, and having, therefore, no transome. In building large boats it is usual to plane away the ends of the planks slightly, so that the rabbet in the stem and stern is not the full depth of the extreme thickness of the plank, but only of the end as thinned down. The under side of the garboard strake can also be treated in this way, and the rabbet cut proportionately smaller. In many details I have sometimes departed from the method pursued in constructing large boats (i.e. boats for use, not models), as the instructions given instead are, I consider, more easily carried out in model building, but wherever this has been done I have also added how the large boat differs in construction from the model, so that you can construct either.

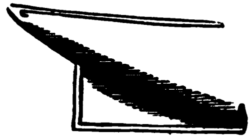
The stern-post in the model is fitted the same way as the stem, but instead of an apron-piece you had better, for a model boat, fit a piece of deadwood, thus:—



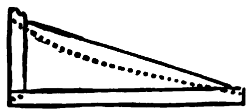
The deadwood will be as thick as the keel, and come up to above the first water-line on the stern-post, but where it joins the stern-post it must be tapered off like the apron-piece, to let the ends of the planks lie in. Say the planking is one-eighth of an inch thick, you must leave this space each side of the apron-piece or deadwood, at their junction with the stem and stern-post, so that when the planks are put on they will fit flush with the stem and stern-post. The deadwood must be screwed up from the keel and from the stern-post. This deadwood is only for model boats, for in large boats you would fit an apron-piece like the one at the stem, or cut a groove in the stern-post to receive the end of the planking. The keel must have a groove cut along its length, to receive the edge of the lowest plank, which is called the garboard strake. This must be done before you fit your stem and stern-post, thus:—



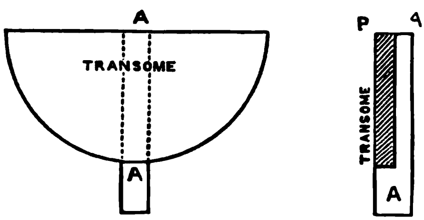
leaving sufficient wood above the rabbet, or groove, to allow the keel to come up well inside the boat, but in using the deadwood you must see in your plan where the body of your boat commences to rise aft from the keel, thus:—



"A" would be the point where the rise commences, and you must start the deadwood piece a little forward of this. Bring the rabbet straight along the keel till you come near the deadwood, where you must continue it up in a nice curve, which you had first better take from your plan, thus:

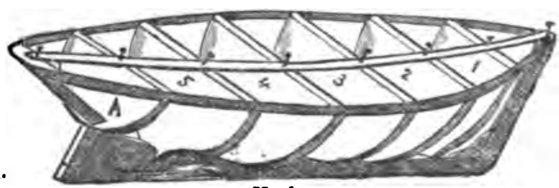


The dotted line will be the rabbet, or you may make the rabbet straight along the keel, and plank up over the deadwood, as you think best. The transome is the next thing to be considered (you will see it marked on the plan). It is halved on to the stern-post from the first water-line up to the top of the stern-post, and is of the shape the boat is to take there.



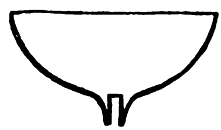
A A, stern-post; B, transome, halved on stern-post.

You will, of course, get the exact shape of the transome, as well as all other measurements, from your plan. I am presuming now that you are working from the one given, having enlarged it. For a square-sterned boat, that is, like any ordinary rowing-boat, without a counter, you must halve the transome on to the stern-post to make a neat and complete job, as the transome is exposed to view. But in making a model with a counter you might simply screw the transome on to the back of the stern-post, seeing it is on square, as the planking of the counter will conceal it. The next thing you will have to do is to get out shadows to build the boat on. Shadows are simply frames the exact shape of the various sections of your intended boat, and you will cut them out by the plan. Pieces of half-inch stuff will do for what you require. They must be fitted on the keel at the stations they are to occupy, which must be marked on the keel from the plan. They will have to be tacked on to the keel strongly enough to hold while you are building, but yet so that you can remove them when you have finished without damaging the boat. You will also have to screw a piece of wood from stem to stern to keep them in their places, putting a tack in each, as

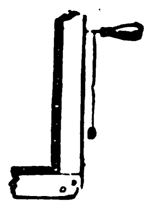


A, Transome; 1, 2, 3, &c., Shadows.

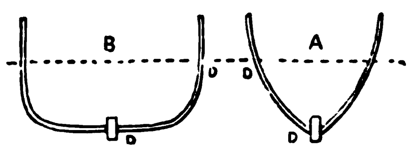
also another small piece each side for the same purpose (as shown in the sketch). If you have put in deadwood, the after-shadows must be joggled thus:



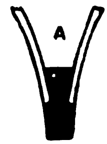
to fit over the deadwood. You must be very careful to get the shadows quite true, as if they are out your boat will be untrue, and perhaps one side different from or bigger than the other. You must plumb the stem and stern-post, and see they are in a line with the keel. The easiest way to do this is to stick a bradawl into the stem or stern-post thus,



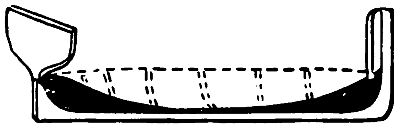
and hang a line from it with a bit of lead at the end, first seeing that your bradawl is in a line with the keel. If the stem or stern-post is true the lead will hang quite fair with it when the keel is fixed on a level surface. I am presuming that your keel has been planed quite fair on the bottom surface. When you find this all right, you must take a good-sized piece of plank and plane it level, and then secure the keel to it, so that it shall be quite firmly fixed for you to work at, and yet so that you can detach it when the boat is finished. The shadows can now be fixed on. You now have, as it were, a skeleton shape of your boat. The next thing is to get the planking ready. We have taken the planking as being about one-eighth of an inch in thickness, which is quite enough for a small boat. And now we will suppose you have bought and planed up sufficient planking to go on with. The narrower the planks you use the easier they are to fit, but they are more trouble in nailing, and require more nails than if you used fewer planks but wider. You will find that some of the planks in boat-building take very peculiar curves (called sneyd), and you had far better ascertain how your plank is shaped by using a piece of stiff paper or cardboard to get the exact shape. The first job will be the garboard strake. A rabbet is cut in the keel for this, which rabbet, of course, you cut to receive the plank, of which you previously had determined the thickness. It is usual in all large boats to let the garboard be a little stouter than the other planking, and you can follow this plan as you please. Your plank will be about an inch wide, or more if you can get it in nicely wider. And if you are building in the ordinary way the garboard will fit in the rabbet right along the keel, till it comes up to the stem and stern. But this rabbet must not be cut at the same angle with the top of the keel the whole of its length. This much depends on the shape of the boat and the rise of floor—i.e., thus:—A has far more rise of floor



(D D) than B, therefore the angle of the rabbet of the keel of A would be much more acute than of B, which would be amidship, almost a right angle with the keel. But then, again, as you approach the bow

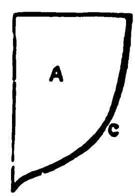


and stern, whatever the angle of the rabbet at the midship section, the angle gets much more acute. Thus take A section, near the bow it would be thus: and therefore the top side of the rabbet is shaved away more as you approach the end to allow the planking to come up near the keel, thus:—



If you do not understand this rabbet you must think it out till you do, or try and look at some rowing-boat, as I cannot explain it more clearly to you on paper. If you are using deadwood you can let the rabbet run up on it, and let the garboard strake fly up aft to the rabbet in the deadwood, which will save you a good deal of work.

When you get the garboard strake fitted, shave it away slightly along the outside upper edge to reduce its thickness there, and allow the next plank, which overlaps it, to lie closely. You must also do this with the planks as you approach the turn of the bilge. [C, the turn of the bilge.] The plank below this must be shaved away at the upper edge, and the plank above on the lower, so as to make a fair turn, particularly if there is a sharp turn to the bilge, as Fig. B. The next plank to the garboard must now be shaped and fitted on. The



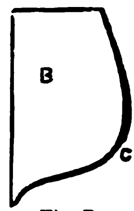
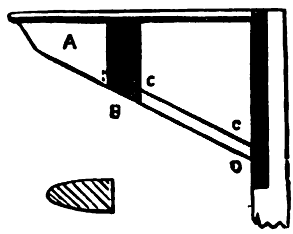


Fig. B.

lower edge of it overlaps the garboard strake. You can rivet the planks together as you go along, or simply tack them to the shadows and do all the riveting afterwards, as you prefer. And as for cutting the planks, you will find it easier to cut one plank from another for two sides—i.e. when you get your garboard fitted and all right for one side, you can cut another from it for the other, remembering to reverse it, and so on for the other planks.

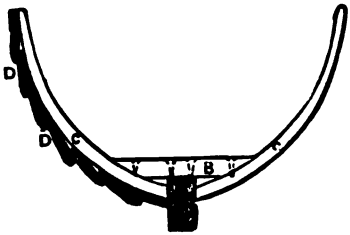
You will rivet with small copper tacks. Bore a small hole through both planks, and cut your tack so as to come very little beyond the inner side of the plank, then putting a flat-iron outside against the head of the nail, with a small hammer you beat the end of the nail inside gently till it spreads out and rivets the planks tightly together. It will facilitate this if you first file a nick across the end of the tack where you cut it, as with the small end of the hammer you will soon spread this out. In large boats, clinker-built, what are called rooves are used with the copper nails, which fit on inside over the point of the copper nail, which is then riveted on; and it requires one to hold a hammer against the head of the nail outside while another rivets inside, so that the rooving is generally done all at one time after the boat is set up. I should advise you to practise this on some waste piece of wood first, or you will probably spoil your first plank.

And now you go on planking up till you get up to near the water-line. If you have decided to make a counter, you must cut a piece of wood about two inches wide, and the exact shape of the extreme end of the counter, and then run a groove of half inch or one inch wide round it of sufficient depth to receive the planking thus :



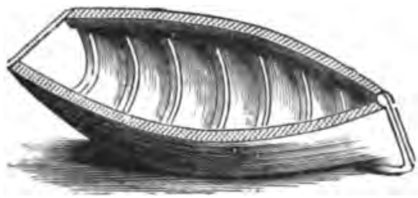
A, the piece of wood ; B, the groove (shaded) ; C C, a piece of wood received into the stern-post at D, the transome having a joggle cut to receive it, and into the piece of wood (A) at the dotted line at B. This piece of wood (C C) had best be shaped wider on the side next the deck than below, that is to say, V-shaped to fit the planking nicely to, the acuteness of this V depending upon the shape of the lower angle of the block for the counter, and the lower plank must run along this stay, and butt on the groove in the block, the other planks forming the counter will be nailed to the transome and to the block. In some cases the planking can come over the block A, concealing it altogether, which makes by far the neater job. When you have planked up to the top of the gun-wale, you must see about the ribs ; they will have to be cut out from a mould so as to fit in close to the planking. Sometimes these are cut for clinker boats, thus :—

so as to fit each plank, but you need not take the trouble to do this. Simply cut the timber to fit, as shown. Some builders simply cut a small mortice in the top of the keel to receive the end of the rib, and this may be very good for models, as doing away with the floor timbers would make the boat much lighter, but for larger work you need floor timbers for strength. You might use small pieces of thin iron for floor timbers. Another way of fitting the ribs or timbers is to bring them in one piece from gunwale to gunwale. Should you wish to adopt this plan, you must not allow the keel to rise too far up inside the boat. Get some nice tough stuff, ash or hickory, as thin as possible consistently with strength; and taking a metal tube large enough to hold the timber, put it in the tube, and filling it with water, boil till the wood is pliable enough to bend into its place. For large work a regular steam-tight box, with a safety-valve, is built to hold the wood, and the steam conducted to it at a high pressure. With this apparatus any wood can be made quite pliable. You might construct a small one and get steam from a kettle; or the most simple way would be to boil your wood in the copper. If you have used the piece of deadwood, cut it down, if necessary, or joggle it, so as to fit the steamed ribs over it neatly. You must, when some of the ribs are fixed, take out the shadows, as probably you will want to put ribs where they have



C C, timbers; D D, planking.

been. When all the ribs are fixed, you will have to put a stringer round the top of the gunwale inside to screw the deck to (I am supposing that you are not putting bulwarks, but that the deck is flush). If you wish to have a rail you must raise another strake above the stringer, which is put thus:—



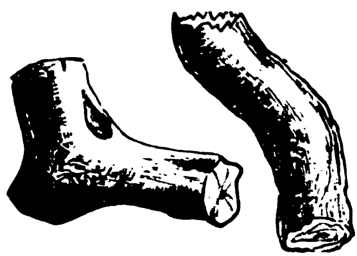
The ticked line is the stringer. The stringer will be about half an inch square, or it may be a little less in width; the ribs should be cut short to let the stringer butt on them. The stringer may be fastened by screws put in from the outside of the top plank, and when finished its upper edge must be flush with the upper edge of the top strake, so that the deck will fit nicely down on it.

A clinker-built boat, if properly fastened, ought not to require caulking of any kind, as after it has been a short time in the water the planks swell and are quite watertight; but any clinker-built boat, whether model, rowing-boat, or canoe, will always leak after being exposed to a long period of dry weather, and will need being left in the water till the planks swell again; but should there be a leak which will not close up, a little white lead (dry) mixed with gold-size will soon stop it. This can be used in putting the deck on, and in any other little joints in the boat, such as the stem and stern-post, etc.

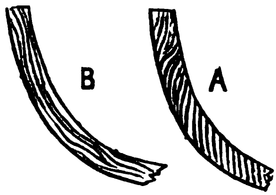
CARVEL BUILDING.

Having seen how a boat is built clinker-fashion, we will now take the carvel method of construction.

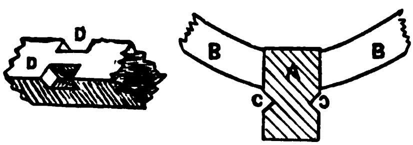
In building large vessels in this way, the keel being first laid down on chocks (pieces of wood raising it slightly from the ground), the stem and stern-post are fitted and knee'd in, then the ribs are cut. In large vessels the ribs are in several pieces, scarped together, as it is very difficult to get pieces of wood, naturally curved, long enough for the whole rib—or timber, as it is called. But of late many vessels are composite built—i.e. the frame is iron and the planking wood, which makes a lighter job, besides giving more capacity for stowage. In building small craft, both clinker and carvel, the knees must be of grown timber thus:—


A B

A and B are pieces of boughs from which several knees can be cut. In building a model carvel-fashion, you can proceed either of two ways. You may first, as in a big vessel, lay down the keel, stem and stern-post—in building always firmly secure the keel to a good-sized block of wood, as long as the keel, so as to be able to have something firm to work on, and also a fixed base from which to fair the stem and stern-post and frames —then from the sections in your plan you proceed to cut out your timbers, selecting wood with sufficient bend in it to allow the grain to run along the timber thus:—



The lines show the grain of the wood. In A the rib would break short off directly a strain came on it, but in B the grain runs with the curve, and therefore it is of great strength. When your timbers are shaped you must fit them to the keel either by putting them short each side, and putting a floor timber across, or by cutting a small mortice each side of the keel to receive them, thus: and securing



D D, mortice; B B, timber; A, keel; C C, rabbet in keel for garboard strake.

them in the mortice by a screw. This latter way will only do for model boats. When you get all your timbers in you must try a spline along them to see if they are perfectly fair, and if not, alter them till they are. But if they have been cut with care from the plan—which I suppose to be itself fair—the timbers should need little or no alteration. When they are all right you had better tack a riband each side (a small piece of wood like a spline) at the bilge, going fore and aft, from the stem to the stern-post; and, taking each rib, this will steady everything. You had also better fix a piece of wood from stem to stern as described in clinker-building, and see all is fair; you then plank up from the garboard two or three planks to near the turn of the bilge; then leave off there and commence planking down from the top. In this way you will have less difficulty in getting in your planks at the turn of the bilge. The planks will not lap one another as in clinker boats, but fit close in to the rib, leaving a joint between the plank, which must be caulked—in large boats with oakum and pitch, but in models with whitelead. You must try and make the plank fit as close as possible; cut out paper shapes till you get what you want, and then cut your wood. The planks will be fastened to each timber by small brass screws or by nails; screws are far the best.

The other way is to put up shadows, as in clinker-building, and proceed in the same way, except that your planks do not lap, and must be tacked to the shadows to keep them in their places. When you get all the planking done you will have to steam timbers and fit them in. If the timbers are only small you can bend them by wetting them and holding to the fire the side you want concave. Fit the timber in a small mortice in the keel, which had best be cut before you put in the shadows, and screw them there, and then nail or screw your planks to them. This is a far quicker way of building, and makes a lighter boat, but not so strong as the first method.

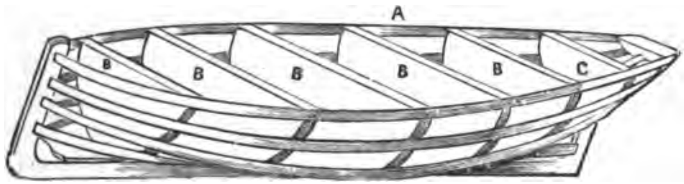
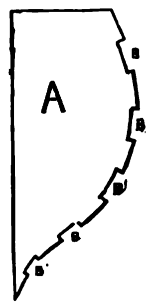
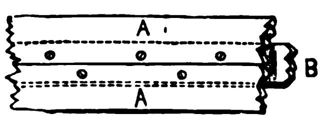


Diagram showing riband carvel construction. A A, ribands; B B B, shadows; C, transome.

There is another method, which is much used lately for building racing canoes, models of Canadian Birch-Bark canoes, etc., and that is the riband carvel. In this method of building you proceed in the way last mentioned, with the exception that you will have to cut slots in your shadows just where your planks will meet each other, so as to fit in a stringer or riband, which will run fore and aft at the back of the juncture of your planks, to which you screw them thus:—The riband must be made of tough wood—elm, hickory, ash, or oak—and be sufficiently wide to take a screw each side. The lower edge of the upper and the upper edge of the lower planks are screwed on to the stringer behind as shown.



A, half-shadow; B B, slots for riband.



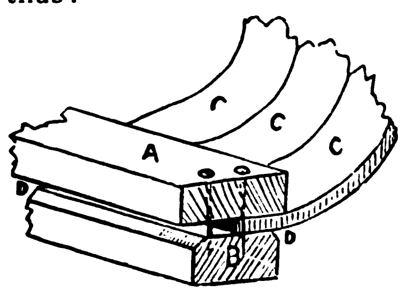
A A, planking. The dotted line indicates the stringer or riband B.

In this way of building you can get a beautifully smooth surface to the plank, and have the joints very tight, hardly requiring any caulking. You can fit a few ribs in where required.

Diagonal Building.

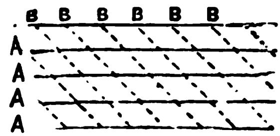
In building boats diagonally frames or shadows are used to form the boat on; and these boats being generally built by firms that have a special name for building them, or by the Admiralty, they keep on hand certain approved models to build from. There are several ways of building a diagonal boat. Their peculiarity is that they are built of two skins or layers of planking, each riveted to the other, forming, when finished, a structure so bound together as to be of great strength, and, at the same time, of extreme lightness; ribs or timbers are either not used or are very small, as the boat depends on her diagonals for strength.

First, we have the construction where the diagonals stop short under the hog-piece, or keelson, which is an especial feature in these boats, and the outer plankings are laid either longitudinally or diagonally, thus:—

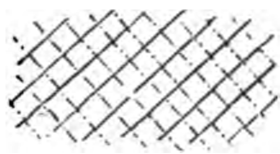


A, hog-piece, or keelson; B, keel; C, inner diagonal skin; D D, rabbet in keel.

You see the inner skin comes half-way in across the top of the keel, and the hog-piece is bolted down to the keel to keep it in its place. D is the rabbet in the keel for the outer skin to fit in; if the outer planking is laid longitudinally it is planked up from the garboard in the same way as a carvel-built boat, treating the inner diagonals as ribs, thus:

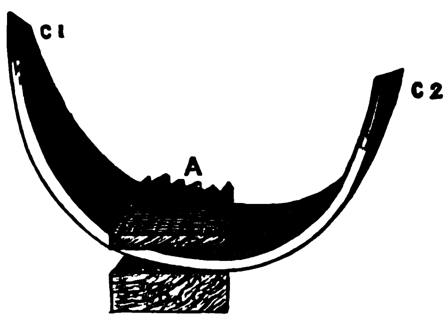


The longitudinal parallel lines A A show the outside planking, and the diagonal dotted lines B B the inner diagonal planking, both are firmly riveted together with copper nails. Another way is to have both outer and inner skin diagonal, thus:



The ticked lines are the inner, the full lines the outer diagonals.

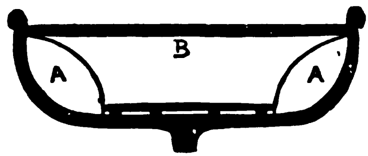
The next and better way of building is when the



A, hog-piece; B, keel; C C, diagonal planking.

inner diagonal skin runs from the gunwale on one side right down under the hog-piece, and up to the gunwale the other side of the boat all in one length, instead of stopping short half-way under the hog-piece:—

In this case the end C 1 of the diagonal will, say, go forward towards the bows, and the end C 2 will go aft towards the stern; and when this is done and the outer planking is diagonal the reverse way to which the inner skin is laid, it makes by far the strongest job, but is more expensive and more difficult. This method is almost only used for lifeboats, either for the National Institution or for large steamers and her Majesty's vessels. These boats are generally strengthened by air-cases, thus:—



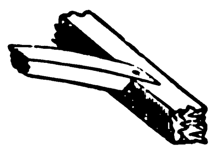
A A, air-cases; B, thwart.

The air-cases run along the whole length of the boat, except in some which are decked in each end, and have there a watertight compartment, in which case the longitudinal air-casing stops short at the bulk-heads fore and aft, to which they are joined. The air-cases along the sides are divided every foot or eighteen inches by water-tight compartments, which materially strengthen the whole boat, and when so constructed there is little need of ribs or timbers. Between the two skins there is generally a layer of some watertight substance such as prepared calico or paper, and sometimes thin sheet copper. But I should not advise you to try and build such a boat unless you are an adept at such matters.

The Deck and its Fittings.

In putting a deck on a model boat, it is perhaps best to have it perfectly flush, with no bulwark or anything to catch or hold the water, and the deck may either be fitted so as to come right out over the top strake, in which case the top strake and stringer must be on a level, or the deck may be brought short inside the top strake, and in this case the stringer should be below the top strake as far as the thickness of the deck. Thus, if the deck is one-eighth of an inch thick, the stringer should be placed one-eighth of an inch below the top strake, so that when the deck is fitted all will be flush. You may adopt either way, but putting the deck on over all is perhaps the easier method. If you desire a bulwark, as I have before said, you must put on an extra strake to the height required.

The deck should be as thin as possible consistent with requisite strength; you must support it by beams put across the boat, the ends of which beams are dropped into a mortice in the stringer thus:—



You must give a certain amount of crop to the beams—i.e. make them slightly curved, the highest point being amidships, so as to throw any water off the deck; and, besides, it gives a better appearance to your craft.

When all is ready, put on your deck over the top-sides and screw it down, putting a little white lead and gold size between the juncture. Line the deck into planks with a pencil and varnish it with pale oak varnish. Before screwing the deck down, be careful to fix the mast-step firmly in its proper position in the bottom of the boat.

We must now consider the deck and fittings.

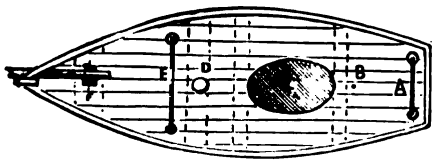
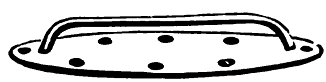


Fig. 1.

A, main-horse; B, eye-bolt for main-sheet; C, hatch; D, extra wide beam to take mast; E, fore-horse; F, bowsprit bitts.

A is the main-horse. This is made of stout brass wire, and is shaped thus:  the ends being beaten out, and holes drilled for screws; or, better still, cut an oval brass plate long enough to take the horse, and bore a hole at each end to pass the wire through, which can be then either riveted or soldered on thus:  holes being drilled and countersunk in the brass plate for the screws. Another way is to get a piece of brass wire, thus: 

with a screw worm cut on the ends; you can then screw on a washer at A, put the ends through holes in the deck, and screw up the nut B, which makes a strong job. However you decide to fix it, you must secure this horse very firmly, as you will hook up the boat by it every time you want to alter the sails or put on the rudder. B is simply a screw-eye to fasten the running-sheet to, while the main-sheet used when tacking is fastened by a hook, thus:  to the main-horse, from which it can be instantly detached when you put the boat before the wind. It is as well to have a second main-horse, similar in form and size to the fore-horse, placed at B—(shown at C on deck plan, No. 2)—this is used to hook on the sheet used when running before the wind.

E is the fore-horse, similarly made; but as it is only to take the strain of the fore-sheet, it need not be nearly so strong as the main-horse. In making horses, take care and make a nice curve at each end, otherwise the hook of the sheet will be likely to jam and put your sail to windward on the next tack.

F is a piece of brass shaped to receive the end of the bowsprit, thus: 

If you have no stop behind you must have a hole in each side of the brass strap to run a fid through to secure the heel of the bowsprit, thus:  another plan is to have a tail-piece to stop the bowsprit; and it will make a neat job if you have them both soldered on a brass plate and screw it on deck, or wooden bitts may be fitted, as Fig. 3.

The deck plan, No. 2, shows the approximate position of the mast, and also another way of fitting the bowsprit. At E a hole is bored in the deck sufficiently large to take a short piece of oak, which is just long enough to project over the deck rather more than the thickness of the heel of the bow-

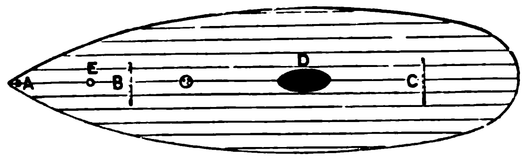


Fig. 2.

sprit, when butted in the bottom of the boat. This piece of oak has a step made fast in the boat before the deck is fitted; or a steel wire or old gimlet can be fitted to it at the lower end, so as to keep it in its place when pushed down in the boat. The heel of the bowsprit is fitted with another pin, and prevented from splitting by a small brass or copper band, and a hole to receive the bowsprit pin is made in the little oak-post which thus receives the heel of the bowsprit, and should it be carried away, it is an easy matter to replace it, or you can put proper bits in, which ought to run down and butt each side of the keel, thus:—

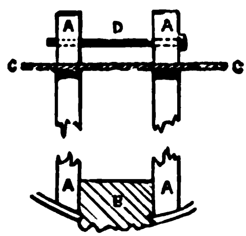
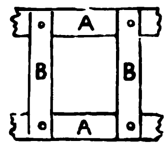


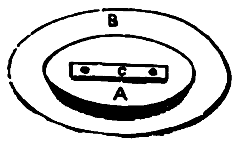
Fig. 3.
A A, bitts; B, keel; C C, deck; D, bowsprit fid.

The dotted lines on the deck show where it ought to be strengthened by the beams, as a greater strain comes in the wake of the hatchway, the mast, and the bits. One broad beam may be used in the wake of the mast, so long as the hole to be bored through the beam is small, so that the beam shall not be too cumbrous; otherwise, you must put a smaller beam each side of the mast-hole – which, perhaps, is the better plan. In a large boat you would have to fit mast-partners thus:



A A, deck beams; B B, partners.

The best thing for a hatch is a piece of cork of a good thickness, say three-quarters of an inch, and cut to fit the hatchway. On the top of the cork fit a small oval piece of mahogany or cedar (a piece of an old cigar-box will make it); this must be rather larger than the hatchway, and fastened by two screws to the cork, which had better have a small piece of wood fitted on the lower side of the cork to hold the screws firmly. The hatchway must be big enough to admit your hand, that you may be able to sponge out the water when requisite. A sponge for this purpose should be left in the boat.



A, cork; B, mahogany or cedar top; C, piece of hard wood.

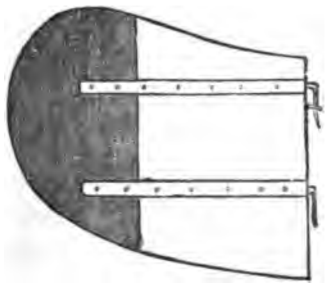
It is best to put on the lead before you start your deck-fittings.

You will see on the plan the position of the lead; you can allow it to run right aft if you like, but do not let it come right to the bow. It is as well to find about what quantity of lead you will require to immerse your boat to her water-line before you cast the lead keel. You can do this by putting your boat into water deep enough to float her fairly, without her deck on, and then load her with lead or stones put inside until she comes to the bearings she is intended to sail on. You can then find the weight of whatever you have used to load her, and that will be the amount of lead you require. Lead costs about twopence-halfpenny per pound new. You will find you can with an old plane, smooth down the lead keel after it is cast until it exactly fits the boat, and also make it of a nice surface, offering little resistance to the water.

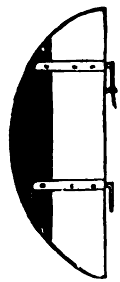
For large boats it is perhaps well to pass bolts right up through the keel, and then screw down the nuts, first putting an indiarubber washer to keep out the water. As it is necessary to have a certain draught of water aft on model boats in order to steer them, and at the same time it is not wise to keep the weight aft, you had better use a small wedge-shaped piece of wood, marked F in Fig. 2, page 51; this will bring the lead lower aft, giving increased draught of water; and you can always either remove it or increase it as you find necessary.

THE RUDDER.

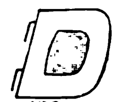
In all model yachts the rudder is a most important point, and without it it would be impossible to sail them off the wind with any accuracy. I am alluding here to the balanced rudder and not to the ordinary fixed one, which is of no use except for ornament, and is never seen on models made by practical men. The weight of the rudder used must vary according to the strength of the wind and the amount of sail carried. This can be done either by having several rudders of different sizes and weights, or by using a metal rudder composed of two pieces, fastened together in such a manner as to enable them to be easily opened if required, so as to alter the weight, which is generally in such rudders given by means of swan shot. But a proper series of rudders to suit all winds is the best plan, though it entails a little extra trouble.



A



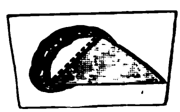
B



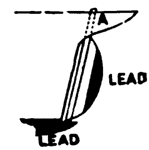
No. 2.
C

As to the best form of rudder, that must depend on the form of the boat, and what she likes. A rudder should not be broad and deep too, but a shallow, short boat runs best with a long, shallow rudder, as at A; for deep boats the most effective form is that as at B.

To make such a rudder, put some brads or screws for the lead to hold to, then lay the rudder on a piece of board, secure it down, and put a mould of putty round,



or, if you can spare the time, make a proper wooden mould; pour the lead in till level with the rudder, leave it to cool. Before using you had better file it smooth, and fit pintles, to fit in eyes in the stern-post. The rudder marked C is made by cutting some wood from the centre, putting a brad or two in, and running the lead in. Or you may make a rudder thus:—



if your boat has a counter fitted with a hole for the head of the rudder at A, and the lead on the keel projects, to enable you to bore a hole to receive a small pin in the heel of the rudder.

For racing boats, brass rudders are very nice; in making them the first thing is to cut out a model in wood of the rudder you intend using, and from this model you can get the founders to make a brass casting, which will be rather rough and need finishing off with a file and polishing with emery-paper. Whatever kind of rudder you use should be so hung as to fit as closely as possible to the stern-post, but at the same time it should swing with perfect freedom, and it is generally considered that a rudder swings more freely and has most effect which has the greatest weight and greatest breadth at or about the L.W.L.

Ballasting.

In all yachts the ballast and the way it is disposed is an important factor in the boat's performance. It is a fatal mistake to put ballast right in the ends of a sea-going boat, the great aim being to concentrate the weight as much as possible amidships;

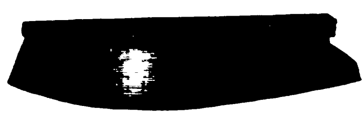
but although this would seem to apply equally to models, I am not sure that it does; model yachts having the lead amidships are frequently too lively and do not keep as steady a course as those in which the weight is more distributed along the keel; but though it may be well for the lead to come right aft in model yachts, it is certainly a mistake to allow it to run right forward; it should terminate some four inches from the stem, the keel being finished off by a piece of wood cut to shape.

Casting the lead keel for a model is a nice piece of work, for which proper preparations must be made. A proper mould should be built or otherwise prepared, and if the keel is of any size care should be taken that the mould is strong enough to resist the weight of the molten metal running into it, as it is unpleasant to have the mould tumble to pieces and the lead run over the floor. Cracks and crevices through which the lead might leak, must also be looked for, and stopped if found; pieces of wood must be inserted in the mould where the screws are to come and of the requisite size; if the screws are small, the wood also being small will be broken or bent by the lead, and you will have to use French nails or thick wire. The whole of the inside of the mould should be dusted with French chalk, and the wire, if used, greased.

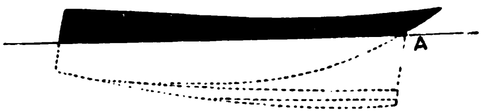
For a large boat it is a simple way to make a model of the keel in wood and have it cast at a foundry, when you can have a brass shoe cast along the bottom of the lead keel at the same time.

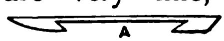
A brass shoe is most essential as it prevents the soft lead from being indented and bruised, which has considerable effect in retarding the boat's speed. The brass should be carried a little way up the stem and stern-posts. If you are not able to get the shoe cast with the lead, you can make one with a piece of thick sheet-brass cut to fit the bottom of the lead keel and the stern-post, and just a bit coming up the stem; as the boat's stem is probably fine, you cannot bring the brass up far, unless you solder a piece of brass wire neatly on to the shoe and fasten it up the stem. To secure the shoe to the lead, holes must be drilled in the brass and countersunk, and small brass screws used; after the brass is firmly screwed on it should be finished off with a file until the sides are level with the lead. To make a better job it may then be soldered all along each side where it touches the lead, and the joint filed down smooth.

Another way of fitting on the lead is as follows, but this is more suitable for small models and after all is only a rough-and-ready plan. First fit a light wooden false keel, and then put two smooth boards, one on each side of the keel; screw these to the false keel slightly, and stop up the ends of the trough with a piece of wood cut to size, and a large piece of putty, which also put along the juncture with the false keel, thus:—



Put the screws to hold the lead, into the false keel before you put on the trough, and then run your lead in, taking care the boat's head is higher than the stern, so as to get more weight at the stern. When cold, unscrew the lead and file it smooth, and then screw it on. Before screwing it on firmly and painting, try your boat and see how she sits on the water. The boat should be down to her tuck, A, and her head should be rather higher, thus :—



See that your trough is tight and firmly stopped with putty, as the weight of the lead will soon force any weak place. Put the most lead where the boat has most body or displacement, and very little on her ends, particularly if they are fine. Another way, when the ends are very fine, is to fit a false keel of wood, thus : 

and put all the lead in the centre part of the boat, A, but as a rule it is better to let the lead come right aft.

The next thing is painting the boat. If she is carvel-built, you will require to see that all the seams in the planking are filled up with white-lead and gold-size, which, when quite set and hard, you rub down with fine glass-paper, and continue going over the boat with glass-paper until it presents a perfectly smooth surface. If you have made a flaw in the boat you can stop it by mixing fine sawdust with gold-size into a stiff paste, and filling the hole with it. This you will find a very useful way of filling up any flaw in the wood.

However the boat is made, you must get the surface of the wood quite smooth before you apply the paint. Get the very best paint you can procure, and, if necessary, strain it through muslin to take out any lumps there may be.

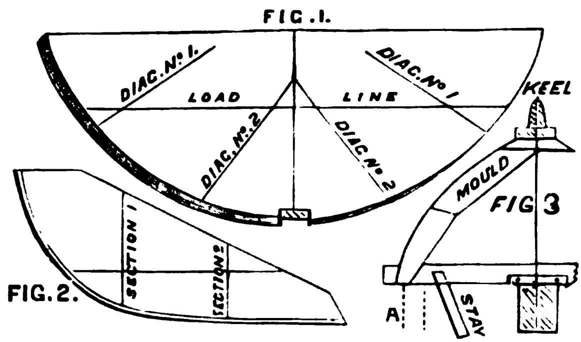
First apply a priming colour, which may be lead-colour, over the whole of the outside of the boat. When this is quite dry and hard—which may take a day or two—go over it with fine glass-paper, and, when smooth, give another coat of priming. The more often you smooth down with glass-paper and repeat the coat thinly the better result you will have; but you will find it a long job, as you must let each coat set thoroughly hard before you smooth it down and apply another. When you have finished your priming coats you can paint the boat as your fancy dictates. The orthodox way of painting yachts is black topsides and copper bottom, as all large yachts, properly fitted, are coppered below water. If you desire to paint your boat this way you must find your water-line—i.e. where the boat sits on the water—and mark this line along the boat. This is best done with a piece of string chalked, which, when the end is fastened to the bow at the proper point down the stem, you hold it away from the boat in a line with the point amidships where your water-line falls, and where the other end of the cord is held. When you let go the string, it snaps down on the boat and marks in chalk the line.

You then reverse the operation from the line aft. The part of the boat above water—i.e. the top sides—you must paint black, and to the bottom under the water, when the topsides are dry, give a coating of gold-size. When this is tacky—i.e. sticky and nearly dry—go over it with a rag rolled in a ball, and just dipped from time to time in gold-bronze powder, which you can get at the oilshop. You will find no more than is necessary of the bronze will adhere, as the surplus passes over where the bronze has fixed to where there are still sticky places left, till at last all the bottom is quite covered, and the surplus bronze dusts off. When this is all finished, and quite dry, you must give one or two coats of good hard copal varnish, letting it set quite hard. Do not lay it on thickly or you will have sticky places for a long while afterwards, and perhaps spoil the look of the boat. Remember that the smoothness of the outside of your boat has a great deal to do with her speed, as the resistance offered to the water by the immersed surface is very considerable, and the smoother she is the more the resistance is reduced. To save yourself trouble, you may paint your boat all one colour, which does not need such nicety of execution, doing away with the waterline, &c.; for a racing model you can make an excellent paint by dissolving red or black sealing-wax in spirits of wine; this composition dries with a beautifully smooth surface and is capable of receiving a high polish. The inside of the boat must also receive one or two coats of paint.

CANOES.

In canoe-building it is an essential point to have everything as light and yet as strong as possible; and while the foregoing remarks may give a good deal of general information, a few details of points special to canoes and small sailing and rowing boats will be necessary.

Having made the small drawing (which must be to a certain scale) to your satisfaction, the next step is to make a working drawing to the full size, or to lay off your drawing on the full scale on to a floor from which you will be able to construct the moulds. These moulds (see diagram) are exact reproductions



of the vertical cross-sections shown in the body plan, but of course on the full scale you are working to. To make them it is necessary to construct a table of offsets in the following manner.

We will assume that your small drawings are on the scale of one inch to a foot; and therefore the offsets will be twelve times the dimensions of those measured from your plans, as each inch and part of an inch will represent a foot or fraction of a foot.

TABLE OF OFFSETS.

No. of Sections.	Stem.	1	2	3	4	5	6	7	Transom.
½ breadths at gunwale									
½ breadths in above, L.W.L.									
½ breadths at L.W.L.									
½ " " 2 W.L.									
½ " " 3 "									
½ " " 4 "									
½ " " upper side of keel. . .									
½ breadths at under side of keel. . .									
Depths from L.W.L. to upper side of keel									
Depths to rabbet of keel									
Depths to under side of keel									

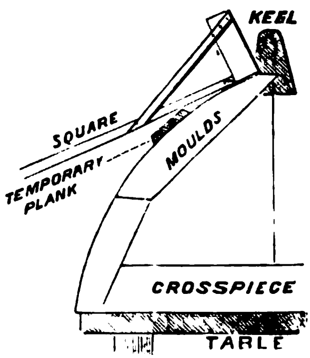
The sections are , apart.
The water-lines , " .

DIMENSIONS.

Length over all
" on L.W.L.
Draught of water (extreme)
Displacement
Ballast {and / or} metal keel

Having constructed the table of offsets from the plans, and in it shown all the different dimensions of your craft, you have the means before you of laying off the plan to the full size; but you must not forget that every slight error that may be in the small plan will be magnified in the larger one, and it will be therefore necessary to fair the lines when they are laid down on the larger scale, which may be done with a fairing-batten, a long slight piece of wood like an exaggerated spline, but rather wider in proportion to its thickness. When the drawing is faired by the diagonal and buttock-lines, and all the breadths and heights of each plan are in, the remaining details, such as bulkheads, tabernacle, centre-board, floors, coamings, &c., can be shown in their proper places. Some plans are drawn to show the outside of the planks, while in others only the outside of the frame is shown, short of the planking, the thickness of which has to be added in. It does not matter which method you adopt, but you must remember, if the first, to deduct the thickness of the planking in laying off the half-breadths for the moulds. If the drawings are laid down on a floor, a batten is laid down over the line you wish to produce a mould from, and this batten is bent to the form of the line and kept in position by a few nails.

The board for the mould is now laid on top of the batten and a mark scratched along the under side by a piece of strong iron wire bent and pointed. If the lines are laid off on paper the moulds can be taken by laying that portion of the drawing you desire to get a mould from, over a piece of suitable board and pricking the line through on to the plank. A batten is then run through the points and the board is sawn to shape; however the moulds are made they must be faired by the drawing and seen to be perfectly accurate, or your boat will be unfair. It is not necessary in laying off drawings to put the body plan at one side of the others—to economize space it is usually put in the middle of the sheer plan. The mould for the stem is as shown in the diagram (Fig. 2), and Fig. 3 shows the half-section of a frame set upon a trestle and stayed—it is better if a regular table, with legs, as shown at the dotted line A; is roughly and strongly constructed to build the boat on; but however the table is made, or if the boat

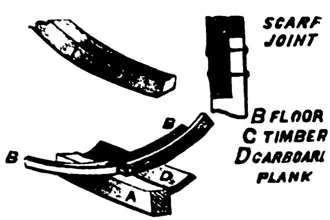


is built on chocks keel downwards, or on a trestle, it must be firmly and securely stayed, and if built keel downwards stays from the roof or sides of the loft will probably be necessary before commencing to plank. All the frame that is up, keel, stem, and stern-post, must be carefully tried with a plumb-line and made perfectly square and true, and this should be done at different times during building, as part of the boat may fall out of the square and need putting right before it is too late.

The stem and stern in a canoe must be very strongly constructed to take the bumping and knocks almost incidental to such craft. A very good form of stem is shown in the diagram of tabernacle No. 2 (page 251); it is termed a wedge joint; the dot at the scarf indicates a stop-water, which is a plug of wood driven into an augur-hole bored through the scarf, one half of the hole being on either side of the joint. This stop-water prevents leakage down the joint and should be inserted wherever a scarf is necessary; the stem is strongly nailed or bolted, and secured to the knee shown at C.

One of the most difficult matters in boat-building is to spile (or measure) the planks correctly; and this is particularly the case with the garboard (the plank next the keel). In spiling, a batten called a spiling-batten, or "staff," is required. This may be made from any rough stuff sufficiently pliable to bend easily round the frame to the form of the boat. It may be in one piece, which is preferable, or if too long to handle, or for other reasons, it may be divided into two pieces, which should overlap one another. We will suppose you are taking a spiling for the garboard, the moulds being up and the keel, stem, and stern put in position and properly secured. The staff, or spiling batten, is selected, long enough to come right along the boat in about the position the garboard will be, and its ends are roughly shaped, so as to fit into the rabbets in the stem and stern-post, while the upper edge (we assume the boat is being built keel up) is shaped roughly to the keel rabbet. This had best be done before the ends are shaped—when the staff is dubbed down so as to take its right position along the rabbet of the keel, touching each mould, and coming home at the butt-ends in the rabbets of the stem and stern. It must be secured by small nails, which are first driven through pieces of wood to act as a head and prevent damaging the batten; these are also used whenever it is necessary to keep a plank in position. A piece of stout leather is better than wood, as the nail can be pulled out and used over again, while wood frequently splits, unless it is a piece of hard wood, as oak. The staff should not be of unequal thickness, or it will have a tendency to buckle, and it entirely depends on the fit, if you can use the term, of this batten, how the garboard will lie.

The next step is to mark both keel and batten with pencil-marks to serve as guides to the measurements you will afterwards take; they must, therefore, be as long as these measurements, say 3 inches. The marks may be 4 or 5 inches apart in the straight, but in curves, as at the rounding up of the bow, they must be nearer, say half that distance, 2 inches. When the marks are made right along the batten, you must set the compasses at say 3 inches, and you may as well start by making a circle on the batten, to which you can refer from time to time to see if all is correct, though, if you use set compasses, and fix the screw at the point you desire them to work to, they are not likely to spread. You now mark off the 3-inch span from the keel, stem, and stern-post to the batten just on the pencil-marks you have previously drawn. The line just at the rounding up of the stem is called a sirmark, and used to adjust the garboard. The position of each mould must be also carefully marked on the batten. Having thus prepared the batten it must be removed and laid carefully on the plank you have selected for the garboard, and secured in position by a few small wire nails lightly driven in. The measuring operation with the compasses is now reversed, as you measure off (the compasses being set at the same distance) from the points on the batten to the plank, and when all are in, a fairing-batten is applied, touching in all the points, and a line run in and the lower edge of the garboad sawn to shape. Before removing the garboard plank the position of all the moulds must be marked off on it and also the sirmark. The upper edge of the garboard is laid off by taking the breadths at each mould, and marking them off from the points on the plank; and if the boat is clinker-built, an allowance of half an inch at least must be added for lapping over. The garboard is now laid in its place by the sirmark, and laid carefully along bit by bit; it will not do to bend it in all at once, but as each part is tried and found to fit, it should be clamped on until it is in its place along the entire length; extreme carefulness must be used in nailing or screwing down the light planks of a canoe, as they are very easily split; the plank and the adjacent frame should be firmly brought together before the



A, keel.

screws are driven home, or the plank may spring out and split. The lower edge and end of the garboard must be properly bevelled to fit the rabbets of the keel, stem, and stern-posts. When the garboard is in, the other planks are fitted by means of spiling battens in the same way as described for the garboard. In putting in the planking, all the nails that secure them to the ribs must be left till the last, but all the other fastenings can be put in, and if necessary, the plank must be secured to the mould to keep it in its place; but if this is done, the place must be marked, that the nail-hole may be afterwards stopped when the mould is removed. When all the planks are in, a batten is used to mark a straight line for the nails, for each rib or timber. This batten reaches from the keel to the gunwale when bent to the form of the boat, corresponding marks being made on the keel and gunwale to fair the batten by, and it must be seen that these marks are square, or at right angles to the line of the boat's keel; the nails are driven in the planking, commencing from the garboard, holes being first made for them by a gimlet or small bit, and the timbers, being steamed if necessary, are bent to shape, and held in position across the planking. The copper nails are then driven through the timbers, and the head being held firm by an assistant with a hammer braced against the head of the nail, the roove is slipped over the point from inside and driven home. With a rooving iron the projecting end of the nail is now cut off, leaving just sufficient to form a rivet to prevent the roove parting; the nail is riveted by a few light blows of a riveting hammer, which must not be too heavy. There is a knack in riveting neatly which it is as well to acquire by practice on some old planking before commencing to close up the boat you are working at. The gunwales may be put on either inside or outside the planking; in the former case the timbers must come short of them, or they must be joggled over the timbers. In the latter, which is easier and makes a strong job, the gunwale is fitted outside the upper strake; they had best be made of hard wood, as they take a lot of chafe, and soft wood would soon be knocked out. The ends of the gunwales where they butt on the stem and sternpost should be thoroughly fastened by being riveted on each side, a bolt passing through all; a similar fastening should also be employed where the gunwales cross timbers, the head of each timber being riveted to the gunwale.

The bulk-heads need careful fitting; they are made of half-inch plank, ordinary pine will do, and are riveted to the forward side of the bow timbers and the after side of those at the stern. It is a common practice to put a door in the bulkheads for stowage and other purposes, and if this is done, as a rule, they are almost useless for the purpose of floating the canoe if upset, as just when it should be closed it is most certain to be open. However, if a door must be put, the best way of fitting one is to cut an oval hole in the bulkhead, with a proper hatch to cover it; if this hole is cut far enough up the bulkhead, the hatch may be hinged on at the lower end, and when open will fall flat against the bulkhead clear of the floor; the side of the hatch which fits against the bulkhead may be fitted with a rubber ring round it, and at the upper end with a thumb-screw on a revolving hinge bolted to the bulkhead, and a slot must be cut in the upper side of the hatch to receive it. To secure the hatch when shut, the thumb-screw is pulled down in the slot, and screwed up; if this is well fitted, as tight a joint can be made as is possible under the circumstances.

The fastening is a peculiar one and will be better understood by looking at one used for closing the lights in the deck or side of a yacht or passenger-steamer. In most canoes, the object is to get the weights as low as possible, and therefore either no regular floor boards are used, as in *Rob Roy*, or they are placed right on the timbers. The objection to this is, that the smallest amount of water, either taken on deck or arising from leakage, wets the crew, and in the larger canoes it is well to raise the floor boards slightly to allow a little water to lie without rising over them. In large boats it is necessary to have limber holes, which are slots cut on the under side of the timbers to allow the water to run freely fore and aft; and, as this would materially weaken such small material as the ribs of a canoe, these had best be left intact, particularly as they are not high enough from the bottom of the boat to do much in preventing the fore-and-aft flow of water; but, if ledges are used to carry the floor higher, it will be necessary that these have water-ways cut in them: these ledges should be high enough to take the floor boards, say, 2 or 3 inches off the garboard, and must be neatly fitted to the planking and joggled over the laps; they are better placed against the timbers, and only the side flooring should be screwed down to the ledges, as it is frequently needful to raise the middle floor board for stowage, shifting ballast, or cleaning the boat.

The deck beams can be about one inch by half an inch, and must have a good crop, as before described in construction. In canoes this crop might be as much as one tenth of the beam. The flatter the deck, the less buoyant the boat will be and the more she will hold the water. The beams must lie on top of the timbers, flush with the gunwale, and can be secured either with small knees or thick sheet brass or copper, cut in strips and bent to the required angle. To support the masts you will have to fit carlines along the beams fore and aft, put far enough apart to take the mast tubes. The cross-beams for the mast may be in two, one each side of the mast, crossed by the carlines, or one extra wide beam may be used instead, and the mast-hole bored through it; the former is the proper method for large craft.

The deck may be, if for a small canoe, in two pieces of mahogany or cedar, joined longitudinally down the middle of the boat; and in this case a broad carline must run under and carry the sides of the deck planks. In large canoes it will be found difficult and expensive to lay the decks in this way, and they will probably have to be put down in several pieces, which method, too, allows part of the deck to be removed for any purpose without spoiling the whole. In this way of fitting the deck it must be seen that those beams that take the butt ends of the deck pieces are wide and strong enough to carry them properly.

When the deck is fitted, and the place for the well (of which the carlines have first been laid) roughly cut out in the deck, the coamings can be got out; they should be of hard wood, as they have a lot of heavy work; oak is perhaps the best to employ. The coamings may be deep enough to come from the full height you intend them to be over the deck down to the bottom of the carline, to which they are secured by rivets or screws, or the carline may be allowed to project as far as the thickness of the coaming, which will then rest on it, and will be shallower by the thickness of the carline. Before fitting the deck, &c., the boat should be thoroughly tested for leaks, the bulkheads and water-tight compartments tried, a coat of lead-colour paint should be given inside, and the hold of the canoe finished off completely before you screw down the decks. The stretchers, foot-steering gear, bulkheads, mast-steps, centreboard cases, tabernacle fittings, and various other internal fittings, require attention and completion before the deck is screwed down. Most canoes are varnished outside, and particular attention should be paid to obtain good copal varnish, and to let each coat dry thoroughly before applying the next. The brush should be lightly used one way, and not run backwards and forwards, which will only froth up the varnish, and spoil the look of the boat. If a good surface is desired, a great many coats must be given, each one being rubbed down when set with fine glass-paper before the next is applied. This was fully described in a previous chapter.

CHAPTER VIII.

MECHANICAL CONTRIVANCES.

BESIDES the paddling and sailing canoe, there are canoes propelled by other means. Amongst these are steam canoes, screw and paddle canoes, in which the motive power is supplied by the occupant through an arrangement of cranks and cog-wheels, something after the principle of a tricycle, and canoes driven by electricity or galvanic batteries.

A friend of mine a short time ago amused himself during the "long" (he was a University man) in fitting a canoe with steam-power. The boat he bought very cheaply; I think it cost about four pounds. It was fitted with a screw and screw-shaft, and was then arranged for propulsion by the working powers of the occupant.

My friend removed all this gear and made a very neat engine, the cylinder turned by himself, and all the parts cast from moulds made from his wooden patterns.

These castings he afterwards filed down as requisite. When he showed me the engine it was complete and screwed down to its bedplate ready for use.

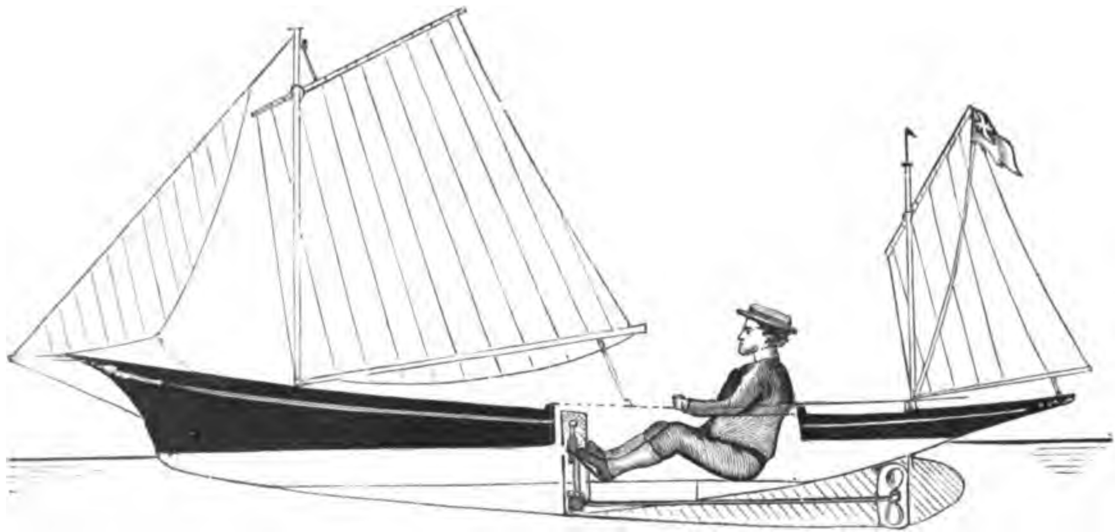
Now, in these small steamboats—and indeed in most contrivances propelled by steam, large or small—much more depends on the boiler than on the cylinder.

Of course the cylinder must be strong enough to carry steam, and tight enough to hold it fairly well, but a very ordinary engine with a first-class boiler able to supply and keep plenty of steam is far better than a second-rate boiler and a first-class engine, though, to be sure, as is related in the legend with regard to the bishoprics of Bath and Wells, "Bauth is best."

The difficulty with my friend, as indeed with many others, was how to get a boiler light enough, strong enough, and, lastly, and by no means leastly, cheap enough. This riddle he solved by making his boiler of hydraulic tube, having ends cast and fitted, while a number of small internal tubes enormously increased the heating surface, and at the same time acting as stays greatly strengthened the boiler.

After several preliminary cruises in the Thames, he sent the canoe by boat to France (Havre), and steamed up the Seine for some distance.

To construct such a canoe as this would be above the ability and resources of most amateurs, and, indeed, after it is constructed it is a constant source of worry and expense. Still the fitting of an existing canoe with screw or paddles for manual propulsion is not very difficult, and indeed is within the capa-



MANUAL SCREW CANOE.

To face p. 173.

bility of any person handy with his tools. But it must be remembered that for speed nothing of the kind is as good as the oar, and for handiness nothing beats the paddle.

It was on the upper waters of the Thames, some years ago, that the writer saw the canoe depicted on the opposite page. It was one of the first of that type ever produced, and created rather a sensation at the time, for with no sail set, and with the owner sitting with his arms folded across his chest, it went through the water at some three knots an hour.

It looked very pretty, and would be useful on a crowded river for dodging in and out of a multitude of craft, but the work would probably be tiring and too much confined to one set of muscles; in rowing both legs and arms are used. The paddle-wheel is a simpler contrivance, and would do very well on a private pond, but the best application of it is for the double-canoe, where the worker is able to sit as on a bicycle over his work, and thus economize power.

All such arrangements are only fancy ones (except the latter), as the power gained by the leverage of the oar is far greater than that obtained in any other known way of utilizing one's strength for the purposes of propulsion of water-borne vessels.

The diagram represents a section of a double-keeled canoe, with a hollow bottom, that was on view at the Fisheries Exhibition. It was claimed in its favour that by the form of the bottom an enormously increased stability was obtained, and it

CHAPTER IX.

CANOES.

THE word canoe, probably derived from the French *canot*, a small boat, includes a great variety of small craft, but although they differ widely in many points, there are one or two which are common to most of them.

One is that they are propelled by paddles or some such contrivance, instead of oars; the paddles being worked without a fixed fulcrum, as a rowlock, and the paddler facing the bow of the canoe, whereas the oarsman uses a fixed fulcrum, and has his back towards the bow.

Another peculiarity of the canoe type is that the length is far greater in proportion to the beam and depth than is the case in an ordinary boat.

Most canoes, too, are pointed at both ends, whale-boat fashion, but in these and other particulars some craft termed canoes differ from the general type, the large Mersey canoes being frequently propelled by small oars (also called paddles), and other "canoes" having been built with a regular counter stern.

To give a hard and fast definition of the word canoe, therefore, is no easy matter, as the varied kinds and types differ in some cases so much that the same name seems hardly applicable to them. For example, the Canadian canoe is undecked and capable of holding several persons, while the kayak of the Esquimaux is completely covered in, with the exception of a small opening, and is as a rule only intended for one occupant.

In England little was known of the capabilities of canoes until the adventurous cruises of the celebrated *Rob Roy* brought into public notice a type of boat that was at once inexpensive, handy, and safe in rough water, and from that time we may date the commencement of canoe cruising and racing, which has since attained proportions which could hardly have been imagined by the originator.

Racing canoes now are as carefully built as racing yachts, and their design is as carefully studied, while to properly handle a racing canoe requires not only a considerable amount of practical knowledge, but a natural aptitude which comparatively few possess.

Successful canoists are also generally authors of various ingenious inventions for saving trouble in managing their craft and for carrying a maximum of sail with a minimum of trouble in managing it, and these clever innovations are seldom worked successfully by a novice.

It is evident on examination that the modern canoe is simply the outcome of the original construction of the savage, improved and altered by the natural principle of selection and survival of the fittest.

N

Those craft most suited to the purpose for which they are used have been handed down from generation to generation without change by their savage owners, until civilized man, taking the general idea, altered it to suit his particular requirements and the materials at his disposal, making a construction possibly more convenient for himself and the conditions under which he intended to use it, but not necessarily improving on the original structure as intended for its particular uses.

Thus the kayak of the Esquimaux is undoubtedly the prototype of the celebrated Rob Roy class of canoes, while the water-velocipede is only the double canoe of the South Sea on a small scale and differently propelled, and the birch-bark canoe of the North American Indian is the model from which all the cedar-rib and bass-wood canoes now so fashionable are built.

Let us then look at the different types of aboriginal canoes before we proceed to consider those more suited to our materials and requirements.

The Kayak or Eskimo Canoe.

The Eskimo canoe is built of skin sewn together over a framework of bone, and is decked completely in by skin except the opening in which the occupant sits, which has a coaming of three or four inches high round it to keep the water out.

The canoe is long for its breadth, about twenty feet, by not quite two feet wide, and is flat bottomed, low amidships, rising at the ends.

A double paddle is used, rather long, and it is impossible to imagine a boat more suited to the region in which it is used.

Able to go with safety through a rough sea, light enough to be hauled up on an ice-floe or hauled over the ice for long distances to open water, it is indispensable to its owner, who uses it for fishing and sealing.

In pursuit of seals he pushes off, armed with a barbed harpoon with a bone head, having a line attached to it, secured at the other end to a large inflated bladder. He sees his quarry before him, and with a vigorous sweep of the paddle he is within range, and the harpoon, hurled with unerring aim, is buried in the blubbery body of the seal, which immediately dives under water, but finds itself hampered in its movements by the float, and soon has to come up to breathe, when another harpoon or a lance renders it fit for the cooking-pot.

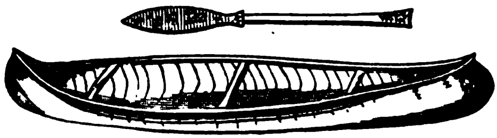
In all such primitive constructions one cannot but remark that although they may differ widely and completely in every detail, yet each type of canoe is exactly suited to the conditions under which its builders intend to use it, and in most cases is so completely adapted for its intended work and to the means at hand for building and repairing, that civilized industry is able to do very little towards improving the principles of their construction.

Thus, the kayak is exactly suited for the rough waters of the ocean, and would be useless for the purpose for which the birch-bark canoe is intended, while the latter would be equally out of place in the Arctic regions, and on the ocean would be very much "at sea."

This adaptability of form of boats to their surroundings is not confined to canoes, but is found to exist in all forms of boats. The Deal lugger and galley are quite different from the Cladagh hooker, and both are the antipodes of the north-country coble, while the Thames bawley-boat, the Yarmouth smack, the Cornish lugger, and the Scotch herring-boats are all again different, and yet these boats are all intended for one purpose—fishing, and are all made by natives of one country—Great Britain!

THE BIRCH-BARK CANOE OF THE NORTH AMERICAN INDIANS.

This canoe in its design and construction is most beautifully adapted to the purpose for which it is used, and I doubt much if one of our best naval architects could give a design more calculated to fulfil every detail of requirement than is shown in this of the rude savage.



The only way to reconcile this apparent anomaly is to concede that the two designs would be produced on an entirely different basis, the one being the outcome of generations of canoes. Thus, the first one possibly was unsuccessful in several points; one by one these were corrected. Designs bad here and there were altered as experience and frequent upsets and disasters indicated.

Probably after several owners had been through various dangers of drowning involved by their bad design, they observed that one of the tribe seemed to escape upsets in a marvellous manner; they ask questions and look into the matter, and find his canoe differs in minor particulars that produce major results, and copying him, they go on till other accidents show further desirability.

For instance, a rock is in the way and the rapids hurling the canoes on; one turns, just in time, while the other is dashed to atoms, and her crew have a narrow escape, but lose all their impedimenta. What is the reason? They examine and question, and find out and imitate, and succeed in making a more handy craft, and so this process goes on.

A good rough-and-ready process, too, but it takes time, till at last all requirements are fulfilled; a complete type is produced by the survival of the fittest, and that type handed down from father to son becomes the orthodox method of construction.

Now the clever naval designer of to-day does not proceed altogether in this way. He knows certain principles and laws of opposing forces, and by regular formula proceeds to draft out his plans, but still when he departs from old types that have been handed down he does not always succeed. Still, the art of naval designing has made great strides of late years, and brilliant successes are achieved by the naval architects of the day.

One of the most curious things in the Canadian canoe is the form of the bow, which is what is termed a U bow from the form of the vertical cross section, and this bow, though used for so long by the Indians, has only lately been introduced and largely used by ship and yacht designers.

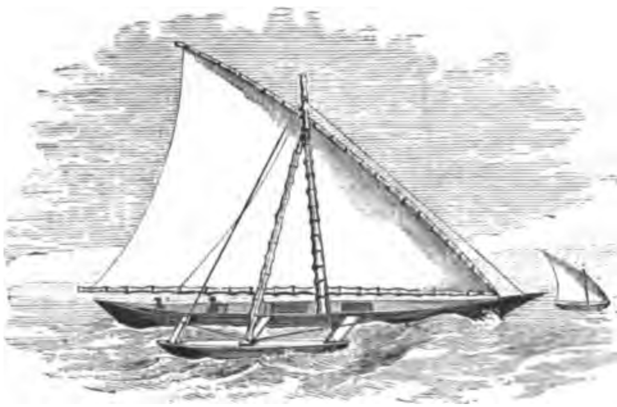
This peculiar form of bow, giving a great amount of buoyancy, enables the canoe, although almost up-ended and buried forward, to go through the roughest water without shipping a drop. This is the more necessary as these canoes are quite open, and if the water tumbles aboard there is nothing in their construction to keep it from swamping them. The Esquimaux kayak, on the contrary, completely covered in, can be driven through the rough water, which may tumble over it without any danger of filling.

Built of the bark of the trees abounding in the country, sewn by the roots of other trees and shrubs plentifully to be found, and caulked at the seams with gum,[1] another common product of the country, the birch-bark canoe is easily built and repaired, while by its form it can shoot the foaming and surging rapid with safety, and when one of the frequent cataracts occur that break the course of the "rivers in the woods," the light canoe is easily portaged past the obstruction and once more launched on the river below the fall.

Many of the canoes of the South Sea Islanders are most beautifully finished, the paddles belonging to them being profusely carved, and finished with a perfection that we rarely see in civilized workmanship. In looking at specimens of the handiwork of savage nations, one often wonders how it was possible to produce such results with the apparently inadequate means at the disposal

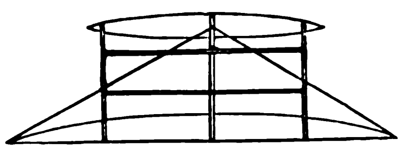
[1] This gum is almost impossible to procure here, and I had great difficulty in repairing some canoes of this description in my possession, but when at the Fisheries I learnt the method of doing so from the old Indian trapper in the American Department. He told me to take resin and oil and boil them together until they were like toffee. The method of ascertaining the proper degree of consistency is by trying a portion with the teeth. If it adheres but slightly it is ready for use. This preparation hardens when removed from the fire, and is kept in the canoe in case of an accident, when by heating it is ready for application.

of the makers, but this wonder lessens when we remember that time is of no object to a savage, and he will therefore spend hours of work with a very trivial result, the carving of perhaps one paddle being a work that would exhaust the patience of



Flying proa of the Ladrones.

any civilized man. The only exceptions that occur to me are sailors, some of whom certainly spend an enormous amount of time and trouble on little matters of ornament, such as fancy knots, &c.



Section of flying proa showing construction.

The canoes constructed by savages being nearly always made from the trunk of one tree, can be made of almost indefinite length, but it is not so easy to give beam to such craft, that being regulated by the diameter of the tree, and as the diameter does not increase sufficiently in proportion to the height, an unusually long craft would be very crank in a seaway. This the savage would naturally try to obviate, and hence the outrigger, which has the effect of making the narrowest boat stable and stiff under sail. In ordinary weather the weight of the outrigger to windward would be enough to keep the canoe steady, and when the wind freshened what could be easier than to send a few hands out to sit on the outrigger to act as shifting ballast?

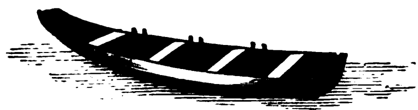
Double canoe, South Sea Islands.

A very remarkable instance of savage skill in this class of canoe is the flying canoe of the Windward Islands. These islands lie in such a position that there is always what is called a "soldier's wind" blowing between them, that is, a wind on the beam, allowing one long reach to be made with almost a certainty of fetching the desired port. Still, it is well in such a case to be as much to windward of your destination as possible, as one can always "bear up" and run down off the wind to the port, but it is not so easy if the craft by some means drops to leeward for it to work up to windward again. To meet this requirement the builders of the flying proa adopted a remarkably clever design. The leeward side of the canoe is left perfectly straight and flat, so as to oppose the greatest possible lateral resistance to the water and thus prevent leeway, while the windward side is shaped in the ordinary way. In fact, the canoe is something like a half-breadth model; from the windward side project the outriggers, with a small canoe at their ends. When the canoe reaches its destination the mast which is amidships, raking forward, is raked towards the other end of the canoe, and the huge sail swung round, so that what was the bow of the boat becomes the stern, and *vice versâ*. Thus the flat side is still kept to leeward, and the canoe is ready for her homeward voyage.

The canoes of New Zealand are beautifully made and generally profusely decorated. Some of the large war-canoes are of enormous size, holding more than one hundred men. The rowers pull or paddle double-banked, and a platform is erected to accommodate the chief and his friends. These large canoes are propelled at a great rate, and the crew generally keep time by shouting and singing as they labour at the paddles and urge the great canoe through the water.

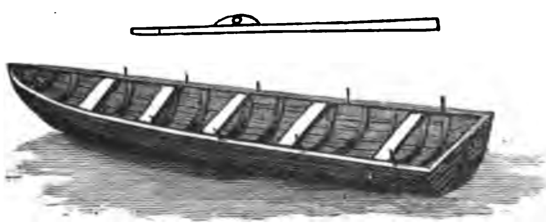
Many of the South Sea canoes are double—that is, formed of two canoes parallel with one another, a platform being thrown over them amidships, and in some cases a house erected on it. These canoes are generally steered by a long oar, and are propelled by large sails made of matting. The boats used in China are called sampans, and generally have a cabin aft.

Their form is much the same as the Norwegian



Norwegian präam.

präam, which is still used on board Norwegian ships. It is round-bottomed, something like the section of a barrel, the stern being much wider than the bow, which curves upwards and out of the water for two



Irish corragh.

or three feet, ending in a small flat half-moon-shaped piece of wood, to which the ends of the planks are fastened, the stern being also flat and semicircular. It is an easy sort of boat to build and tows remarkably well. The corragh used on the west coast of

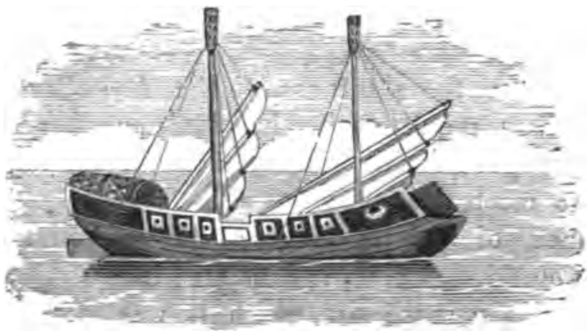
Ireland is somewhat of the same shape, but constructed of canvas over a framework of wood. The paddle or sculls used with it are peculiar, as shown in the sketch; they are fitted with a piece of wood pierced with a hole to take the thole-pin, and by this contrivance, even if let go, they cannot break away from the boat. The corragh is a fine sea boat and very dry.

On the Severn and in Ireland a curious kind of craft called a coracle is used. It is something like a half walnut-shell in shape, made of skins or tanned leather over a wooden framework.


Coracle.

Although many canoes of savage tribes are intended for sailing, it is difficult to find in them any means of offering lateral resistance and preventing leeway, with the exception of the flying proa, the construction of which has been alluded to. Keels, centreboards, and leeboards, all of which are intended to give lateral resistance, seem only to appear in craft constructed by civilized man. And some contrivance is absolutely necessary to prevent leeway, for a vessel deprived of these would only be able to sail with the wind and be incapable of beating to windward against it.

This indeed was the case even with large ships down to a comparatively recent date. It is not many years ago that large sea-going vessels had to wait weeks together for a favourable wind, their build being so unsuited for beating to windward that it would have been mere waste of time for their captains to put to sea until a fair wind arose. In the present day most sailing-vessels are so constructed as to be able to make at all events some way to windward against an adverse breeze, though of course a square rigged merchant-vessel, although



A small junk, or sampan, from a Chinese painting.

a clipper amongst her own class, would do very little against a smart yacht or other fore-and-aft-rigged vessel, which on a dead beat to windward would soon leave her out of sight to leeward, as any fore-and-aft-rigged vessel can sail several points nearer to the wind than a square-rigged craft, and would thus gain on every tack, even if only going through the water at the same speed.

The *Rob Roy* was the first canoe of a safe and handy type, the canoes in existence before its appearance being generally exceedingly shallow and very dangerous, for although they were partly decked, they were left open amidships for the reception of the occupant, the fore part of the deck stopping short some nine or ten inches from his feet, and it was impossible to keep out the water if from any accident the gunwale of the canoe was forced under water. Such canoes are even now used in some places, and the general type of canoe let out for hire at most boat-houses is of this description, *Rob Roys* being in general only constructed for private owners.

Owing to the shortness of the *Rob Roy* type, which was requisite to give sufficient handiness. extreme speed could not be attained "under paddle," and to meet this want the *Ringleader* canoe was designed, of extreme length as compared to the *Rob Roy*.

For the purpose for which it was intended it answered very well, and it was capable of being paddled at a great speed, but in the *Rob Roy* races, which are a compound of paddling, sailing, drawing the canoe over a certain length ashore, jumping over a ditch, and climbing over a hedge hauling it after, and sundry other evolutions, finishing up with an upset and a swim in clothes, towing the canoe, the *Rob Roy* type came off victorious, being possessed of more all-round qualities.

The *Ringleader*, which was built on the axiom that "length means speed," is not much seen now, and canoeists have as a rule gone in for craft that can carry canvas and go to windward under it; and in considering them we come to sailing canoes, such as the *Nautilus*, *Pearl*, and *Mersey* canoes. These canoes, which can be readily paddled on occasion (with the exception of the latter type), depend more on their sails than the paddle while there is any wind at all, as they can work to windward under sail faster than they can be paddled, which is not the case with the *Rob Roy* type, which is a sort of compromise, being neither a racing paddling canoe of the *Ringleader* type, nor a sailing canoe, but a canoe that can be easily paddled and carries sail on suitable occasions.

The great difference in the two forms of sailing is this: Supposing in a *Rob Roy* you have a fair wind, either a run or a ratch. All you have to do is to up sail and off you go merrily enough; but if the wind be dead against you, then perhaps with a specially good boat of the type you might draw a little to windward close-hauled, but it would not be much, and would be such slow work that you would soon find that if you wanted to progress against the wind you would have to douse sail and get up steam.

Now, in a sailing canoe all is quite different. She will outpace the *Rob Roy* off the wind at such a rate that in no time the travelling canoe will be where the little boat was, "a long way astern," and when close-hauled the *Rob Roy* would never see the way she was going, for the sailing canoe would, thanks to her centreboard, lie as close to the wind as a cutter, and with patent reefing-gear could snug down at a moment's notice so as not to care how many hands were at the bellows, and if blowing up a gale of wind a *Mersey* canoe with mizen set in place of the main or with other snug sail would go over the seas like a duck; but—and there is always a "but," for it is not easy to find perfection—you would not much like the job of using a sailing canoe for travelling, not only on water, but over hedges, on railways, and occasionally dragging it yourself overland from one piece of water to another.

The *Rob Roy* is best for what it has been designed for, and the sailing canoe for its purpose, and an intending builder must first know what he wants, and then set about getting those wants fulfilled in the most complete way in the craft he proposes to construct.

The *Rob Roy* canoe and its adventurous owner and designer, J. MacGregor, Esq., are well known, not only to canoeists but to the reading world in general. It is not, however, so generally known that the inventor of the *Rob Roy* is one of the survivors of the crew of the *Kent*, East Indiaman, lost by fire many years ago. Colonel MacGregor, the father of the canoeist, was in command of the troops on board, and "Rob Roy" MacGregor, then an infant in arms, was passed down into the boats with those of the troops and crew who escaped. Some time since the writer had, by invitation of Mr. MacGregor, the pleasure of a most interesting inspection of the various *Rob Roys*, that of the *Baltic*, *Jordan*, &c., and the many objects collected during the canoe travels, which formed quite an extensive museum of extreme interest, not only to a canoeist, but to any one fond of foreign travel; for Mr. MacGregor's researches extended to such out-of-the-way places thanks to his unique means of locomotion, that he saw the countries he visited as probably no other traveller had done before, and in such new and varied aspects as to make the numerous mementoes

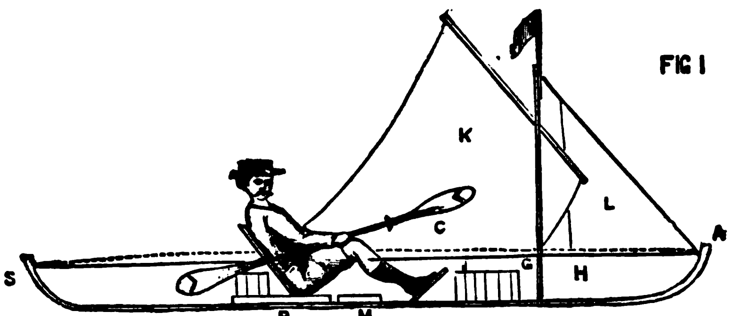
"Dolce far niente."

of these canoe voyages of peculiar interest, for each paddle spoke of the exploration of some new regions, and every little flag, with its silk faded and torn, told of sunshine and clouds, calm and storm, and dangers and trials of many kinds, manfully overcome, cheerfully endured, and graphically related. At the same time Mr. MacGregor kindly gave me permission to use his description of the canoe invented by him, which I have therefore given unaltered, as no one can better state its salient points and complicated details than the man who first originated it and afterwards showed the wide and varied uses to which it could be put.

The *Rob Roy*, Mr. MacGregor says, was designed to sail steadily, to paddle easily, to float lightly, to turn readily, and to bear rough usage on stones and banks, and in carts, railways, and steamers; to be durable and dry as well as comfortable and safe. To secure these objects every plank and timber was carefully considered beforehand as to its size, shape, and material, and the result has been most successful. In the efforts to obtain a suitable canoe for this purpose ready made, it was soon found that boat-builders might be proficient in the cabinet-maker's work of their calling without any knowledge of the principles required for a new design, especially when sailing, paddling, and carrying had to be provided for at once, and the requirements for each were unknown except to those who had personally observed them and had known how to work the paddle as well as the saw and plane. A canoe ought to fit a man like a coat, and to secure this the measure of the man should be taken for his canoe. The first regulating standard is the length of the man's feet, which will determine the height of the canoe from keel to deck, next the length of his leg, which governs the size of the well, and then the weight of the crew and baggage, which regulates displacement to be provided for. The following description is for a canoe to be used by a man six feet high, twelve stone weight, and with boots a foot long in the sole.

The *Rob Roy* is built of the best oak, except the top streak of mahogany and the deck of fine cedar. The weight without fittings is sixty pounds, and all complete seventy-one pounds. Lightness is not of

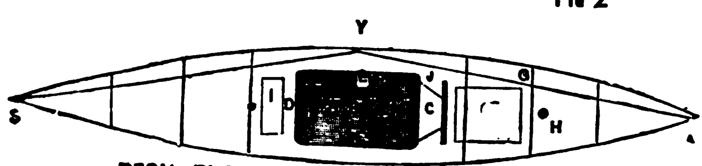
FIG I



SHEER PLAN

so much consequence in this case as good lines, for a light boat if crank will tire the canoeist far more in a week's cruise than would a heavier but stiff

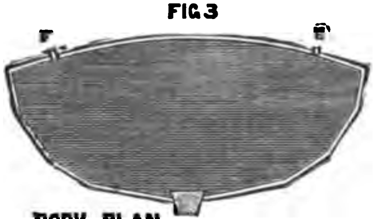
FIG 2



DECK PLAN

craft which does not strain his body every moment to keep her poised under the alternate strokes of the paddle or the sudden pressure of a squall on the sail. Fig. 1 is a section of the canoe with masts and sails, Fig. 2 a bird's-eye view of the deck, Figs. 3

FIG. 3



BODY PLAN

and 4 cross sections at the beam and at the stretcher, Figs. 9, 10, and 11 the backboard and the apron. The other drawings show particular portions more minutely. The principal dimensions are—length over all (A S), fourteen feet; from stem to beam (B), seven feet six inches; beam outside, six inches abaft midships, twenty-six inches; depth from top of deck at C, fore end of the well, to upper surface of keel, eleven inches; keel depth outside, one inch, with an iron band along its whole length three-eighths of an inch wide; camber, one inch; depth at gunwale, eight and a half inches. The upper strake is of mahogany, and quite vertical at the beam, where its depth is three inches. The garboard strake and the next on each side are strong, while the next two are light, as it is found that they are less exposed than the others, particularly where all these lower strakes are of oak. The stem and stern posts project over the deck, so that the canoe if turned over will rest on these points and on the upper edge of the combing round the well, seven-eighths of an inch deep, projecting half an inch, of steamed oak curved at the corners, and adding by its angular position very much to the strength of the deck about the well. The well is thirty-two inches from C to D, and twenty inches from E to F, so placed that D M is two feet, and thus, the beam of the boat being aft of the midships, the weight of the luggage (G) and of the masts and sails stowed forward brings the boat to nearly an even keel. The additional basket of cooking things at 1 (Fig. 2) brings her a little by the stern. For a boat without luggage the beam should be one foot abaft the midships to secure an even keel. The deck is supported by four carlines forward and three aft, the latter portion being thus more strengthened because in some cases it is required to support the weight of the canoeist sitting on the deck with his

FIG. 4

FIG. 5

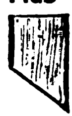
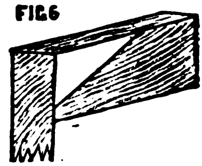


FIG. 6

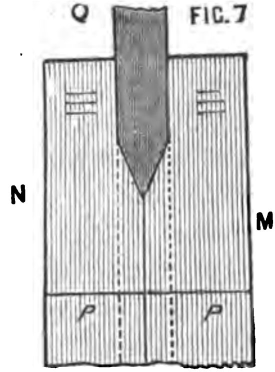


legs in the water. Each carline has a piece cut out of its end (see Fig. 6), so that the water inside may run along to the beam when the canoe is canted to sponge it out. The after end of the carline at C is bevelled off (Fig. 5 in section) so as not to catch the shins of your legs. All the carlines are narrow and deep to economize strength, and the deck is screwed to them by brass screws so that it might be removed for internal repairs. A flat piece is inserted under the deck at the mast-hole (H), which is also furnished with a flanged brass ring. The deck is so arched as to enable the feet to rest comfortably on the broad stretcher J (Fig. 4), the centre of it being cut down in a curve in order that the masts and sails rolled together may rest there when there is no luggage, and be kept under the deck but above any wet on the floor.

When there is luggage (as in the Baltic voyage) the masts and sails were usually put under the after-deck. The cedar deck round the well at E F is firmly secured by knee-pieces, and the boat may be lifted up *by any part*, and may be sat upon *in any position* without injury. The luggage for three months, weighing nine and a half pounds, is carried in a black leather-cloth bag, one foot by one foot and five inches deep (G, Figs. 1 and 2). A water-tight compartment may be made by an after bulk-head with a lid to open, so as to allow the air to circulate when on shore.

The floor-boards, about two feet long, rest on the rimbers, until at the part below C (Fig. 2); they end at P P (Fig. 7) in notched grooves, which fit into short oak pieces M N, a quarter of an inch thick, sloping forwards on each side of the keel (O). Their ends rest on the garboard streaks, and so lower the heels nearly one inch below the level of the floor-board on to the top of the timbers. The canoeist sits on the floor-boards. I prefer this to any cushion or mat whatever, but of course these can be used, but they should be firmly fixed, especially in rough water. The canoeist's knees touch the combing and the apron-boards, while his heels touch the keel. Thus Fig. 1, from the stretcher to the deck, shows how the shin-bones are supported in comfort, enabling the paddler to sit for hours together without straining. But comfort is additionally secured by my new kind of backboard shown

FIG. 7



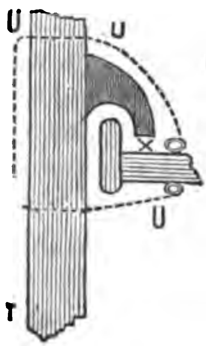
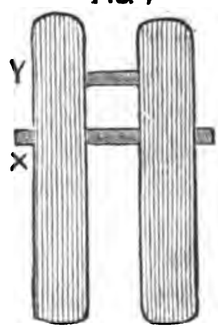


FIG. 8

FIG. 9



in Figs. 8 and 9 in section and elevation. This consists of two strips of oak eighteen inches long, two and a half inches wide, and united by a cross-piece at Y and another at X, the latter being grooved (Fig. 8) so as to rest on the top of the combing and to oscillate with the movement of the canoeist's back, which is thus supported on both sides along the muscles, while the spine is untouched between the strips. The dotted line U (Fig. 8) is a strong cord passed round all (through a hole in the deck or two eyes), and this serves to keep the back-board in general upright, while it is free to vibrate, or when on shore to be closed down flat on deck or be removed entirely in a moment by unloosing the cord.

The use of this backboard is a leading feature of the canoe, and adds very much indeed to the canoe-ist's comfort, and therefore to his efficiency. The length and width of the oak strips, and the width of the interval between them, ought to be carefully adjusted to the size and "build" of the canoeist, just as a saddle ought to fit a horse and its rider too. The paddle is seven feet long, flat-bladed, with a breadth of five inches in each palm, which is copper-banded, and made of the best spruce-fir, the weight being little over two pounds. The spoon-shaped blade is better for speed, and a longer paddle is suitable for a racing boat, but for a travelling canoe, where long paddling, occasional sailing, and frequent shoving require the instrument to combine lightness, straight edge, handiness, and strength, it is found that a short paddle is best for the varied work of a long voyage.

Leather cups have been usually employed on the wrists of the paddle to catch the dripping water, but round indiarubber rings look much better, and answer every purpose if placed just above the points where the paddle dips into the water in an ordinary stroke. These rings may be had for twopence, and can be slipped on over the broad blade. If necessary, two are used on each side, and they bear rough usage well, while if they strike the cedar deck no injury is done to it.[1]

After numerous experiments, the following very simple plan has been devised for a waterproof apron, and its application at once removes one of the chief objections to canoes in rough water as heretofore constructed.

It is necessary to have a covering for the well which shall effectually exclude water, and yet be so attached as not to hamper the canoeist in case of an upset, or when he desires to get out of the boat in a more legitimate manner. These desiderata are completely secured by the new apron, which is not permanently attached in any manner to the boat, but is formed as follows:—A piece of light wood of the form in Fig. 10, two feet long and three inches deep at the deepest part, is placed along each side of the deck vertically, so as just to rest against the outside of

FIG. 10

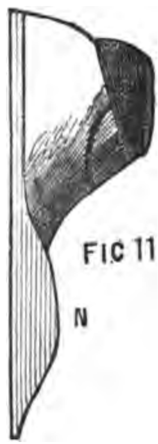


FIG. 11

[1] The paddle of an Esquimax kayak lately examined was 6 ft. 11 in. long and $5\frac{1}{2}$ in. broad in the palm, and the ends had the corners rounded off. The Esquimaux use a piece of fish skin wound spirally round the paddle in place of the rings above mentioned.

each knee of the canoeist, and then a piece of macintosh cloth—drab colour is best—is tightly nailed along and over these so as to form an apron, supported at each side on N (Fig. 11), and sloping from the highest part forwards down to the deck in front of the combing, over which its edge projects an inch, and then lies flat. The other or after end is so cut and formed as to fit the body neatly, and the ends may be tucked in behind, or when the waves are very rough they should be secured outside the backboard by a string with a knot. When this apron is so applied, and the knees are in position, their pressure keeps the whole apron steady, and the splash of small waves is not enough to move it. But for rough water I place a string across the end and round two screw-nails on the deck, or an india-rubber cord may be run through the hemmed end and catch on a beading at the fore part of the combing.

A button-hole at the highest point of the apron near the waistcoat allows it to be supported there, but the whole affair will at once separate from the boat in an overset or sudden leap out, and can be lifted off and folded up in two seconds. When you have to get out on shore, or when sailing, it is usually best to stow the apron away so that the legs may be turned into any desired position of ease.

The apron I used in this tour has answered perfectly, but it is to be remembered that it has been perfectly fitted by myself to me and the boat.

Several others roughly made for other canoes have, as might be expected, failed to give satisfaction. One important advantage of a canoe is the capacity for sailing without altering the canoeist's seat, and we shall now describe the mast and sails found by experience to be most convenient after three masts had been broken and eight sets of sails had more or less failed. The mast is an inch and three-quarters thick (tapering) and five feet six inches long, of which the part above deck is four feet nine inches. The lugsail (K, Fig. 1) has a yard and boom, each four feet nine inches long, so when the sail is furled the end of the boom and mast come together. The fore leach of the lugsail is two feet long, and the after leach six feet six inches, giving an area of about fifteen square feet. The yard and the boom are of bamboo, and the yard passes into a broad hem in the sail-head, while the halyard is rove aloft through a small boxwood block three-quarters of an inch long, and with a brass sheave, and through another (a brass blind-pulley) well fastened to the side of the mast near the deck, so that the sail can be lowered and hoisted readily. The lower joint of a fishing-rod, four feet nine inches long, is a spare boom. The tack end of the boom is made fast to the mast by a flat piece of leather lashed to its upper part and to the mast, so as to be free to swing in every direction. After many other plans had failed this was quite successful, and lasted through the whole voyage. No hole is made in the mast, and no nail or screw driven into it, for these are causes of weakness. The cord-loops about six inches apart near the masthead support the flagstaff of bamboo cane two feet long, and with a silk flag seven inches by nine inches. When the mast is not used this flagstaff is detached and placed in the mast-hole, which it fits by a button about two inches wide permanently fixed on the staff, the lower end of which rests in the mast-step. The halyard and sheet should be of woven cord, which does not untwist, and is soft to handle in the wet. The sheet when not in hand may be belayed round a cleat on deck on either side of the apron where it is highest, and thus the cleats are protected from the paddle. For the sake of convenience the mast is stepped so far forward as to allow the boom to swing past the canoeist's breast when the sail is jibbed or brought over. This also allows the luggage-bag to be between the stretcher and the mast.

The mast-hole H is three feet six inches from the stem. The mast-step is a simple wedge-like piece of oak (see R, Fig. 14) made fast to the keel and

Fig. 14.

butting on the garboard strake on each side, with a square hole in it for the foot of the mast. It may be thought that the mast is thus stepped too far forward, but the importance of having the sail free to swing without lying against the canoeist's body or getting entangled with his paddle, which is used in steering, is so great that some sacrifice must be used to secure this point. However, it is found that the boat sails very well on a wind with this sail if the breeze is strong, and in light breezes it is only expedient to sail with the wind well aft when the jib can also be used.

A canoe must have a light, strong, and flexible painter (or head rope), suitable for constant use, because a great deal has to be done by its means in towing on dull water, guiding the boat while wading down shallows or beside falls, lowering into locks, hauling her over hedges, walls, lochs, banks, and even houses, and raising and lowering her (with luggage in) to and from steamboats. The "Alpine Club" rope used in the new *Rob Roy* was found to be hard and kinky when wet, and the softer rope used in the old *Rob Roy* was far better.

Another kind of brown tanned rope has been recommended. The painter should not be longer than twice the length of the boat. Each end is whipped with wax-end, which sort of fine twine is also invaluable for all the other fastenings, as it never slips. The painter passes through a hole in the stem and another in the stern-post, and is drawn tight to lie on the deck in the lines A Y and S Y, Fig. 2. The slack of about four feet is belayed round the windward cleat and coiled outside, so that it may be seized instantly when you go ashore or have to jump out to avoid a smash or upset in a dangerous place. This mode of fixing and belaying the painter I adopted after numerous trials of other plans, and it is found to be the best by far.

The jib is a triangle of three feet hoist and three feet foot, the fore-leach fast by a loop passing under the painter and over the stem. The head is fixed by a loop over the masthead and under the flagstaff button. Thus the jib can be struck while the canoeist remains in the boat by pushing off these two loops with his paddle. To set the jib it is best to land. This is much more generally convenient than to have jib tackle on the mast. The sails are of calico, without any seam. This lasts quite well enough, dries speedily, and sets well too, provided that care is taken to have it cut out with the selvedge along the after-leach, and not along any of the other sides. Inattention to this last direction simply ruins sails, and it cannot be too often repeated that the success of the voyages of the *Rob Roy* could not be expected if great care had not been paid to all these details. The new *Rob Roy* may, of course, be improved upon, but I have not one suggestion to make, except as to the cooking apparatus, which, in this case used for the first time, was open to many alterations.

But while it is desirable that canoeists should experiment in all directions, it is hoped that young sailors will try first at least the plans here explained, and which have stood the severe tests under which perfect success and continual enjoyment were obtained.

The *Rob Roys* were built at Messrs. Searle's, of Lambeth, where some twenty-three others have been constructed. Mr. Simmons, of Putney, and Mr. Wheeler, of Richmond, have also built some according to the same design, while a large number of canoes have left the stocks in various parts of the country. A good travelling canoe, costing 15*l.*, ought to last a long time, for it is not racked and pulled in pieces at every stroke as a rowing-boat is.

The sails, apron, luggage-bag, and outfit can be had at Messrs. Silver's, Cornhill, the flag and blocks at the Model Dockyard, Fleet Street, where the handy-book is published, and the boom and yard and woven cord at Farlow's, in the Strand.

The timber required in the construction of the *Rob Roy* will be as follows, in the rough :—

The keel, oak, thirteen feet long, one inch and a quarter by one inch.

The hogpiece or kelson, thirteen feet long, three-quarters of an inch by three inches.

The ribs, quarter inch by half inch, bent to shape.

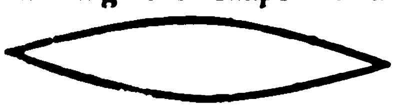
The deck may be in four pieces, one for each end, one for each side of the well, and should be about five-eighths of an inch thick; the coaming of oak one inch and a quarter by one inch and a quarter, standing about three-quarters of an inch to an inch above the deck. The planking of the *Rob Roy* should be a quarter to five-eighths of an inch. I have seen such a canoe planked with Willesden paper, and it appeared to make a very good job.

The corners of the hatchway or well, and other such places, should be strengthened by means of copper brackets, and the stem and stern parts may be made of wood the same dimensions as the keel or rather larger. The ways of constructing them are given in a former article. Strong knees should be used, and the boat strengthened in every way, as such a canoe has a great deal of knocking about in a voyage. The hatchway may be three feet long by half that width.

The Canadian or Birch Bark Canoe.

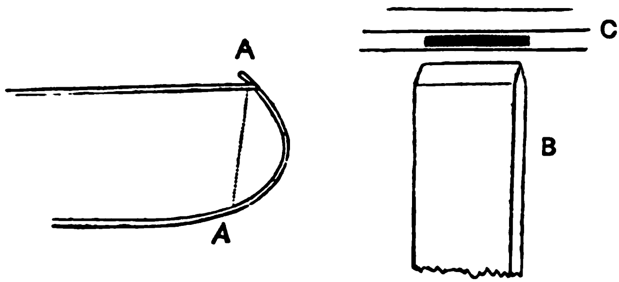
This form of canoe built in different materials, as basswood, cedar, &c., has become in the last few years, perhaps, the most generally used of any form of canoe, probably because its undecked form admits of several persons sharing the pleasures of a paddle, which in the *Rob Roy* and other similar types is confined to the solitary occupant, unless cruising in company. In order to give a good idea of this kind of canoe, it will be as well at first to describe one in the writer's possession which is of birch bark, built by North American Indians (see the designs). Its dimensions are 17 ft. long, 27 in. wide, and 1 ft. deep. She is built as follows.

Two strong pieces of tough wood, forming together something the shape of a snowshoe, thus,



and lashed strongly together at the ends, form the gunwale.

The ribs (B) are of thin stuff about one-eighth of an inch thick, and two to three inches wide, running from gunwale to gunwale in one piece, the ends slightly pointed to fit into notches cut in the under side of the gunwale C. Between these ribs and the outer skin is placed some kind of thin bark pitched over, and the outer skin is composed of birch bark.



At each end, at the dotted line A A (see cut), there is a strong apron-piece, but the bows are simply sewn together, as are the other joints in the boat, which is very light and handy. Now the thing is for those who have no birch bark to build a canoe on the same principle, easily and at little cost, and to do this one may employ for an outside covering or skin, either thin planks disposed longitudinally, diagonally, or vertically, paper, or canvas.

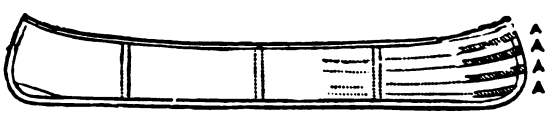


Fig. 1.

In the diagram you have sheer plan, body and deck plan, of a modified Canadian canoe;

the ends are less curved than the original, but otherwise it is much the same. The first thing you

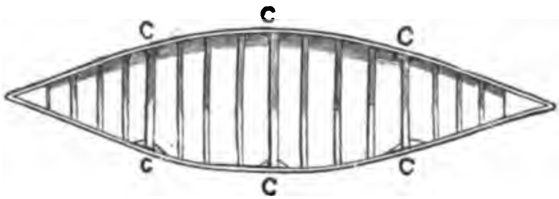


Fig. 2.

will have to do is to draw a plan to scale on this principle of the canoe you propose building, and

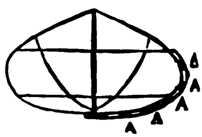


Fig. 3.

the simplest scale you can use is that of one inch to a foot, and in this way, if you decide on a canoe fifteen feet by two feet by one foot, the plan on paper will be fifteen inches by two inches by one inch, which you can multiply by twelve to gét your measurements for any part.

A Canadian canoe proper has no keel whatever, and is composed merely of the outer skin (birch bark or whatever else may be used), and the interior ribs or timbers, which are about three-eighths of an inch thick and two and a half inches broad, spaced very close together and almost forming an inner skin.

The diagonal principle of construction with two water-tight skins would admirably suit this class of canoe, but it would almost need a model to build from to turn out a neat job; it would not, however, be a difficult matter, or one taking much time, to construct a skeleton model of the canoe consisting of shadows and stringers (i.e. a longitudinal batten), on which you could build the canoe itself.

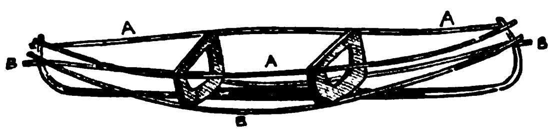
The simplest way, however, of building this class of canoe for those who have not enough experience to attempt the above, is to lay down an actual keel and build from it, if this plan is adopted the keel proper had best be shaped broad in the middle—say, six inches—and tapering off to the ends where the stem and stern posts are joined on. Having got your keel ready, and the stem and stern posts kneed in, and ascertained by a plumb-line that they are perpendicular to the keel, the next thing is to cut out shadows, or frames, from the body plan. Three of these shadows will do (see Fig. 2, C C C), one amidships, and one each

Shadows.

between midships and the stem and stern. These shadows must be secured to the keel in such a way that they will not shift from the perpendicular, to which you must plumb them. The keel can be made of any good wood, elm or oak for preference; but common deal will do very well. It should be three-quarters of an inch by six inches in the middle, and taper to the ends.. The stem and stern posts can be of three-quarter inch deal or hard wood, of sufficient length, and two to four inches deep, shaped out and secured with a galvanized iron or wooden knee to the keel. You can use an apron-piece or not, as you prefer.

If you elect to dispense with the apron-piece the stem and stern posts must be deeper than if you use it, and a slight groove of, say, one-eighth of an inch cut to receive the ends of the stringers. (A A A A, Fig. 1.) Or this groove can be dispensed with, and the end of the stringer tapered off so as to come flush.

You will now want two or three stringers each side, of elm, ash, or other tough wood, of sufficient length, and about half an inch thick by one inch wide. These will run from stem to stern over the shadows, and be firmly secured to the parts. The gunwale must be of the same sort of wood, say one inch square, and let in half an inch into the shadows to bring it flush with the stringers. The gunwale



A A, gunwale; B B, stringers.

must be secured to the stem and stern posts, leaving about an inch of the posts above it; and a triangular piece of hard wood an inch thick and about three to six inches deep must be shaped to fit between the gunwales and the stem and stern posts, and the gunwales firmly secured to it by countersunk screws. This will bind all firmly together. As you will have taken the measurements from your plans, in which you have decided the sheer of the boat, the gunwale will follow this sheer, starting from the midship shadow and curving up towards the posts.

You have now got the framework ready, with the exception of the ribs, which are put in afterwards The next step will be to form the outside skin.

The most fashionable way of building these canoes is by alternate strips of white and dark wood, as cedar and pine, disposed vertically, each strip being about half an inch by two inches, but this description of building needs more knowledge than an amateur is possessed of, as it is no easy matter to get all the joins even and tight; this mode of building is described under " diagonal building," the only difference being that the outside layer is disposed vertically instead of diagonally or longitudinally. The inner skin had better be disposed longitudinally if the outside one is in vertical strips. Another plan to adopt is the riband carvel, which is a good mode of building canoes; it is described under "Construction," page 141. Of the remaining methods of covering the framework, canvas and paper, we will first take the former. Sufficient canvas must be purchased to cover the canoe; see that it is close and strong (No. 6, Navy unbleached, or something as near that as possible). Turn the canoe upside down, and stretch your canvas over it, tacking it firmly along the keel with copper nails about an inch apart, and then strain it tightly to the gunwales and secure it there with copper tacks (iron or large tin tacks may be used here if you are short of copper), first turning down the raw edge of the canvas. Then tack down the ends to the stem and stern posts, lapping one side of the canvas first round the opposite side of the part and securing it, and then bringing the other side of the canvas over the part secured and tacking it on the opposite side, thus doubling the canvas over the stem and stern posts. It is as well to run a copper band from six inches down the stem and stern posts to about a foot along the keel, to take the wear off the canvas, and a slight wooden false keel may be screwed over all with brass screws, or fastened with copper nails. Any slackness that may exist in the canvas must now be taken up. Turn the canoe right side up and gather in the canvas where you can find it slack, which will probably be at the bow and stern; and after gathering it tightly in in a pleat, sew it strongly down on the inside. This, perhaps, had best be done before you completely secure the canvas down, and while it is only secured at the ends and along the gunwale, leaving it unfastened along the keel.

Next get your ribs ready; these had best be

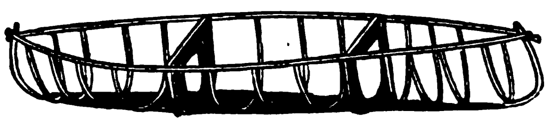


Diagram showing ribs.

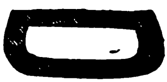
made of rock elm or other tough wood, to avoid the trouble of steaming. They must be about three-sixteenths of an inch by three-quarters wide, or one inch or even two inches wide will do if you can bend them. Space the ribs about six inches apart; you can put them closer if you want extra strength. See that they are cut the right length, that when put in—which must be done by main force—the ribs take all the stringers, and butt tightly under the gunwales. You may either cut a slight notch in the gunwale to receive the ends of the ribs, or, after all the ribs are in, run a strip of wood half an inch by half an inch under the gunwale and over all the ribs, screwing it firmly to the gunwale to keep the ribs in their places. When the ribs are all in their places you may remove the shadows and look over the canvas again to see if it is all tight, putting an extra rib in wherever you have taken it up, and securing such a plain to the rib by a few tacks.

You must now cut the crossbars the proper size and fit them in, securing them to the gunwale by knees on each side. You have now only to paint the canvas, and when it has had two or three coats firmly dried on, the canoe is ready to use. After using it turn it upside down, so that water cannot accumulate inside, as if it does it will soon rot the canvas; and whenever the paint wears off a little, be careful to replace it. With these simple precautions such a canoe will last a long while, and will be of great use and amusement to you, as it can be easily carried from one piece of water to another by one person. Should you wish to make it a life-boat, all you have to do is to get two zinc cases fitted to each end, which will float the canoe if capsized, or run a tapering belt of painted canvas filled with corks round the canoe outside on the water-line (see Diagram, A A). If you take this

A

precaution you will probably not regret it, as a capsize is a very simple matter to achieve in any round-bottomed light boat, and there is not much stuff in such a slightly-constructed craft to float the occupant if capsized.

After building the canoe, in the ordinary way you would remove the shadows on which you built her, the ribs when secured supporting the boat sufficiently. If, however, you are only proceeding in a rough and ready manner, to save trouble you might leave the shadows in the boat and use them as ribs; they can either be left solid as compartments, in which



case they would add considerably to the weight of the boat, or they could be hollowed out as shown, but such a form of construction would be but an unsatisfactory affair, at best.

In making a paper canoe it will be necessary to first get a strong under skin of stiff wrapping paper, and the stringers and ribs of the canoe should be closer together (though they may be lighter) than when the boat is planked up. When the inner skin is in its place several layers of thin hand-made paper should be put on with rubber solution or varnish, the idea is to put the layers on so thin that whatever waterproof medium is used can thoroughly permeate the whole of the paper skin.

If this is carefully done, a strong and smooth surface is produced impervious to water. I have seen model yachts built in this way, in the sides of which it was impossible to detect any joining or seam whatever, all that could be seen being a beautifully smooth and glossy surface.

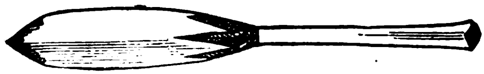
Another excellent material for forming the outside skin is Willesden paper.[1] This paper is thoroughly waterproof, and is manufactured in all thicknesses. The best for the purpose is about one-eighth of an inch thick. It runs in sufficient length to build an ordinary canoe in one piece, and the width, being fifty-three inches, is amply sufficient. The price is five shillings per yard run, which, for a canoe say fifteen feet long, would be twenty-five shillings, and would be the principal part of the cost. This paper will not only make a strong and safe boat, but also a very handsome and fast one, as, being in one piece, there is no joining or unevenness, but one perfectly smooth surface, offering little resistance to the water. For the purpose of building models it would be hard to find a better substitute for wood, and in most cases it would be found far cheaper. It can be obtained of the Willesden Paper Company, 34, Cannon Street, London, E.C.

It must, however, entirely depend on the surroundings of the maker as to what materials he had best use. A person who has the ability to build a canoe at all, must be the best judge of the easiest way for him to set about it, and it is impossible to

[1] There is no doubt but that the best of all is the Willesden green waterproof canvas.

lay down hard-and-fast rules as to what he shall use in its construction. All he requires is the general idea which is given here, and where one builder with every convenience and a long purse will use the best materials, another under different circumstances, and perhaps far away from opportunities of getting the most suitable timber, &c., for his purpose, will have to exercise his ingenuity and bring into use those materials he is limited to. So, perhaps, in some instances where thick and good canvas cannot be got, a serviceable boat can be made of a thinner and cheaper material, such as unbleached calico put on over a skin of old newspapers pasted together to form a backing; and such a covering thoroughly varnished with several coats, or if that is too costly, well painted inside and outside with a mixture of tar and pitch boiled together, half and half, would give a great deal of amusement to its owner, and cost a mere trifle. Of course it would not look so well. The best backing to use under thin canvas or calico would be good paper prepared in this way. Take a large sheet of good strong paper, brown preferably, and cover it with a coating of marine glue; place another piece of paper over it to cover the glue, and take a flat-iron, warm, but not too hot; thoroughly iron the top paper till the glue comes out through the pores of the paper; the two sheets will then be firmly held together by the waterproof glue, and any size can be prepared in this way, making a first-class stiffening inside skin, which can be covered outside with thin calico in one piece, painted and varnished.

The paddles used with these canoes are single-bladed. The stern paddle, which is used to steer as well as propel the canoe, is considerably larger than the bow paddle. The lengths of the paddles



are—stern, five feet; bow, four feet; breadth of blade at broadest part—stern, six inches; bow, five inches; length of blade of paddle, two feet. The handle may be about three-quarters of an inch to one inch in diameter, but much thicker at the extreme end, where some of the paddles now used are shaped like the figure T to afford better hold.

The paddle is used as follows. You will readily understand that a stroke of a paddle used only on one side would cause the boat or canoe so propelled to turn its bow in the opposite direction; to meet this, before the paddle is withdrawn from the water it must be slightly feathered and the handle brought inwards, the middle of the paddle resting on the gunwale of the canoe, the blade thus bringing the bow round and steering the canoe in a straight course. The pressure used must be merely adequate to bring the canoe straight, and will depend on the amount of sheer she has taken. If this is properly done, which requires some practice, it will not at all interfere with the forward propulsion of the canoe. The handle of the paddle is left rather wide at the end, to allow of an easy grasp, and the other hand holds the paddle not quite half way down.

In stalking game the Indians never withdraw the paddle from the water at all, but feather under water without making the slightest noise and scarcely causing a ripple.

The Canadian canoe having no keel is easily turned and managed; at the same time they are as easily turned by the wind, if there should be any, and for rough water I should prefer giving a small exterior keel screwed on to the keel on which you build the canoe, and which forms part of the body of the boat itself; but this you must decide for yourself. If you only want to punt about in smooth water and in shallows, you can dispense with any exterior keel, and in any case you can easily screw on a false keel of whatever depth you consider necessary afterwards.

Another description of boat made of canvas is the Irish corragh (see page 187), used principally in the south-west of Ireland. Some of these boats are of considerable size—I have seen one twenty-six feet by four feet beam—and are used in the heaviest weather and the roughest seas, and from their extreme lightness are wonderfully good sea boats, the peculiar construction of the bow, which rises very much, lifting the boat over the seas. They have a strong frame made of ribs with stringers spaced only about three inches apart. The stringers run the whole length of the boat, which is something of the shape of half a barrel greatly elongated. They are simply and easily constructed, and are covered with common canvas. Several coatings of a preparation of tar are given to the canvas, converting it into a species of tarpaulin, and as the interior framework is very close it is impossible to stand or press in any way on the canvas skin, which is thus kept from injury from that source. The corragh is propelled by paddles used as sculls, and a large one has six men, each pulling two paddles. They have no rowlocks, but an iron pin stands up from the gunwale, and a chock is fixed to the paddle with a hole to fit the iron pin. In this way the paddles can be left without being unshipped if necessary, and fall alongside the boat with no chance of being lost.

The coracle used for fishing in Ireland and in Wales is merely a framework, sometimes of wicker and sometimes of wood, somewhat in the shape of the half of a walnut-shell. They are generally covered with leather, and are extremely light.

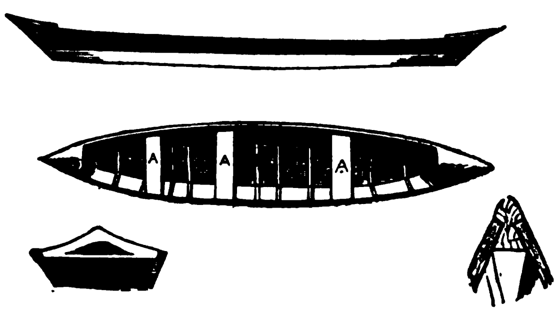


Fig. 5.

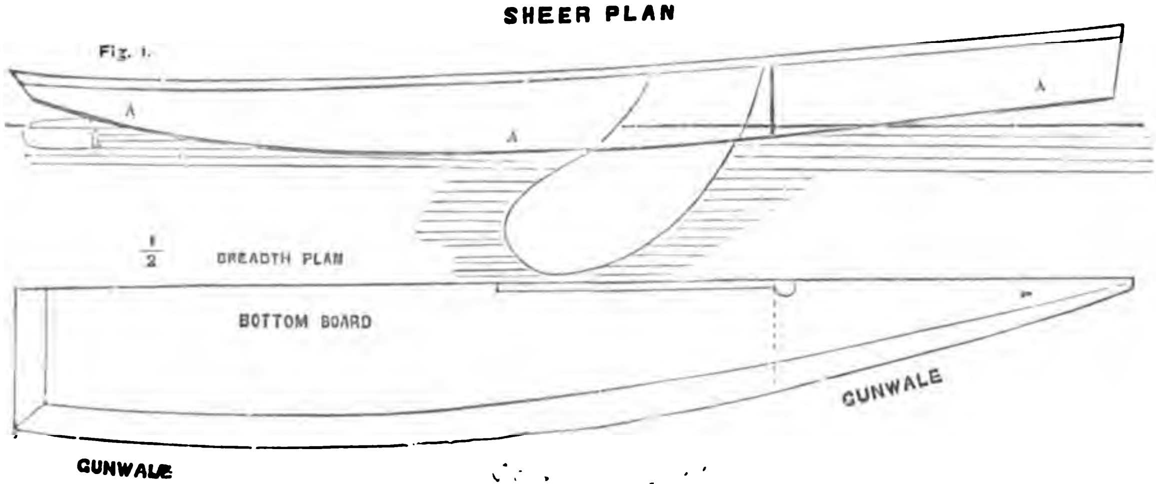
The Canadian batteau (Fig. 5) is a class of boat that is very easily constructed in paper, canvas, or wood, and you will see from the plan how it is made. It differs from the preceding canoes in that it is flat-bottomed, and the sides are also flat, flaring out a good deal. If it is desired to build this in wood, full details will be found under the head of "Sharpie."

In order to thoroughly test the merits of the Willesden green waterproof canvas as applied to boat-building, I have recently had a canoe, which was damaged to such an extent as to allow the water to run in and out like a sieve, covered with the thick green canvas of this company's make, and after it was finished, tested in the most severe manner, both as to the strength given by the canvas and its waterproof qualities. The result was highly satisfactory in every respect, and, speaking from experience, I can say that I know of no material so suitable for constructing a light, strong, and thoroughly watertight boat or canoe, with the additional advantage of being easily manipulated by amateur builders. No paint is required. A coat of varnish, though not necessary, may be given.[1]

[1] For details in the manner in which the canvas skin was fitted, see Appendix.

AMERICAN FLAT-BOTTOMED CANOE OR SHARPIE.

Fig. 1.

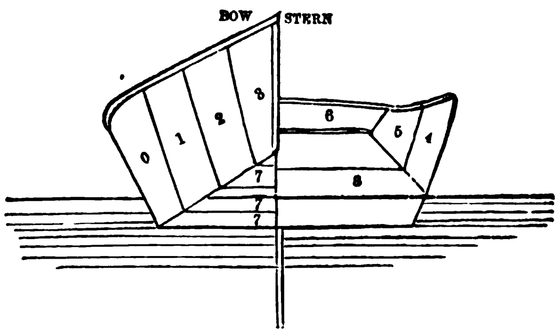


To face p. 223.

CHAPTER X.

THE AMERICAN FLAT-BOTTOMED CANOE OR SHARPIE.

FROM the annexed drawings, giving sheer plan, body plan, deck-line, and the floor-line (shown by



BODY PLAN.

0, midship section; 1, 2, 3, bow sections; 4 and 5, stern sections; 6, stern or transome; 7 and 8, bottom sections.

the inner line), you will be able to form a very good idea of the general form of this peculiar species of craft, which is a kind of link between a canoe and a boat, as a small sharpie is little else than a flat-bottomed canoe; while, on the other hand, there are sharpies built more than forty feet in length. The sneak-box is generally a smaller boat, differing in some details and more difficult to construct than the sharpie proper. As an easy boat to build, useful in shallow water, and fairly good under canvas with the centreboard down, the sharpie is perhaps without a rival.

The one that crossed from America (*Nautilus*) was some nineteen feet long by four or five feet wide, and two feet deep. I am only speaking from memory, as I unfortunately lost the notes I took when examining her. By the account of her adventurous navigators she made very good weather, though several times the sea was so bad they had to ride to a drogue, or sea-anchor, for twenty-four hours together. The plan given on the preceding page is about six feet long and a foot and a half wide, being approximately four beams the length and to about eight inches deep amidships, on a scale of one inch to the foot. From this plan, by doubling the measurements, with the exception of the depth, which will be rather less proportionately, you can easily construct a boat twelve feet long, three feet wide, and the depth not to exceed one foot, which would be a handy and safe boat.

The first thing will of course be to decide the dimensions of the sharpie or sneak-box you intend building, and draw your plans to scale on a large piece of paper; and the next to buy some wood to proceed with. The floor of the boat will be the best basis to proceed on, and in a small craft—say ten feet by three feet—this can be made out of three nine-inch planks, as the bottom will be considerably less in width than the beam at the gunwale—say nine inches for the three-feet beam, which would give two feet three inches greatest beam at the bottom. The bottom planks had best be tongued and grooved. A good and easy way of doing this is to run a saw-cut down the plank to admit the insertion of a strip of zinc for a tongue. This zinc ought to be fairly thick to take a strain, and it makes a stronger job for small work than a wooden tongue; the bottom boards will have to be cut to the shape indicated by your plan (which will simply be an enlargement of that given, the bottom board being shown by the inside line of the half-breadth plan). The fore-and-aft rise of floor is shown in the sheer plan and in the body plan, and the bottom board will have to be bent to this position to meet the edges of the side boards, which will be cut out to take this rocker in the plan. This is shown at A A A, sheer plan. As the side boards join the bottom boards at a certain angle depending on the beam aloft as compared to the width of the floor, the edges of the floor boards must be bevelled off to this angle. If a deck is fitted, the sides may be made of boards a foot wide; but if undecked, the sides ought to be at least eighteen inches deep. The most simple plan of building one of these canoes would be to get out the floor boards (say one inch thick) to the requisite shape, and then carefully measure off on your plan the amount of stuff necessary for sides and deck, and buy sufficient waterproof paper (Willesden paper) for the purpose.

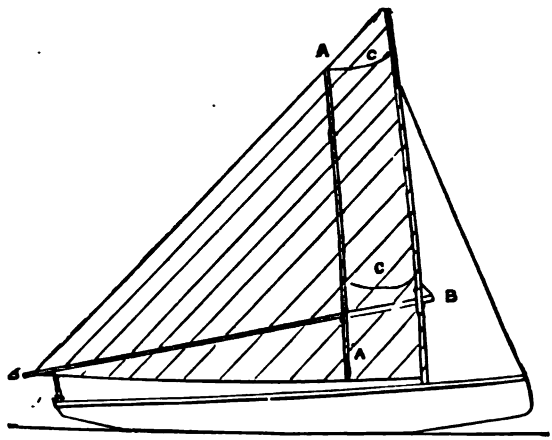
In either case (wood or paper) a stem and transome must first be fitted to the bottom boards to take the ends of the side planks. If Willesden paper about one-eighth of an inch thick is used, a wooden gunwale must be fitted to nail it to, and in this case it would be better to fit a few timbers or ribs between the stem and transome each side to strengthen the boat, running the gunwale over all the ribs, but siding it on to the stem and stern post, which should project above it about an inch, and the projecting piece be bevelled off on the inside (i.e. that next the interior of the boat). If the paper is used it should be fastened to the gunwale with copper nails, and the deck secured in the same way, first running a few deck beams across and securing them to the gunwale by a mortise or other joint to give strength to the deck. There should be a certain amount of crop to the deck beams—that is, they should be semi-circular, the highest point being amidships, which should be, say, two inches higher than the gunwales. A beam should be placed at each end of the opening for the well, and carlines or cross beams fitted running fore and aft on each side of the opening, and long enough to butt on the two beams, which should be stouter than the ordinary beams to take the extra strain which invariably comes at the ends of the hatchway or well. If necessary a sliding cover of the same paper can be fitted to the well. Such a boat is within the constructive capacity of any amateur, as it does away with all trouble as to keel and fitting garboards, &c., and planking up and caulking.

After the deck is fitted, a neat beading can be run over the junction of the deck and gunwale, and another outside to hide the edge of the paper side where it is fastened to the gunwale.

Even if it is decided to make the side of wood, it would be advisable for the sake of lightness combined with strength to use the prepared paper for the deck. But if it cannot be procured, light pine or cedar about a quarter of an inch thick will do instead; and if it is difficult to obtain wood sufficiently wide to deck the boat in one piece, a good job can be made by using two pieces, joined down the middle, in the centre of the boat fore and aft, such joint to be concealed and strengthened by a stout piece of mahogany or teak, say half an inch thick by three or four inches wide. Of course if you are going to use a mast, this longitudinal strip must needs be wide enough to allow the mast-hole to be cut in it, or a wider piece can be inserted at the mast and the rest joined to it in two pieces.

It will be better, if this form of construction is used, to fasten the fore-and-aft strip to the two deck boards with small brass screws, screwed from the under side of the deck up into the strip, which is twice as thick as the deck, and better able to hold the screw; three-eighth screws will do, and the points should not appear through the mahogany. This of course must be done before the deck is screwed to the gunwales.

After a deck is fitted, a coaming of three-quarter-inch stuff must be made to fit round the well; this coaming should be about an inch and a half high, and the end dovetailed. It will fit over the beams



SAIL PLAN, "SHARPIE."
A A, Reefing Batten; B B, Sprit or Boom; C C, Brails.

and carlines of the well, and will hide the joint of the deck with those fastenings, and make all complete. A rack should be fitted each side on the floor-boards to take the stretcher, and the back-board can be on the *Rob Roy* principle. If a sail is used, it would perhaps be best to adopt the American sail shown in the sketch; either one or two masts can be used. The batten A A, on being hauled close to the mast by the hauling-lines C C, which lead aft to the well, immediately reefs the sail; when this is done, more sheet must be given to allow for the extra drift, or the sail allowed to run in on the sprit; a

BOOM WITH DOUBLE JAWS FOR REEFING

boom with two or more jaws, as shown, may be used instead of a sprit.

The American plan of fitting a rudder to these boats is by a watertight tube fixed just where the stern rises from the waterline aft, part of the rudder being generally forward of the stern tube, in which case it is termed a balanced rudder. I should not recommend you to do this unless you are a fair workman, as you might establish a leak; you could fix a rudder from the square stern aft, letting it come down far enough to obtain a good hold of the water, and making it as shown in the sheer plan—that is, shallow and long.

If a centreboard is desired—and one must be fitted for sailing purposes, unless you use leeboards—a case must be made of wood one inch thick, the sides being spaced about one inch apart, and secured to the bottom boards by screws from the bottom of the boat up through the sides of the casing. A slot must be cut in the bottom boards in the centre line of the boat, at the place where the casing is to be fitted, sufficiently long and one inch wide; the ends of the case must be closed by a stout piece of wood one inch by three inches (hard wood preferably) well secured to the sides, and the joints of the casing with the bottom boards must be further secured by a beading run round them, the joint being first made watertight with white lead, and all the joints of the casing must be made watertight in the same way. The upper part of the casing will serve to support the deck, through which a slot must be cut of the same form and dimensions as the one in the floor, and the deck screwed down tightly, a layer of white lead being first given to the top of the casing and under side of the deck where it butts the case; in fact every means must be taken to strengthen all the parts of the centreboard case and to see that all its joints are watertight. For rough work considerable additional strength could be given to the C.B. case by means of angle irons tying it to the floor, and spaced about a foot or eighteen inches apart. The centre-plate can be made of wood or iron; if of wood a metal bearing must be fitted to take the pin on which it works, and such pin must be tightly driven (to prevent leakage) through holes bored at the forward end of the case about a couple of inches from the floor. A certain amount of drift must be given between each end of the case and the centre-plate to allow it to work easily. A hole must be bored in the upper after-end of the plate to fasten a chain or cord in order to raise or lower the plate as required, and some cleat should be fixed in a handy position to secure this chain or line to, when it is desired to keep the centreboard in any required position without holding it.

If an iron centreboard is used the sides of the case may be spaced less than one inch; in fact just so close as to allow free play to the centre-plate; but if wood is used an inch will be quite little enough; in fact an inch centreboard would probably be required to give the requisite strength, and, if so, of course it would need the casing to be spaced sufficiently apart to allow it room to work properly, possibly one inch and a half. A centre-board three or four feet long, dropping below the boat a foot or eighteen inches at the after-end, and coming to nothing forward, would be amply sufficient to enable the boat to beat to windward under sail. The best position for the centreboard is to allow it to come as far aft as it is possible consistently with giving sufficient room in the well for the occupant to stretch his feet.

If a deep rudder is used, the centreboard might go more forward, but its best position will be about midships, and in that case the legs of the occupant must be put on either side of it. This constitutes one of its inconveniences, and can only be obviated by having two small centreboards, one forward and the other aft, which leaves the midships free, and is far more comfortable for the crew. If the latter plan is adopted the fore centreboard might be double the size (superficially) of the after one, as best suited to this form of boat, which has little or no hold on the water forward, but there is no doubt that all the effect of the after centreboard might be more economically obtained by the use of a deep rudder.

CHAPTER XI.

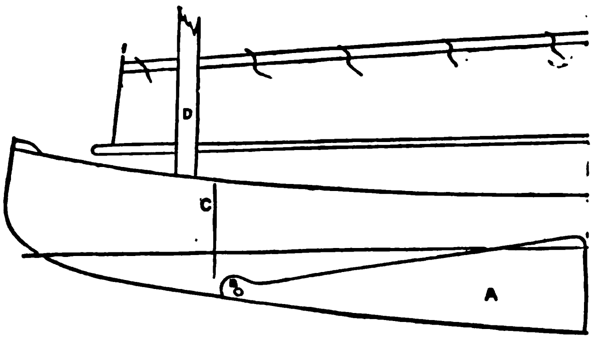
ON CENTREBOARDS.

WE have seen that in order to use the sails in a sailing-vessel to the best effect some form of lateral resistance is absolutely necessary, and we have also seen that in a canoe the centreboard is the most handy form in which such resistance can be given. The next question will naturally be, What is the best form of centreboard to use?

This, however, is a question that cannot be answered offhand, as the peculiar form of the particular boat in question must be studied, and also the uses to which it is intended to put her. Thus, a canoe of very shallow draft, and with little or no rise in her floor, will require a larger board than one with more rise and greater depth; and again, there is no doubt that one centreboard amidships is easier to construct than two, one fore and the other aft, but the former system encumbers the most useful part of the canoe, and greatly interferes with the comfort of the occupant.

With a canoe carrying only a moderate sail plan a light centreboard answers very well, while one intended to carry a large sail area will necessitate the use of a heavy centre-plate as well as shifting ballast. Again, it will be found most convenient as a rule to have the centreboard a fixture, but in isolated cases it will be found more handy to have it so constructed as to be easily removable without the necessity of hauling the canoe ashore. Such points as these must therefore be appreciated before the centreboards are constructed, and in the plan the position of intended bulkheads, &c., must be so arranged as to allow the board to be placed in the required position. Proper means must also be thought of for hauling up the centreboard when required. An ordinary small board of light weight will require no special appliance for raising it, as a piece of light chain will be amply sufficient with a strong cord attached for a hauling part; but with a large and heavy plate some better purchase will be required, and for this a short piece of chain can be attached to the centreboard just long enough to leave a part of the chain on deck when the board is down to its full extent.

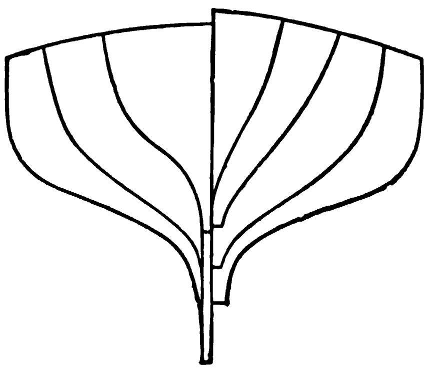
This chain may terminate in a ring just large enough in diameter to prevent it going down the well of the centreboard; to such ring a snatch-block can be hooked, to the base of which one end of a strong line is attached, the other end being led through a block placed sufficiently far aft and then back through the snatch-block, the hauling part of the line going aft to the well, and being left long enough to enable the crew to use it with ease. If the hauling part is passed through a small fairlead on the deck just in reach of the occupant's hand, and



SHEER PLAN, Fig. 1.

A, Centreboard; B, Centreboard-pin; C C, Ends of centreboard case; D, Fore-mast.

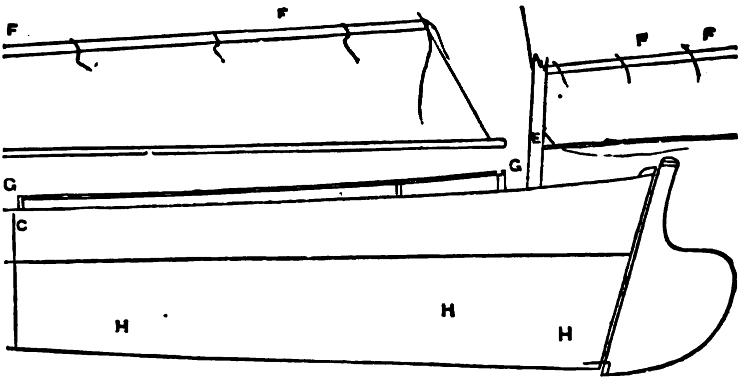
the end is knotted or otherwise arranged as to stop it from passing forward through the fairlead, it will be



BODY PLAN

Fig. 1.

always at hand for use, and if a cleat is placed next the fairlead the line can be made fast immediately as required.



E Mizen-mast; F F, Reefing battens; G G, coaming round well; H H H, deadwood aft.

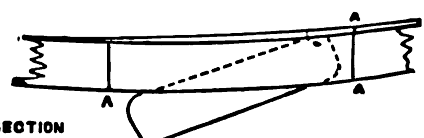
The knot in the line must be made when the centreboard is fully down. By this arrangement the line is always at hand for use, and is never in danger of getting loose and entangled, and it also affords a powerful purchase to help in lifting the plate.

With a heavy centreboard it is advisable to use an indiarubber spring of sufficient strength to take the greater part of the weight of the board or plate.

In the sheer plan of the canoe shown at Fig. 1 you will see that only one centre-plate is used (which is shown hauled up), and this plate is placed extremely forward; this is necessitated by the form of the canoe, which has a great deal of drag aft given by the amount of dead wood there. This immersed surface gives sufficient resistance aft to enable the canoe to carry her sails to advantage, but without a centreboard forward she would be likely to fall off, from her shallow draft forward, besides being unsteady on her helm. This only applies when on the wind, as when her sheets are eased off the forward board would be hauled up as having a tendency to make her steer wild, besides offering unnecessary resistance.

Such a form of canoe is an extreme one, and being very difficult to build and having few advantages when built, is a design that it would be unwise to imitate; sufficient lateral resistance could be given in a simpler form by designing a canoe whose body should draw little more aft than forward; the immersed area thus cut away could be given in a centreboard placed aft. With two centreboards the boat would be far handier, as by pulling up the fore board when on a wind the boat would immediately fall off, and when off the wind by letting go the forward board and hauling up the after one the boat could immediately fly up into the wind. The dagger form of board is shown in the chapter on the sharpie; this style of board is useful where it is desired to haul the plate completely out on occasions without trouble.

Another style of centre-plate is shown in Fig. 3. It is a very simple form and can be pivoted either



SECTION
SHEWING DIFFERENT FORM OF CENTRE BOARD

Fig 3.

from the top or bottom or left movable as in the case of the dagger board, in which case the pin must be fitted outside the deck. Enough has been said on the article on the sharpie to impress the necessity of making a strong and watertight fit of the centreboard case. The centreboard in English boats is generally pivoted at the bottom, as in Fig. 1, but if it is easier to fit you may pivot it at the top as in Fig. 3; the ends of the case are shown A A, Fig. 3, and the sides at Fig. 2, where the thick black line shows the centreboard. Two centreboards are sometimes fitted; the advantage is that this arrangement leaves the midship portion of the boat entirely free, which is very much more agreeable to the occupant. The fore centreboard is placed just aft of the fore-mast, which is stepped well forward, and the after board is placed just behind the mizen-mast right aft.

In constructing a boat of any kind for a centre-board the keel ought either to be made in two pieces (see Fig. 2. KK) or of an extra width to admit of fitting

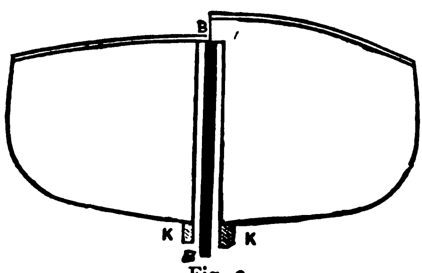


Fig. 2.

the case for the board. The strongest way to fit this case is to let it run from the keel B up to the deck B, thus securing great strength, for nothing needs strength and good fitting more than a centreboard case, which, particularly in a heavy boat, after a time frequently becomes a source of leakage.

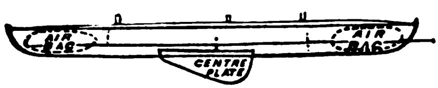
The centreboard is generally made of iron (boiler-plate is very good); after being fitted it is galvanized, but in fitting you must not forget that the galvanizing will increase slightly the thickness of the plate. In American boats wooden centreboards are sometimes used. The centreboards are of very different forms, as Figs. 1, 3. Fig. 1 is the common form; Fig. 3 is a very useful form, as it is easily made and is effective; another form is the dagger or sword centreboard, which is American in design; it can be lifted right out of the boat It is used generally in small boats, such as the design given in the preceding chapter, which is a flat-bottomed boat of the sharpie type. The *Nautilus*, that crossed the Atlantic, of this build, had no centreboard.

The principle of the leeboard as used in barges is exactly that of the centreboard, and answers well enough in the barge as it takes up no useful room, and leaves the hold intact for stowage. It, however, looks clumsy, and is exposed to the danger of being damaged, more than the centreboard, though such danger is less in a barge, which is heavily and strongly constructed, than in a small pleasure-boat, and for this and other reasons leeboards are not used in such craft, centreboards being employed instead.

If, however, it is desired to make a boat or canoe sail to windward, and for some reason it is not desirable to give her a deep keel or centreboard, you may easily improve her capabilities by making and fitting a couple of leeboards, but it is well to remember both as to centreboards and leeboards that if they touch on a bank or bottom the boat will most probably capsize. This may be obviated by applying an indiarubber spring sufficiently strong to take the weight of lee or centreboard so that on touching, the board will rise at the slightest pressure, and fall again when the bank is passed. Off the wind boats fitted with centreboards generally steer better with the boards either entirely or partly up—that is to say, when only one board is used. When two are employed, the forward one is raised in running when off the wind, the one aft assisting in keeping the boat running steadily.

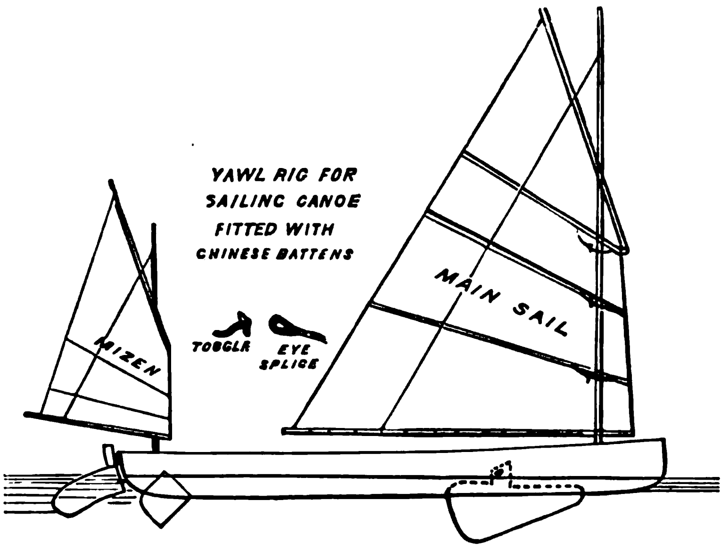
The weight of the centreboard is indispensable to help the canoe to right when an upset occurs while sailing.

From the diagram you will see that a canoe fitted with air bags or compartments is practically self-righting, as a lifeboat is, the centre of buoyancy of the air bags being high, and the centre of gravity



of the centre-plate low. But to be of any use in this way, particularly if the canoe is heavily sparred and canvassed, the plate should weigh from fifty to sixty pounds; if heavier than this it is troublesome and difficult to manage.

The triangular shape of centreboard is not suitable for large and heavy plates, as the weight is carried too high if part of the plate is always housed, and if it is not, but is let right down, there is nothing to steady it. A better form, which is almost universally used, is shown in the diagram of the yawl rigged canoe. It will there be seen that the



centre-plate has a piece left projecting upwards from about midships, which tongue is always housed in the case, and thus steadies the lower part of the plate, and at the same time considerably lowers the centre of gravity of the plate. The diagram also shows the deep rudder aft; if this form of rudder is used, it does away with the necessity of an after centreboard, which, however, is also shown. If it were used, the mizen-mast would have to be stepped more forward to clear the case, and an ordinary rudder could be used ; but the deep rudder answers every purpose of an after centreboard, and can either be in one piece and so fitted to the stern-post as to rise if it touches the ground, without being detached from the boat, or it can be obtained of the same depth as an ordinary rudder, but with the addition of several small fan-shaped joints riveted at the forward end to the rudder, which drop when required below the ordinary draft of the main rudder, and can be hauled up in shallow water or when needful. Centre-plates, constructed in the same manner, can also be obtained, which take up hardly any room inside the boat, in some instances, in fact, being fitted outside alongside the keel.

With ordinary metal centre-plates it is obvious that at times, particularly when the centreboard is raised, the centre of gravity of the boat is also considerably higher than is desirable ; to meet this, a composite centreboard has been designed, constructed in the form of a hollow plate, being open only at the top ; two or more plates are then constructed which fit easily within the larger one, and as the lower part of the small ones is loaded with lead, a considerable weight is dispersed low down in the big plate, which too can be made of almost any desired weight, and when it is necessary to lift out the board, instead of having to deal with a plate weighing some 50 to 60 lbs., which is a pretty heavy pull, particularly when the canoe is bobbing about, all that is required is to remove the small inner plates, which may be of suitable, easy weight, one by one, and lastly lift out the plate itself, which being only of $\frac{1}{16}$ iron plate by about $\frac{5}{8}$ wide over all, does not weigh much, perhaps from 20 to 28 lbs.

It is, of course, quite possible to construct a wooden centreboard shod with lead so that even when raised all but an inch or so, the weight would be carried low down, and when it was not often necessary to lift the board out altogether, such a structure would answer better than an ordinary iron plate in many ways, preventing rolling and giving greater righting power, but being more clumsy.

CHAPTER XII.

SAILING CANOES.

THE great feature in all sailing canoes is the lateral resistance they offer in some form or another, and without which they could never haul on the wind to advantage. This is obtained in most cases by a centreboard or centreboards, but some racing (sailing) canoes have been designed with a deep fixed keel, as we shall presently describe. The advantage of a centreboard is that the draught of water can be altered as required, whereas in the case of the fixed keel it remains the same. In canoes with a deep fixed keel, lead can be carried on the keel and they can be designed on the principle of a modern racing yacht, but it is not at all certain that this is an all-round advantage, as the principles involved in sailing yachts and canoes are not the same.

It is an undoubted advantage in a yacht that her ballast shall be mostly on the keel, and so arranged that the greater the angle of heel the greater the righting power becomes. Such a craft, as long as the water can be kept from below—which can be done in a decked craft by closing the hatches—is practically unsinkable, as she cannot capsize—and the knowledge of this is extremely comfortable when pressing a craft in racing. She may careen till her lee-rail and several of her deck planks are under water, but her crew know that unless her lead keel drops off she is as safe as a house. But in a centreboard boat this is not the case. She generally depends on her beam for stability, and, up to a certain point, is safe enough, but there *is* a point at which she is unsafe and will capsize, and though some people who are fond of risking their lives may like to carry on in such boats, there is always an element of uncertainty and danger, which to most is decidedly unpleasant.

Now, in a canoe, her displacement is too small, in proportion to the size and weight of her gear and occupant, to allow of as proportionately good results being obtained by outside ballast as in the yacht. It is found by practical experience in the canoe-sailing that the alteration of the position of the occupant gives greater proportionate results than the amount of outside ballast suitable for her to carry, and that ballast sufficient to be equivalent to the shifting bailast obtained by the occupant trimming the canoe by the alteration of his position would tend to make a canoe unwieldy for many purposes. Of course, in a racing yacht, however small, the same effect cannot be obtained by shifting the position of the crew.

In the sketch you will see that the occupant, having a certain weight, must be taken as an integral part of the canoe, and in calculating her centre of gravity this will entirely depend on the position of the person in her. For instance, if he inclined past A, the centre of gravity would be so altered that the canoe would immediately upset. At A, in a line with the keel and centreboard, he would probably upset, but at C the range of stability

would be great, and increasing at every inclination of the occupant to windward in the direction of D. The canoe is kept in the position indicated by the pressure of wind on the sails. The sails and spars in themselves have a certain weight which must not be forgotten; the direction of that weight may be taken from some point in the direction of A B in a plumb-line. To allow the occupant to shift well out to windward, the side-flaps of the well are hinged, so as to throw back, as at F. In a racing canoe shifting ballast is used as well, which would be stowed to windward by the side of the canoeist. Of course, as the boat was put on the other tack the ballast would have to be shifted over, and the occupant's position must also be altered to the best advantage. (E is the rudder and G is the centre-board.)

In American racing boats—I allude to the smaller class of open boats and also in those used by the Malays for racing, this principle is carried out to a far greater extent. As many "crew" as possible are carried, who simply act as live ballast, with the exception of the helmsman. When the craft is close-hauled on a wind the "crew" range themselves along the weather gunwale, holding on to a life-line, and leaning out over the gunwale as far as they possibly can. At the same time all the ballast is shifted up to windward. These boats carry an enormous amount of sail, which they could not stand up to for a moment if ballasted in the ordinary way, and the labour involved is excessive when tacking, as in the shortest possible space of time the ballast—no light weight—must be shifted over, and the crew resume their position on what is now the weather gunwale. Hardly a race occurs without one of these craft capsizing, and more generally three or four are upset. They seldom or never sink, as the ballast falls out, and the crew hang on coolly—especially if the water is not particularly warm—until taken off by another boat!

A marked improvement on all previous arrangements for shifting ballast,—at all events so far as the comfort of the crew is concerned,—is the latest American idea of a sliding seat or thwart, as recently fitted to one of their most advanced racing canoes. The sliding seat is supported, and travels laterally on the deck or on a fixed thwart, and being of the full width of the canoe, can be run out to windward for a considerable distance, affording a secure and fairly comfortable seat, and enabling a canoe so fitted to carry a maximum sail area on a minimum displacement.

It is this power of trimming the canoe by the disposition of the occupant, combined with the carefully-studied details which enable sail to be reduced in a few seconds, that enables these craft to carry the enormous amount of canvas they are able to set. It will be seen by this that sailing-canoe racing is no easy matter, and it is evident that a man must be an adept and full of resources to succeed in it.

Sailing canoes offer, perhaps, more than any other form of craft, the greatest variety of type, each owner being, probably, the designer, and in many cases the builder, carrying out his own ideas as to form, and when the canoe is built, proceeds to fit and rig her as his experience and fancy dictate. To enter fully, therefore, into all the different varieties of this class of canoe would take a volume by itself, and for the purpose of aiding an amateur to commence, it will be quite sufficient to give a general idea of the form and peculiarities of these canoes, as before you succeeded in making one you would have to be well up in construction; and not only in that, but would have to understand from practical experience, the principles that govern these craft, and the points to be attained, as well as those to be avoided; together with a great many little wrinkles which can only be picked up by canoe sailing; and then when the canoe was built you would have to find the best way to set a large amount of canvas in such a manner as to be able to reef down at a moment's notice, besides learning by practice how to do this effectively, as well as to keep the balance by the almost intuitive motion of your body while your hands are occupied by gear, and your head by the difficulty of sailing the canoe to the best advantage, taking advantage of every puff, avoiding any obstacle in the way, taking into consideration sets of tide and tricks of opponents. In fact, you would be divided something after this fashion: Your body, as ballast, shifting to every puff, and doing so at once, and being equally ready, if the canoe is taken aback, to shift the other way—keeping, in fact, the balance as well as the rider of a bicycle has to, and by practice keeping it, as a good bicyclist will do, almost unconsciously. Then your hands, representing the crew, always ready to pull and haul, to manage the several sheets, to reduce sail instantly if necessary or to make it again as quickly, and the head, as the captain, guiding, deciding, and taking into consideration all contingencies—not an easy task. And before attempting it, it would be advisable to build an ordinary canoe, and gain experience in her while, by examination of the sailing canoes you would meet, and from the hints you would be able to obtain when cruising, you might, after a time, have sufficient practical knowledge of the character and peculiarities of sailing canoes to start building one with a better chance of making a successful job.

Although at first almost every rig was tried by canoeists, it has been found by experience that the one best suited to sailing canoes is that comprising only two sails, the main and mizen; the jib or fore-sail which was used in the *Rob Roy*, and also in some of the earlier larger sailing canoes was found to be exceedingly troublesome to handle, being so far away from the crew, and doing little good when beating to windward and none at all before the wind. The position of the masts, too, has been changed about, in various canoes, from one place to another, every owner having his own ideas on the subject, until it is commonly agreed that the fore-mast is best stepped right forward, allowing the boom to clear the occupant, while the mizen should be almost as far aft. Although, however, it may be considered a settled matter that only two sails need be used to obtain the best results, it is still an open question as to what character these sails shall assume. The ordinary gaff and boom main-sail, with its parralls or rings on the mast, and double halyards, is voted too complicated and otherwise unsuitable for canoe work, while the sprit is also tabooed on account of the troublesome spar.

In England the general rig for canoes is the balance lug, which is almost invariably, if of any size, fitted with reefing battens. In America the lateen is a good deal in use, and also the leg of mutton; these are similar to the rig described for the "sharpie." Another rig used there is one very similar to the bat's wing, but termed in America the "Mohican;" this is much the same as that described in the chapter on Sails.

The diagram of the yawl rig for a canoe also indicates the method of reefing by battens, which is fully described in "Sails." It is this system of reefing, of which the principle remains much the same, though individuals alter and modify details to suit their views, which enables with comparative safety, the enormous amount of sail to be used which some of these craft carry, particularly when racing.

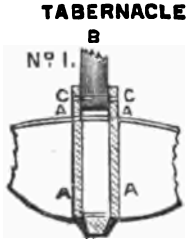
In racing canoes a spinnaker is used when off the wind; it is of the same form as that used in an ordinary racing yacht, but of course considerably smaller. It is fully described in the chapter on Sails. A canoe spinnaker is set as the owner thinks best; he has the general idea to guide him; and carries out the plan that he considers most likely to give him satisfaction.

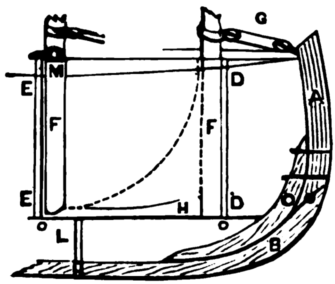
There are two great types of sailing canoes—those that depend on a centreboard for the requisite lateral resistance, and those which have a deep enough fixed keel to enable them to dispense with the centreboard. Of the former are the *Nautilus* and *Pearl* classes, and of the latter is the *Mersey* type of sea canoe. The *Mersey* canoe is designed purely and simply for sailing, and is too heavy and has too much beam, for a paddle to be of any real use; these boats, therefore, are usually fitted with short sculls and rowlocks. The other classes are paddleable sailing canoes, and while they are so designed as to be capable of proceeding under paddle alone for long distances, on the other hand, by means of the centre-boards, they can make almost as effective use of their sail power in smooth water as the deeper and heavier *Mersey* type.

One great feature in most of these canoes is the arrangement for lowering and raising the mast, called a tabernacle. See Diagram.

No. 1 shows the simplest arrangement of the sort. A A are the sides of the tabernacle which butt on either side of the keelson, and come up four or five inches above the deck. The heel of the mast ships

TABERNACLE



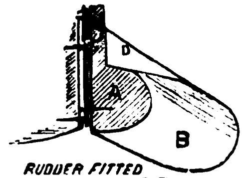


TABERNACLE
Nº 2. SHOWING
CONSTRUCTION OF STEM

between them, and is rounded up at the forward side and bound with brass to prevent splitting, a pin C C passes through all on which the mast pivots. At the back of the heel of the mast at A A the back piece of the tabernacle projects above the deck, sufficiently to stop the mast falling forward, or if no back piece is used a chock must be fitted on deck for this purpose. The mast is raised and lowered by a stay from the masthead hooked to a tackle at the stern; this stay is very much in the way, and to clear it the sail of a lug has to be cut with a high peak, but the short stay used with the second form of tabernacle would hardly give enough support where the mast is not housed more than four or five inches.

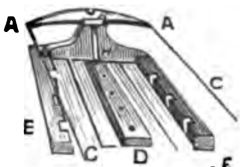
The second and better plan is to have a regular built case, something like the centreboard case, lined with copper and fitted with a drain to take the water off; D D and E E are the sides, and O O the bottom of the tabernacle, a drain pipe being fitted at L. The mast F, if placed aft, swings on two lugs M, like the trunnions of a cannon, which project from a band round the mast; these lugs are shipped in ring bolts on the deck; the mast swings on these trunnions and is raised or lowered by the tackle at G; if necessary or advisable, the mast can be shifted forward, as shown by the dotted line, the heel being supported by the chock H, or by an arrangement of small hollow blocks or boxes, of which two or three take up all the space of the tabernacle-case left free by the mast; the mast can be stepped anywhere in the case by the boxes being used before or behind it securely wedging the mast firmly in the case in any required position.

A useful form of rudder is shown here, fitted with a plate, which can be raised or lowered, as desired, by the line D, which passes over the sheave at C on the rudder head. The rudder proper A is hollow, and made of brass, the piece B fitting in it in the same way as the centreboard fits in its case. If, instead of hooking the rudder on to the stern-post both rudder and post are fitted with gudgeons, and a pin passed through all and secured by a small nut on the lower end, the rudder can be always kept on, as, when the plate is up, it will clear everything, and even if it should not, it can always lift on the pin so as to clear any impediment. A guard should be fixed on the keel, forward of the rudder, to prevent any ropes or gear fouling and disabling the rudder.



RUDDER FITTED WITH LOWERING PLATE

The steering gear is another point that, in a sailing canoe, demands attention. With only small sails, as on the *Rob Roy*, the paddle is sufficient to steer the canoe by, but with a large area of canvas it will be found insufficient, and to meet this want, the rudder is used, but in all boats with no counter, carrying a mizen, there is a certain amount of difficulty in adopting suitable and efficacious steering gear. One system has been alluded to and illustrated by a diagram, and it is probably, for many purposes, as good as any other mode, but for racing it is necessary that the hands should be free to deal with the sails and the manifold gear connected with them, and therefore the steering is generally done by the feet, and for this purpose the yoke-lines are led down from the back of the well to a yoke below the deck, on which the feet rest as on a stretcher. The yoke A A pivots on a metal pin B. This pin is steadied by the block H, and the pin can either be passed through a metal tube, secured in front of the block H, or behind it, whichever seems most desirable; the centre piece D is pierced with holes to take the lower end of the pin B, and the side pieces E E are fitted with notches to take the block H, which shifts on them as would an ordinary stretcher. The yoke-lines C C are led up from the yoke A A, through the back of the well-coaming to the rudder yoke. The side pieces should be of hard wood, as oak, and about 1½ by 1¼ inch by a foot long, screwed down on each side of the keel. Another way of fitting is to cut a rabet instead of the notches in the side pieces, and tongue the block to run easily between them. The pin on which the yoke pivots, should be fixed at the back of the block, with a tail piece 6 inches long resting along the floor forward to take the strain of the pressure on the upper part of the block; if this tail piece is fitted with a short piece hinged on the end like a pawl, so as to fall into notches cut along a centre-piece of oak, it will keep in any required position until the pawl is lifted out, otherwise it must be secured by a lanyard fitted with a euphroe hooked aft so as to be out of the way; when it is desired to shift the block forward or aft, the euphroe must be slackened up or hove taut, and if necessary the whole arrangement can be removed.



FOOT YOKE

If the canoe, however, is fitted with a centreboard, it may be found simpler to pivot the rudder foot yoke on the after end of the centreboard case. If fitted in this way there is always the objection that the yoke cannot be shifted to suit the different requirements of the crew, unless by altering the yoke itself; for instance, a straight yoke would suit a long-legged man, a yoke with the ends curving forward would give more room still, and in some cases the same yoke taken off and reversed so as to curve backwards would be more suitable; but these little details must be left to the owner and builder, to be carefully thought out, and the best practical result obtained.

The *Nautilus*, which crossed the Atlantic, was steered in another way, simple enough and effective. There was only one arm to the yoke of the rudder and to its end was loosely bolted a long piece of ash, which acted as a tiller, being drawn forward or pushed back as required. There is, of course, no necessity in a canoe to make this tiller a fixture, or to have only one arm to the yoke, which might have two arms in the ordinary way, fitted with small studds with large heads, an ordinary light boat-hook staff could then be fitted at one end with a piece of stout copper wire, very much in the same way as the method of fitting the boom jaws, or rather rings, was described in Model Yacht Rigging. This staff could then be hooked in the yoke and used to steer by whenever it was needed.

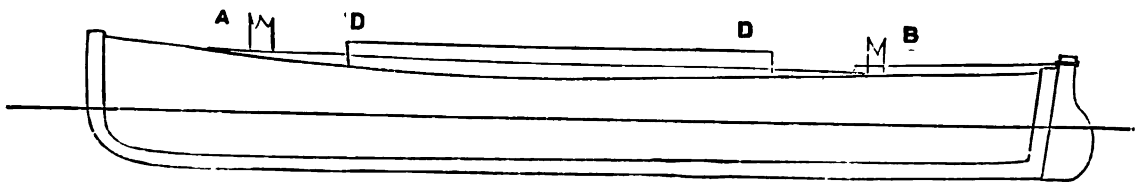
The well and its covering is another important matter to decide in a sailing canoe, and as in other details almost every canoeist has his own pet method; besides the ordinary "well proper" it is necessary that all sailing canoes, which depend largely on the disposition of the crews' weight for stability under sail, should be fitted with "side flaps," hinged on to the deck on their outer side, so as to allow them to be thrown back to let the body of the "crew" come as near to the side of the canoe as possible; it is necessary to run a coaming round where the deck is cut for the flaps, to keep the water out.

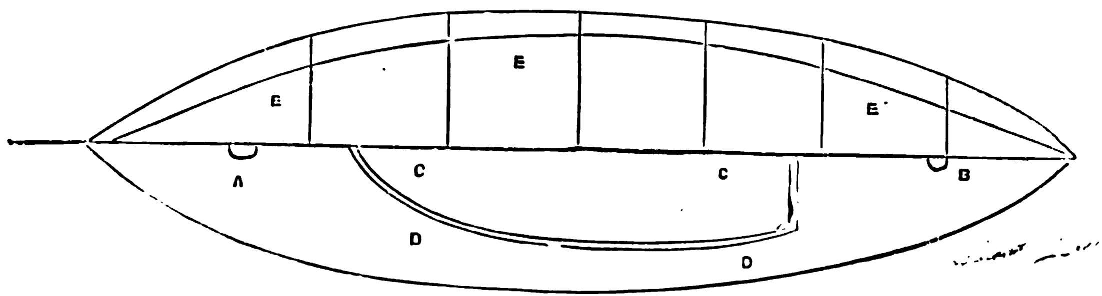
In the *Rob Roy* only a small well is necessary or advisable, but in larger sailing canoes, which frequently carry two persons, it is usual to have a much larger opening, say 4 feet or even 5 feet by 20 inches. These wells are generally of a square shape at the after end, and the forward end is sometimes elliptical. Another form of well is the octagonal, though this form is, in some cases, modified by the after end being left square. The coaming round the well should be about two and a half inches higher than the deck, and in some canoes rises forward with a bold sheer, terminating in a V shape, the upper portion of the apex of the V projecting forward beyond the lower; this form is common in this country in wager (sculling) boats, and serves to throw off any water that may come on board, and also drives the spray off on either side away from the well, but as applied to canoes is more frequently seen in America than in England.

Whatever may be the form of well, it is generally covered in by one or more hatches, in some cases entirely distinct and separate, and in others hinged to each other, so that the after one can be laid back flat on the forward one. Besides the hatches an india-rubber apron is frequently used, which is fitted with a rubber cord, so arranged as to fit tightly round the outside of the well coaming and yet be easily detached in case of an upset. For racing a mackintosh cloak is often used, which is made with a double skirt, the inner skirt going into the well and the outer one extending round and over the opening, including the side flaps, and secured round the coaming by a rubber cord. For an ordinary sailing canoe a handy form of hatch could be fitted in the following manner; across the well, at such interval as might be convenient, slight beams should be fitted, having a good crop or arch, and dropped at either end into slots cut in the coaming to receive them, these slots not extending through the coaming to the outer side, but leaving the full height of the coaming next to the deck intact. The slots should be full wide for the beams, to allow them to be readily detached, even if swollen by wet. To each side of the coaming a half hatch can be then hinged, the joint being covered and made watertight by a strip of mackintosh cloth properly fitted; these longitudinal halves should be wide enough to lap over each other, and may reach as far aft as is convenient, the after portion of the well being covered in by the skirts of the canoeist's mackintosh, which are secured round the coaming, and the sleeves of which are made watertight by indiarubber rings or [illegible] a heavy sea [illegible] be [illegible] of the canoe [illegible] to fall open and the beams to [illegible] form of hatch is merely a general [illegible] by [illegible] The material used [illegible] wood or better still Willesden paper [illegible] which would be [illegible] strong and impervious to water. It [illegible] with the coaming might [illegible] by the strip of mackintosh cloth [illegible] to the coaming [illegible] mackintosh hinge could be secured [illegible] over it outside all and screwed [illegible] and another such batten fitted [illegible] way along the edge of the paper hatch and screwed down over the other edge of the strip of [illegible] cloth into another batten run along the [illegible]

In the sheer plan, Fig. 1, of a sailing canoe we have a yacht-like form with a considerable amount of drag and deadwood aft, and a long stern-post, giving a deep heel; such a boat could carry her centreboard well forward, as by her form she has sufficient lateral resistance aft to balance it, but it is a question whether such lines are of practical value. It would appear that a design with a flatter floor and rounded up aft, drawing little water at the stern-post,

SHEER PLAN of SEA CANOE





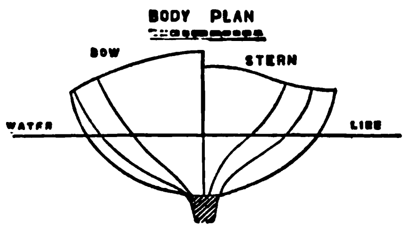
HALF BREADTH PLAN

A *Foremast.*
C C *Well.*
B *Mizen-mast.*
D D *Coaming of well.*
E E E *Load water-line.*

To face p. 259.

would be much better for all ordinary purposes, and the requisite lateral resistance could easily be given aft by means of a drop rudder, or an after centre-plate (see Canoe Yawl). The body plan would be better suited for a small sailing boat than for a canoe, particularly if designed with about three and a half or four beams to the length on the water-line.

The last form of canoe we shall now consider is the sea canoe; this canoe, being larger and stronger in build than a river boat, and being generally used



SEA CANOE

Fig. 2.

in deep water, may be constructed without centre-board and with sufficient draught and false keel to give the requisite hold of the water. Such a form of canoe is shown in the plan. As you see, she has considerable beam in proportion to her length, the plan being a little more than three beams to the length; the depth is rather less than was intended, half the beam being the proper proportion for depth, the measurement being from the under side of the deck to the top of the keel. A little more draught of water would do no harm, as shown in the body plan, Fig. 2. E E E in the half-breadth plan shows the shape of the canoe at the water-line, and D D shows the coaming of the well. The rudder-head is fitted with a brass yoke; a similar yoke, to which a tiller is attached, is pivoted to the deck just forward of the mizen-mast, the yoke being in a line with the one on the rudder, and at the same height. These yokes are connected by light chains or lines. so that the tiller forward of the mizen on being moved immediately acts on the rudder as required. By this plan the boat can be steered as easily as if the position of the mizen allowed an ordinary tiller to be used. A shows the position of the foremast and B of the mizen. For particulars as to building I must refer you to the chapter on Construction, and shall merely give a few details not touched on in it.

The sea canoe may be built rather heavier than the *Rob Roy*, as she is not intended for land transport. The planking may be three-eighths of an inch or even half an inch, as such a canoe is to all intents and purposes a small decked boat, and will carry two or even three people. Her length is about eighteen feet, beam five feet, and depth two and a half feet. But such a beam is extreme, and three feet six inches or four feet would be ample for most purposes. It is of course, impossible to paddle such a craft, which is only a canoe in name. Short light sculls are used with brass crutches to fit in holes in the gunwale. The size of the hatchway is seven and a half feet by three and a half feet. The ballast is best carried in the form of an iron keel, which will give a considerable amount of stability to the boat at a small expense, and leave the interior unencumbered by ballast, save a small amount in shot bags for the purpose of trimming the boat. The balance lug is perhaps the best form of sail, though a couple of sprits and a staysail set on a short iron bumpkin forward will answer extremely well, and under them the boat can be kept very close to the wind. However, before the amateur attempts such a craft he will do well to try his hand on some easier form, and it would not be a bad plan to build a model about two or three feet long as an experiment, which would cost a mere trifle, and would teach more of practical boat-building than any number of books on the subject.

CHAPTER XIII.

THE DESIGNS.

Model Yachts.

Defiance, twenty-ton class, was designed by her owner, Charles H. Beloe, Esq., C.E., Commodore Liverpool Model Yacht Club, to compete under the tonnage rules used by the Club (see Appendix). In the body plan No. 11 section is left out, and follows Nos. 10 and 12 so closely as to be almost identical, on such a small scale as is used.

The following are dimensions of spars:—

	1st Suit.	2nd Suit.
	′ ″	′ ″
Mast deck to hounds	41·0	33 0
Topmast	30·0	31·0
Bowsprit outboard	30·0	26·0
Boom	43·0	47·0
Gaff	29·0	27·6
Topsailyard	26·6	
Area of mainsail	1500 sq. ft.	1343 sq. ft.
„ foresail	446 „	380 „
„ jib	450 „	303 „
Total area of lower canvas . .	2396 „	2026 „

For further particulars see Sail-plan, *Defiance*.

It will be seen from the sheer plan that this boat's forefoot is considerably rounded up. It is a question if it is advisable to cut so much away, in a model; at the same time, the after-sections show a tendency to V forms, causing considerable displacement in the run, which, in a model, is extremely likely to run the boat off the wind when going at high speeds, as the water displaced by the boat, coming rapidly up, and being opposed in its passage by the course run, causes excessive wavemaking, taking the vessel off her normal sailing lines and altering her trim, which with the pressure of the wave caused by the water abruptly displaced, tends to run the vessel off her helm. A case occurred in my own experience, some years ago, in which a model, otherwise exceedingly fast, used to run off the wind when pressed. She had just such full after sections as a clipper ship would have, having been cut out by a ship's carpenter. As an experiment, the whole of the deadwood aft was fined down, until it was only about the thickness of the keel, except just where it was rounded off so as to merge into the body of the boat. This cut away a considerable quantity of wood, and the boat was afterwards a marked success, never showing the least tendency to run off, the extra fineness allowing the water to pass away as quickly as it was displaced, without undue friction or causing pronounced wavemaking.

Isolde.—This is a design of an extreme type, and like the *Evolution* in real yachting, it is probable that this boat is carried a little too far. She is a very good specimen of what a tonnage rule will produce, and must be considered in the light of a racing machine, and not as a "form that salt water likes." It is very questionable if she will ever be a success. The secretary of the Club informs me that up to the present she has not been properly tried, and he has great hopes of her, and intends doing his best to assist the owner to make her answer. There is a minimum of beam beyond which, whatever the amount of lead, it is almost impossible to make a boat stand up, and if models are designed on the lines, or nearly so, of an extreme type of actual racing yacht, say *Jullanar*, it will be found uncommonly difficult to make them stand up in a blow, though the real vessels may do so very well. The real vessel's beam is sufficient when coupled with her ballast, for her requirements, but when the scale is run down to the size of the model, it is frequently found her beam is less than that absolutely necessary for stability, unless the draft is proportionately increased as in small racers, as *Doris*.

Ten-tonner.—This boat, designed by C. Bathurst, Esq., Liverpool Model Yacht Club, is an extremely graceful and yacht-like craft, and as she has shown considerable speed and general good sailing qualities, has been evidently appreciated by the members of the Club. If the old saw is true, that "Imitation is the sincerest flattery," the designer should feel highly complimented, no less than four other boats for various owners having been built from these lines, viz. *Ruby*, for T. H. Hodd, Esq., Secretary Liverpool Model Yacht Club, *Ulerin* (G. Hankinson, Esq.), *Rosebud* and *Bathurst* (A. W. Kiddie, Esq., Southport), besides the original *Dot*, owned by Mr. Bathurst.

Bonny Jean.—This boat was designed and built by T. A. Bruce, Esq., Commodore Kingston Model Yacht Club, Hull. The boat is 4 ft. 9 in. in over all, 4 ft. 2 in. on the water-line, 10¾ in. beam, and 8½ in. extreme draught; she is cutter-rigged, but generally carries a sloop foresail instead of two headsails.

Mr. Bruce writes that the boat may be considered a fair type of the Kingston Club boats in the length classes, and though not the fastest boat, has a good turn of speed, especially in a whole sail breeze, and is extremely steady on her helm. The forefoot is purposely rounded up for the purpose of clearing any floating weeds, an advantage in the waters used by the Club. For ordinary sailing it is possible that the boat might be improved if the bow were kept at the dotted lines, and the stern-post also placed as indicated in the same manner.

The boat was built of canary-wood laths on frames of the same material, the hull being built one-half at a time, and then screwed together.

Canoes.—The design of a Mersey paddling canoe, by Samuel Bond, Old Slip, Birkenhead, is that of the ordinary class of single canoes used in the Liverpool river. It may be mentioned that Mr. Bond obtained the gold medal at the Liverpool Exhibition for his boats, which, too, were not specially constructed for the purpose.

The lines of the Canadian canoe were taken from one in my possession. If building from this design, it might be advisable to reduce the sheer as far as the ends are concerned, as when they are so high out of the water it is difficult to keep the boat straight in a head-wind.

L'Hirondelle, sliding gunter rig, centreboard canoe with counter stern. This type of canoe, of which the following is a description, is a speciality of Messrs. Dennes and Porrett, Hylton, near Sunderland.

Length of the hull over all 14 ft., beam extreme 2 ft. 6 in., depth moulded 14½ in. amidships. These vessels are clinker-built, of either spruce or oak, with five solid timbers of oak and steamed American elm timbers spaced 5 in. apart. They carry their greatest beam well aft, and have no rise of floor there, a very fine entrance and quick run; a quick sheer aft serves to lift the vessel when in a surf, the centreboard or plate lowers and raises with a screw, an advantage over the chain, as it retains its position if the boat should be capsized. The gunter spar, bowsprit, and main boom are bamboo, there are two shrouds, one on each side, and the mast, with all gear complete, lowers right down aft on to the deck by slacking the forestay. The jib is made fast to an endless tack, and all sail is easily set from the well; a fife rail within reach contains all the belaying pins. The steering is done by foot pedals, thus leaving both hands at liberty. The centre-plate weighs 1 cwt., and the boat complete, with plate, 2 cwt. Two bulkheads, one forward and one aft of the well, make the vessel unsinkable, but in some of them zinc tanks are fitted inside so that even if the boat gets holed, she cannot sink. The upper works are all oak and mahogany, and brass fittings throughout.

These vessels sail wonderfully fast, and carry a surprising amount of canvas, with the additional advantage that, through their having a flatish bottom, they are well adapted for up-river work and paddling when the centreboard is left ashore. The mainsail is reefed by means of running reef tackle, one end of which is made fast to the tack and the other to the boom end; by hauling on any part of the bight the sail is instantly reefed. The mainsheet is endless, and runs through a block on the boom, and through a block on each quarter; the lee part is belayed and the weather one held in the hand.

As in the *Tit Willow* (which is fully described in the next chapter), the ropes are cotton, and dyed different colours for ready distinction.

Dabchick—This small yacht was designed by her owner and builder, Charles Livingstone, Esq., of Liverpool. Mr. Livingstone is an amateur yachtsman and canoeist of considerable experience. The well-known canoe *Laloo* was in a great measure his conception, and his open racing-boat *Nanette* inside with large metal nuts. Nine of the bolts come through centre of wood keel, but rake alternately to port and starboard.

"The lead was cast first, and bolted in its place before the stem and sternpost were set up, as being much more convenient than having to cant the boat over after she was finished. The lead keel makes a capital building block, and the weight keeps the boat steady while the construction is progressing. The stem and stern-post were then set up and the deadwoods placed in position, and the whole structure securely bolted together with yellow metal. The deadwoods come very far aft and forward, in fact both the forward and after keel-bolts come up through the deadwoods. The next operation was to make temporary frames of 1½ in. deals and set them up in their places, being careful to put the correct bevellings on the edges. When they were levelled, plumbed, and secured, the battens were nailed on to them to keep everything in position and show whether the frames were fair. The steamed timbers were then turned into their places and a nail driven through the battens into each timber, where they cross, to keep them in position. When all was fair the top batten was pulled off and replaced by the top-streak; then the second was replaced by second plank, and so on down to the bilge. When she was planked down to bilge we canted her over and started planking from garboards up. The clamp was then fastened in, also the breasthooks fore and aft. Two bilge-stringers were put her full length inside. The deck-frame came next, and then the decks were laid. The coamings were then turned in, leaving only the hatches and other deck-fittings to be arranged, and the rudder to be made and hung. When evening sailing I have a 9 ft. well, but when cruising, a small roof 5 ft. 5 in. long, with skylight and sliding hatch, ships over the fore end of well and makes a comfortable little cabin, with 4 ft. 2 in. headroom, leaving a cockpit aft, 3 ft. 6 in.

"The hatch is built on a coaming of its own, which ships over and is screwed against the well-coaming of the boat. The *Dabchick's* sails are very small, and were I ordering new sails for her, I should considerably increase the sail-plan. Even for the rough work of the Mersey she is considerably undersparred.

"The sails were made by Perry of Birkenhead, who has made all my racing sails, and it is only fair to say that they are most satisfactory.

GENERAL PARTICULARS.

Length over all	16 ft. 9 in.
„ on L.W.L. . .	15 „ 9 „
Beam	5 „
Draught aft	3 „ 8 „
Displacement	1.93 tons.
Ballast on keel	16 cwt., lead.
„ inside	10 „ „
Mast deck to hounds . .	12 ft. 9 in., to pole-head 21 ft.
„ diameter at deck . .	4½ in.
Boom	14 ft.
„ diameter	3½ in.

Gaff	9 ft. 6 in.
„ diameter . . .	2½ in.
Bowsprit outboard . .	8 ft. 6. in.
„ diameter . .	3½ in.
Spinnaker boom . . .	17 ft.
Topsail yard . . .	13 „
Jack yard	7 „

Sails:—Mainsail, topsail, foresail, 3 jibs, trysail, and spinnaker.

"I did not use any iron floors. As will be seen by specification, three oak floors are in centre of boat. With timbers jogged *full* size into keel and a metal spike through foot of each, iron floors are not necessary. Of course they make a stronger boat at first, but with lead ballast inside I do not care for the iron.

TABLE OF OFFSETS OF "DABCHICK."

No. of sections.	Stem.	1.	2.	3.	4.	5.	6.	Stern.
Half-breadth at gunwale . .	1½	1.1½	1.11	2.3¼	2.6	2.4½	2.	.1½
Ditto, L.W.L.		.10½	1.8½	2.2½	2.5¼	2.3¾	1. 6	
„ „ 2		.8¾	1.5¼	1.10¾	2.1	1.10¾	1.1	
„ „ 3		.6¾	1.1¾	1.6	1.7½	1.5	.8¼	
„ „ 4		.4½	.9½	1.0¾	1.1½	.11½	[illegible]	
„ „ 5		.2¼	.6	.7¾	.8	.6½	.2½	
„ underside wood keel		.1	.3	.4½	.4¾	.3¾	.1¼	
Heights L.W.L. to gunwale .	2.4¾	2.1	1.9¾	1.7	1.5½	1.	1.6	1.9
Depths to underside keel		2.6½	3.1	3.5	3.6	3.5¾	3.2	

TABLE OF BLOCKS AND CORDAGE FOR "DABCHICK."

	Number of single blocks.	Size of blocks.	Size of cordage.
Throat halyards .	2 Hook	3 inch	1¼ tarred.
Peak halyards .	3 „	3 „	1¼ „
Jib halyards eye-bolt and sheave on mast . .	1 Cliphook	3 „	1¼ „
Forehalyards .	1 Ropestrop tail	2½ „	1 „
Bobstay . .	1 Iron	2 „	¾ wire.
Reef pendants .	. . . .	. . .	1½ Manilla.
Topsail sheet .	1 Ropestrop tail	2½ „	1¼ „
Topsail halyard .	. . . .	. . .	1¼ tarred.
„ tacktackle .	2 „	2½ „	1 „
Topping lifts .	2 „	2 „	¾ Manilla.
Spinaker halyards .	2 Ropestrop tail	2½ „	1 „
„ afterguy .	. . . .	. . .	1¼ „
Mainsheet . .	2 Ropestrop .	. . .	1¼ „
Jibsheets . .	. . . .	. . .	1¼ „
Foresheets . .	. . . .	. . .	1 „
Jib outhaul . .	. . . .	. . .	1¼ tarred.
Topmast forestay .	. . . .	. .	7/? wire.
„ stays . .	. . . .	. . .	7/16 „
Shrouds, two each side . .	. . . .	. . .	¾ „
Main outhaul .	. . . .	. . .	½ „
Anchor working[1] .	20 lbs.		
„ kedge[2]. .	12 „		
Chain . . .	25 fathoms		¼ „
Kedge rope . .	15 „		½ tarred.

1 Riding lamp
1 Red and green (railway guard's) lamp.
1 Spirit compass, 3 inch, in boat binnacle.
1 Marling-spike.

"Nicholson's anchors are, in my opinion, far and away the best for small boats. They are to be had from Campers and Nicholson, Gosport.

[1] Nicholson's patent. [2] Ordinary pattern.

"The following gives some idea of my cabin fittings:—

"I use oilcloth on floor, as it is always drier than carpet. For sleeping accommodation two iron frame cots, which fold up against side in daytime, and form a comfortable cushion to lean back on. Each contains a mattress, pillow, and two blankets. Cots are certainly the best form of bed for a small boat. They keep the blankets out of the way in the daytime, and I generally pack my change of clothes in one of them. Two cabin cushions, covered with American cloth. One waterbreaker, holding about five gallons.

"Methylated spirit-stove, with two lamps, kettle (about 1½ quarts), boiler, steamer, frying-pan and small tin pot. All the utensils should fit the holes in the top of stove, and they will not tumble off if the boat is at all lively. I find the most convenient way to carry the methylated spirit is in half-gallon tins; three tins last me about a fortnight with two living on board.

"Four plates, four mugs, four knives, four forks, one large, four dessert, and four teaspoons. Tin-opener, pepper-pot, and small tin box of salt. Two tins for tea and coffee, teapot and coffee-pot, small looking-glass, clock, and aneroid barometer."

The Munster Model Yachts.—These little craft are eminently adapted for single-handed cruising and sailing, and have the great advantage of being exceedingly moderate in cost. One of the most celebrated of this class is *Wideawake*, designed by her owner, C. Walrond-Skinner, Esq., of Haulbowline, and built for him by Roche of Passage. A very full description of this boat by her owner, is appended.

The other design is by G. L. Watson, and two boats have been built from it, the *Wren* and *Myosotis*.

The Munster Model Yacht Club, now the Munster Corinthian Yacht Club, has made a special feature of this class of boat as a type of singularly good sailing qualities, with safety and fair accommodation, at such a small cost as to be within the reach of most amateur yachtsmen. *Wideawake* was specially designed for racing, and for mere cruising it is possible that the other design might be more suitable in many respects.

Description of 16-ft. Sailing-boat Wideawake, Munster Model Yacht Club.—"Munster Model Yacht Club (now Munster Corinthian Yacht Club), Cork Harbour. Rule adopted for New Class, 12th March, 1885.

"1. Boats not to exceed 16 ft. between perpendiculars (or over all).

"2. The sail-area by Y.R.A. rule not to exceed 256 square ft., of which the *main-sail* is not to contain more than 140 ft., and the fore-sail to be measured as if set from the masthead to bowsprit end. The top-sail not to exceed ·4 (two-fifths) of the area of main-sail.

"3. One triangular spinnaker may be used, the boom of which is not to exceed 14 ft. from goose-neck, or mast, to outer end when set."

The *Wideawake* was built in compliance with the above rules, and has proved herself to be perhaps the most successful boat of the new class. She is more than a match for the old 18-ft. class (measuring 3 tons), and in 10 starts this season has taken 6 firsts and 1 second prize.

"Being limited in sail-area, it would not pay to build too large a boat, so four beams to length was thought to be enough; a counter not being allowed, she had to be built with a square stern.

"She was essentially built as a single-handed boat for knocking about in, in all weathers, and as such has been used all the season, and has proved herself all that could be wished for.

"For racing a second hand is carried, but nearly all the cruising has been done single-handed.

"The boat is very stiff, and rarely wants a reef tied down. She will lie over to 45° before her deck is immersed, and she has never taken any water into the well, although she has been raced on a wind in a heavy sea with her main boom dragging the water.

"If the boat were not tied down to sail-area, a larger mainsail and jib would be a great improvement, as for racing in light winds, she is under-canvassed The large topsail is only used when racing out of her class, as it puts her over the sail-area.

"A little more sheer would perhaps have improved her appearance, at present she is straight. Her transom being well tucked up,there is no drag at all aft. The sternpost was given a little less rake than shown in the sheer plan, the dotted line will about show it.

"The boat's best point is undoubtedly *on a wind*, running free in a sea way she is wild, and on all points she requires careful steering as she is very quick and will not let you leave the tiller. She is the quickest boat either in stays, or wearing that I ever saw.

"With regard to cruising, the weather here changes so rapidly (with little or no warning), and the surrounding coast is so wild and devoid of shelter, that cruising in small boats is not much indulged in, though of course in making, say, a run to a regatta at a neighbouring port, we might get a taste of it.

"Whilst at Plymouth, I owned a good, comfortable cruising 3-tonner, with good cabin-room, &c., and did a lot of coast cruising, but I consider the *Wide-awake* and boats of her class equal, if not superior, on all points of safety and speed. I consider that a 2-tonner on similar lines, with a water-line of 20 ft. and beam of 5 ft. would have first-rate accommodation, and be large enough for anything. As to management, &c., there is nothing peculiar in them, being much the same as the handling of a 3-tonner. Of course sheets are all made fast, main-sheet being never started except for purposes of trimming; in going about, the smallest touch of the helm is enough, the boat carrying way well, and head reaching a long distance in stays; with two hands both head-sheets are eased and hauled in together, if single-handed (sheets lie right aft), both are eased off together; jib is hauled in first, and then foresail. *Wideawake*, under whole mainsail and jib, foresail being doused, would be very handy in strong breezes, single-handed, and as tack-tricing-line is always handy the boat could be always eased to it, but she would rarely require such treatment.

"Of course, being so short, in a sharp, quick sea (for instance, a strong wind against tide), she will pile-drive a little, and water will fly over the deck forward, but nothing will come inboard. During close-hauled work and *pressed* in racing *she has never shipped a drop of water.* It is a rare thing for her to go beyond her covering board.

"This class of boat is sailed here in almost any weather; it is difficult to find a day too wild for them to get under way, and then it is the heavy tide sea here, more than anything else, that would keep them in; still, where an ordinary 3- or 5-tonner would go, they will.

"The sail-area is far too small, and would be better as under:—

Main sail, say . . .	200
Head sails	100
Top sail	50
	350 sq. ft.

"I carry an anchor weighing about 35 lbs., but on account of the weight I did not use chain, finding about thirty fathoms rope answer every purpose."

Keel elm 5 in. moulded, 18 in. sided amidships, tapering as shown in body plan. Stem, sternpost, and transom, of oak. Garboards with next plank, also sheer strake and covering board of $\frac{3}{4}$ in. elm. Planking of sides and deck $\frac{5}{8}$ yellow pine.

A worked floor and timber at each section, and between each section a worked floor and steamed timber. Worked floors $2\frac{1}{2}$ in. moulded, $1\frac{3}{4}$ inch sided. Worked timbers $2\frac{1}{2}$ in. moulded, tapering to 2 in. at top, $1\frac{3}{4}$ sided. Steamed timbers (American elm) $1\frac{1}{2}$ in. sided, $\frac{3}{4}$ in. moulded.

Thickness of plank is shown on plans, also covering board on sheer plan. Lead keel 7 ft. long, 3 in. thick at bottom, weighs 1 ton and is fastened with 4 iron $\frac{7}{8}$ in. bolts, with nut and screw inside. A 1 in. square elm batten is screwed to the covering board to serve as a rail.

Area of mainsail	139 square ft.
„ jib and foresail . . .	90 „
„ small topsail . . .	26 „
Total . .	255 ft.

Spinnaker 112 ft.

Large topsail about 45 ft. Both topsails have at lower end of yard a spring hook, which, when hoisting, is sprung on the main throat halyard and travels up and down on it, keeping the heel of the yard into the gaff. It is disengaged in an instant.

Length of boat over all	16 ft.
„ water-line	$15\frac{1}{2}$ „
Outside beam	4 „
Draught greatest	$3\frac{1}{2}$ „
Displacement to water-line	30 cwt. (about)
Ballast on keel	1 ton.
„ inside	1 cwt.
„ total	21 „
Tonnage Y.R.A.	·85 of a ton.
Mast centre from fore side	$6\frac{1}{2}$ ft.
„ deck to hounds	13 „

Mast head	5 ft.
„ diameter at deck	4¼ in.
Boom greatest diameter	4 „
Gaff „ „	2 „
Bowsprit outboard	6 ft.
„ diameter	2½ in.
Yard for large topsail	15 ft.
Jack yard for „	8 „
Spinnaker boom	14 „
„ diameter	3 in.

Rigging running 1¼ inch Manilla. One wire shroud on each side and wire forestay.

Well of a boat 5 ft. long, and 2 ft. 4 in. broad. The head sheets are led through the peter-board to cleats close aft.

TABLE OF OFFSETS OF "WIDEAWAKE."

Number of Section.	2.	4.	6.	8.	10.	12.	14.	16.	18.
	in.	in.	in.	in.	in.	in.	in.	in.	in.
Height above L.W.L. to deck inclusive	24	23	22½	21¾	21	21	21¼	22	23
Depth from L.W.L. to top of keel	15*	19½	21	22½	24	25½	27	28½	...
Half breadths on deck, including plank	11½	18½	21½	23½	23¾	23½	22	20	18
Half breadths on 6 water-line, including plank ...	10	17	21	23¼	23¾	23½	22	19½	16
Half breadths on 5 water-line, including plank ...	8¼	15	19¾	22½	23½	23½	21½	17¾	7
Half breadths on 4 water-line, including plank ...	6½	12¾	18	21½	23	22	19	12½	...
Half breadths on 3 water-line, including plank ...	4½	9½	15	18½	20	19	14½	7½	...
Half breadths on 2 water-line, including plank ...	1¾	6½	11	14	15¼	13½	8½	4	...
Half breadths on 1 water-line, including plank ...	...	3	6½	9¼	10¼	9	5½	2½	...
Half breadths of keel on top.........................	...	4	6½	8	9	7	4	1¾	...
False keel depth below keel	...	3	6½	9½	10½	10	8	4	...

* To rubbet in stem.

Sections are 1 ft. 8½ in. apart, water-lines 6 in. apart.
All half-breadths include plank.
All heights above L.W.L. include covering board.
Moulded depth of wood keel, 5 in.

APPROXIMATE COST OF "WIDEAWAKE."

	£	s.	d.
Hull and spars	25	0	0
Lead keel, and casting (according to price of lead), say	12	0	0
Rigging, 25*s*., blocks 25*s*.	2	10	0
Sails, if Lapthornes, say	11	0	0
Pump	1	10	0
Anchor and chain	2	0	0
2 Life-belts and cork cushions	0	15	0
Warps	1	0	0
Painting and sundries	2	10	0
	£58	5	0

Wren and *Myosotis*, both from same design (which appears on same sheet as *L'Hirondelle*), were built by Monaghan of Cork, and are owned by W. Morrogh, Esq., and George Lynch, Esq. Both *Wren* and *Myosotis* cost about 50*l*. to build, no expense being spared—considerably more than *Wideawake*, which cost under 40*l*., and is, in the opinion of the hon. secretary of the club, a stronger boat, though probably not so powerful. They are powerful little craft, very fast and well able to take care of themselves in a blow. The hon. secretary of the club writes that this class was specially designed for "greenhorns," that they might learn without coming to grief, and that from the construction and confined sail area of the boats, even a "duffer" could scarcely get knocked down in them. However, from the manner in which the races of this club are sailed, it would appear that the "greenhorns," under the fostering care of the committee, rapidly develop into first-class Corinthians.

OFFSETS 16-FOOT SAILING BOATS "WREN" AND "MYOSOTIS," MUNSTER CORINTHIAN YACHT CLUB.

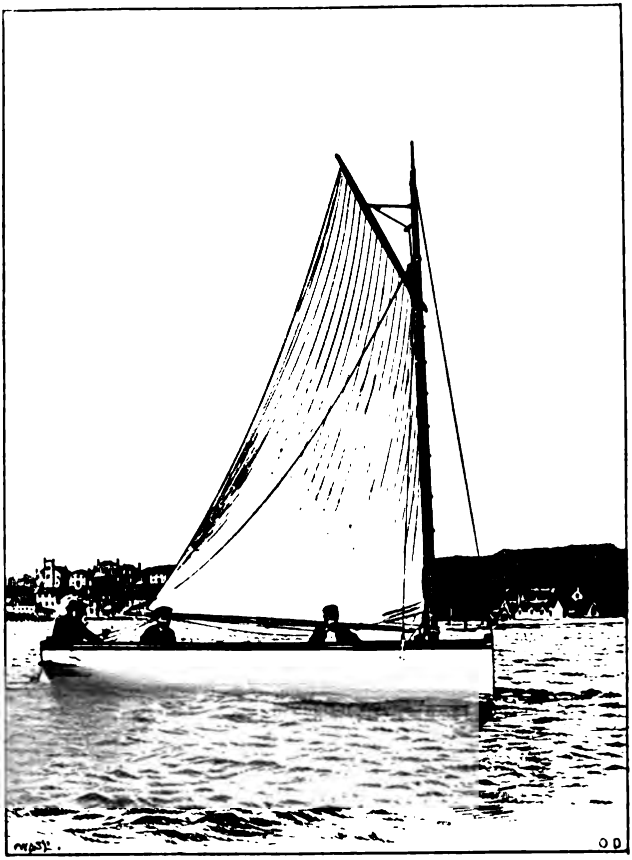
Vertical Sections.	1.		2.		3.		4.		5.		6.		7.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in
Deck heights from L.W.L.	2	0⅛	1	10½	1	8	1	6⅝	1	5⅞	1	6⅛	1	7⅛
Top wood keel from L.W.L.	1	5	1	5⅜	1	6½	1	7⅜	1	8¼	1	9	...	
Bottom lead keel from L.W.L.	1	5⅜	1	11	2	4½	2	8½	2	11¼	3	1	...	
Half breadths covering board	0	11	1	7¼	2	2¾	2	5⅜	2	4½	2	1¾	1	9⅛
18-inch C water-line	0	10⅛	1	6¼	2	2⅝	2	5⅜	2	4½	2	1¾	1	9⅛
12-inch B water-line	0	8⅞	1	4⅞	2	1½	2	5	2	4½	2	1⅞	1	7½
6-inch A water-line	0	7⅜	1	3⅛	2	0	2	4⅛	2	3⅝	1	11⅞	0	11⅝
Load water-line	0	6⅛	1	1	1	9⅞	2	2¼	2	1⅜	1	6⅜	...	
6-inch water-line	0	4½	0	10¼	1	6¼	1	10⅜	1	8¾	0	11⅝	...	
12-inch water-line	0	1⅞	0	6¾	1	2	1	5¼	1	2⅜	0	6	...	
18-inch water-line	...		0	3⅛	0	8¾	0	11⅞	0	8⅞	0	2⅜	...	
24-inch water-line	...		...		0	4¾	0	6⅜	0	5⅜	0	1¾	Lead keel.	
30 inch	...		...		...		0	3½	0	3	0	1		

Wood keel is 3½ in. in thickness.

SPARS.

	ft.	in.
Centre of mast from fore side of stem	5	0
Mast deck to hounds	11	0
Head and pole	7	6
Boom	15	0
Gaff	9	3
Topsail yard	12	6
Jack yard	7	6
Bowsprit outside cap	4	0

Weight of lead, 20 cwt.



"UNA."

To face p. 283

Una.—This exceedingly handsome craft is eminently adapted for single-handed sailing, where the accommodation of a decked boat is not required, though considerable accommodation might be obtained by half-decking the boat; for speed and handiness she would be almost impossible to beat on the dimensions. The lines speak for themselves. As regards the sail-plan, that might be altered to suit the convenience of the owner, so long as the centre of effort was kept in the right place.

Mr. William Fife, jun., to whose courtesy I am indebted for the design, gives the following details, under date August 3rd, 1886:—

"The 18-ft. open boat *Una* was designed in 1884, for Mr. James Grant, jun., to sail in Class VIII. of the Western Yacht Club, in which the yachts are not to exceed 18 ft. over all, the extreme breadth not to exceed 6 ft., and the extreme depth 3 ft. 6 in., the latter measurement to be ascertained as follows:—by measurement at right angles to keel to extreme height of gunwale, camber of stern-board not to be included. Ballast all to be of iron, and under platform, and no splash-boards to be allowed; but these Open Boats may be decked-in two feet from the stem-head. They are allowed two sails, one of which must be a jib, and used as such. The minimum freeboard must not be less than 18 in.

"When *Una* was built, the Club rules only allowed one sail (as shown in the sketch), but under the present rule two sails are admitted, so that *Una* is now rigged with a lug sail and jib. She is extremely fast for a boat of her size and depth, and can beat all comers easily. (She won last Saturday on a strong breeze by 20 minutes.)

"The boat is carvel built, and full advantage has been taken of the sizes allowed by the rule, as will be seen by the design, the keel being cambered to suit the sheer of the boat, so that the full depth allowed by rule is carried nearly fore and aft.

"I may say that she is much admired here, and her owner considers her quite a marvel of speed. I think she is a very good type of boat for shallow rivers or lakes where there are objections to a centre-board. With reference to the sail-plan of *Una*, that which is shown in full lines is her present racing outfit, and she is cruised under the lug shown in dotted lines, *without a jib*, she carries 23 cwt. ballast, including a heavy iron shoe on her keel. For racing the mast would be 4¼ at beam, 3½ at head; boom 3¼ at centre, and 2½ at either end; bowsprit 3¼ at stem, and 2¾ at collar at bowsprit end; yard 2¾ at centre, and 1½ at either end.

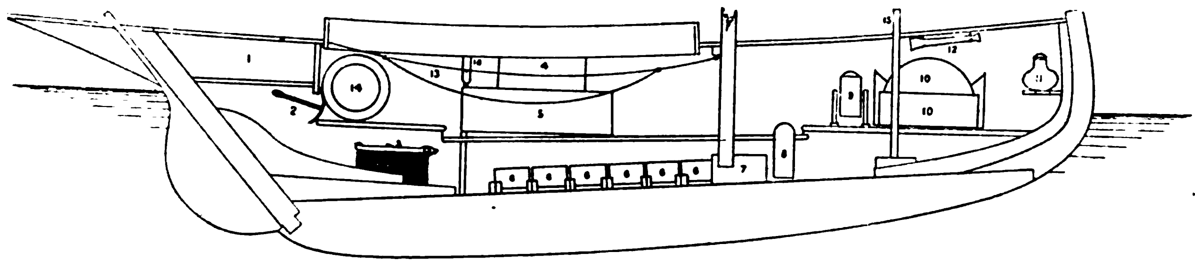
"Her rigging is set up with neat brass rigging screws, and she has her bowsprit fitted with shrouds, which are not shown on plan."

Design for a small Cruiser. (C. P. Clayton.)—Mr. Clayton, the designer of *Curtsey* and *Lil*, to whom I am indebted for the above, is well known as a successful designer, particularly of small racing yachts. The small cruiser in question was designed allows it to appear in these pages), for single-handed cruising on the west coast of Scotland. The drawings show all the details of construction, the scantling being shown in the midship section. The natural frames would be 30 in. apart, about 2 in. × 1¾ in. with 2 bent elm frames between. The planking and decks about ⅞ in., keel sided to shape of lead. Keel, as shown in the design, 4½ in. deep. Stem and sternpost 3 in. sided, beams 2½ in. × 1¾ in., risings 2¾ in. × ¾ in., according to the material. This craft is a perfect little "ship," affording comfortable accommodation, and being as handy as a top; with a good side and fair displacement she would be an able and dry sea-boat, and where water is sufficient to keep such a craft, it would be hard to select a better design. There is little doubt but that she would be extremely fast even under her snug canvas.

The Puffin, 3-*tonner*.—This little boat was designed some time since by her owner, the Rev. S. Penrose, of Scilly, Kinsale, Ireland, for his own use for pleasure and fishing round the coast. The design has many good points, and has produced a fast and seaworthy craft, at the same time being inexpensive to build. There is no doubt that it would be preferable in such a boat to have the keel of greater thickness, which would strengthen the boat materially, and enable her to carry all the ballast outside, or at all events most of it. In this the owner agrees with me, and also says that if he were building now, he would give less hollow in the bottom on the midship section, but from his experience with the boat he cannot suggest any further alteration, considering his requirements. She is easily rowed with a pair of oars in a calm, has a good deal of room in the cockpit, not too much draught of water, is fast, dry, and handy. She can work an otter trawl thirty-six feet on the foot rope, and is very convenient for hand-line fishing, having so much open space. With the hatches on, and a waterproof cover laced over them, she is not at all uncomfortable to sleep in. The designer does not think that more beam would improve her, as she would be more uneasy in a sea, and besides would be over three tons. If fishing was not an object, there is no doubt that the accommodation might be arranged so as to make a more comfortable cabin, and part of the movable hatches might be replaced by a cabin-top. The *Puffin* must, however, be considered as a design for a definite purpose, for which she appears to be well adapted.

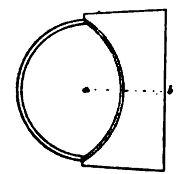
As to her sea-going qualities and speed, Mr. Penrose says, "*Puffin* is, as you will see, an old boat, and of course cannot compete with the modern 3-tonners, but she has advantages. While not expensive to build and fit out, she is buoyant, handy, and easily managed, and an excellent sea-boat, having gone through some very bad weather in her frequent passages to Queenstown, fifteen miles of the open Atlantic. She is very fast for her length, and has won a great many races. One last summer, at Queenstown, a 7-ton handi-

LONGITUDINAL SECTION OF "PUFFIN," SHOWING INTERIOR ARRANGEMENTS.



1. Sail locker.
2. Anchor 25 lbs., 5 fathoms of chain, and 35 fathoms 2" manilla.
3. Anchor 42 lbs., and 35 fathoms ¼" chain.
4. Locker under side deck.
5. Some hatches stowed 1' wide of ⅝" mahogany, strengthened by ash ribs on under side 1' square.
6. Lead ballast.
7. Mast step.
8. Water.
9. Petroleum stove, copper weighted, and swung in pivots.
10. Hatches.
11. Lamp.
12. Fog-horn.
13. 2 Hammocks.
14. Life-buoy.
15. Bowsprit bitts.
16. Pump.

Diameter of mast at deck, 4⅛".
Do. do. at hounds, 4⅛".
Do. of boom in slings, 4".
Do. of bowsprit at stem, 3½".
Do. of gaff, 3".
Area of 3 lower sails, 395 sq. ft.



After-end of cockpit and after-hatch, which has a coaming 4" high to throw off water falling on the hatches.

Section of after-hatch through line *a b*.

To face p. 287.

cap, in which she was beaten by a 5-ton yawl by only seven minutes, over a twenty-mile course. The following details may be of interest.

"To Queenstown from this place is about twenty-two and a half English miles, and in the run to which I refer we had two miles with wind abeam, eight miles wind aft, seven wind abeam, and the remainder wind dead ahead and adverse tide, the wind strong from the westward, under double-reefed mainsail, whole foresail, and second jib. The boat did the distance in three hours three minutes.

"From the Seven Heads to the Old Head of Kinsale, seven knots, with one knot tide in our favour, but a heavy sea, on the open Atlantic, under whole mainsail and spinnaker, occupied forty-eight minutes.

"Two years ago we were caught off Queenstown Harbour in a northerly gale, with a flood tide running against it, kicking up a terribly short, hollow, and angry sea. We beat up against the gale with cockpit open, and a punt aboard, under a jib-headed trysail and foresail, and though getting a great flogging from spray, yet we shipped no serious amount of water. To give some idea of the force of the wind, I may mention that one of the powerful Queenstown whale-boats, about thirty feet by seven feet beam, pulling six oars, could make no headway against it, although helped by the tide, and had to be towed up by a tug.

"On Thursday evening last (Oct. 14th, 1886), about 7.30, in the height of the S.E. gale blowing, a brigantine dragged her anchors, and coming down on *Puffin*, burst her moorings. A neighbouring pilot managed to board her just as she was touching the rocky shore, got a line from the brigantine and hauled her alongside. He kept her as well as he could from grinding against the vessel's side, until my son and three other men got on board; they laid out an anchor ahead of the vessel, got her small tanned winter mainsail close-reefed and foresail on her, hauled her out to the anchor, weighed it, and worked her off the dead lee-shore to a safer part of the harbour, she towing a 16-ft. gig. It will be evident that a boat must have weatherly qualities to do this in the teeth of a heavy gale, the sea feather white, and torn into spindrift in the puffs.

"Almost all the fishermen in the place were on the bank watching, and very few believed that any boat could work off the shore."

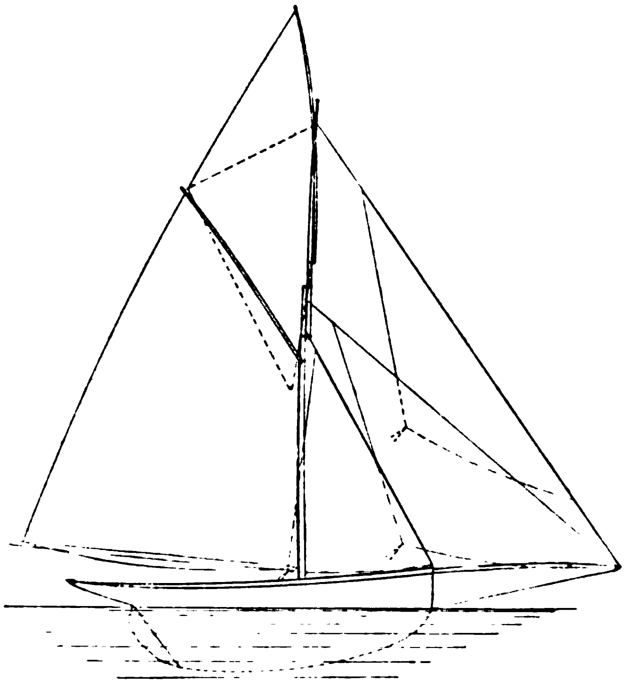
Design for a 3-tonner.—Mr. Penrose's other design has not yet been built from, his objective in drafting her was to get the greatest displacement and sail-carrying power with the smallest amount of wetted surface, and in this it will be seen he has succeeded, the design having a displacement of over seven tons, and measuring only three.

It is also intended to do away with all unnecessary deadwood, which is cut away as far as possible, while the rudder is placed in such a position as to enable it to act in comparatively undisturbed water, and thus to get greater steering power with a smaller rudder than usually employed; which, too, from its position, would never come out of the water when the boat was pitching. This design may be taken as an experimental one, offering many points likely to be instructive to those interested in small yacht designing; and though many may object to certain points in the design, there is no doubt but that Mr. Penrose has produced the result he aimed at, and designed a boat likely to be a fast and powerful craft, particularly in strong winds and sea. If built from, she would probably prove a very unpleasant competitor in the three-ton class.

This design will strike many as being much on the same principle as *Jullanar*. Mr. Penrose, however, had never seen *Jullanar's* lines when drafting this boat, but on showing the drawings, on completion, to his friend Mr. Beevor Webb, the likeness was pointed out.

In both these designs the tumble-home of the stem is a marked feature, especially in *Puffin*. The advantage is that the length on the L.W.L. being greater than on deck, lessens the top weight, and in Mr. Penrose's opinion prevents plunging, and gives an easy slope to receive a breaking wave. As a matter of fact, *Puffin* is unusually dry, and never throws any spray aft, from the bow. When she is hard pressed off the wind, a small, steady stream of water runs up the weather bow over the extreme fore part of the deck, and away over the lee bow. It will be seen that this form of bow has undoubted advantages, though many may prefer, for beauty and deck-room, the clipper bow, which, too, gives longer lines, but has the disadvantage of being extra weight not water-borne.

Design for a fast Cruiser of 3 *Tons. Y.M.* (H. Wynne Fairbrass, N.A.)—This design (table No. 1) represents a large and powerful boat,



Mr. Fairbrass' Design, Sail-plan.

as may be gathered from the fact that she has a displacement of nearly six tons, and would require over three and a half tons of ballast to bring her to her line of flotation. In speed and weatherly qualities she would be superior to No. 2 on all points and under any conditions whatever, and although drawing less water, her lead keel is heavier and its centre of gravity lower down, not only increasing her metacentric interval of safety, but also giving both an increase of canvas and a decrease of wetted surface, which is an important factor at low speeds. The increased area of the load water-line, and the formation of the midship section, would further augment stability, more especially at large angles of heel. By way of analogy and comparison, table No. 2 has been added, which sets forth the particulars of the *Naida* (by the same designer, for C. W. Courtney, Esq., Herne Bay), but subsequently to these calculations, sundry alterations have been effected, including the paring of forefoot, and a reduction of lead, this latter considerably affecting her stability, and reducing her speed. The centre of gravity of lead keel below load water-line and metacentric interval of safety will therefore be somewhat less than stated in the table. In all other respects her alterations do not make any perceptible difference to the data given.

TABLE OF COMPARATIVE ELEMENTS.

Dimensions.

	Design No. 1. Feet.	*Naida*, No. 2. Feet.
Length over all	32.33	32.00
Length, L.W.L.	26.00	26.00
Beam extreme	5.28	5.28
Greatest draught . . .	5.50	5.75
Mean draught	3.88	4.04

Areas.

	Design No. 1. Feet.	*Naida*, No. 2. Feet.
Area of L.W.L.	97.36	93.68
„ midship section	14.24	12.65
„ effective surface of rudder	6.30	7.10
„ immersed vertical longitudinal section	115.50	120.64
„ wetted surface	264.38	282.50

Displacements.

Displacement in cubic feet	204.99	186.24
„ in tons	5.85	5.32
„ per inch of load water-line	.231	.223

Co-efficients of Fineness.

Co-efficient of L.W.L.	.709	.687
Mean co-efficient of water-lines	.553	.566
Co-efficient of midship section	.490	.435
Co-efficient of displacement	.384	.330

Centres.

Centre of immersed vertical longitudinal section abaft middle of load water-line	.87	1.69
Centre of immersed vertical longitudinal section below load water-line	2.38	2 42
Centre of buoyancy abaft middle of load water-line	.86	.55
Centre of buoyancy below load water-line	1.56	1.48
Metacentre above centre of buoyancy	.86	.84
Centre of gravity below load water-line	2.56	2.37
Centre of gravity of lead keel below load water-line	4.60	4.40
Centre of gravity of lead keel before centre of buoyancy	.08	.25
Centre of effort above centre of gravity	16.56	15.94

	Design No. 1. Feet.	*Naida*, No. 2. Feet.
Centre of effort above load water-line	14.00	13.56
Centre of effort before centre of immersed vertical longitudinal section	.40	.60
Metacentric interval of safety at an angle of 2°.	1.88	1.76
Centre of gravity of load water-line abaft its mid-length . .	1.43	1.35
Midship section abaft middle of load water-line	1.50	1.05
Centre of mast from stem on load water-line	11.25	10.45
Angles.		
Rake in sternpost	39°.0	38°.0
Angle of entrance of load water-line	14°.30	14°.0
Fore rake of stem—expressed in inches	1.	
Weights.		
Weight of lead on keel. . . .	3.60 tons.	3.2 tons.
Weight of lead inside . . .	none.	.07 "
Weight of hull and equipment .	2.25 tons.	2.05 "
Proportions.		
Length as to beam	4.92	4.92
Length as to depth	4.72	4.52
Sail area to wetted surface . .	3.02	2.68
Sail area to load water-line . .	8.21	8.11
Sail area to midship section . .	56.18	60.00
Sail area to 1 ton of displacement	136.75	142.66
Freeboards.		
Height at stem	3.0	2.87
Height at taffrail	2.37	2.33
Least freeboard	1.75	1.66
Round of beam in inches . .	$3\frac{3}{4}$	$3\frac{1}{2}$
Depth of bulwark in inches [3] .	4.	3.

[3] Bulwark should taper at the stern; depth given is at the stem head.

Area of Sails.

	Design No. 1. Feet.	*Naida*, No. 2. Feet.
Area of mainsail	500	495
„ foresail	120	105
„ balloon jib	180	159
„ balloon topsail	185	166
„ jib topsail	143	135
Total area of lower sail	800	759
Total area with balloon sail	1128	1060

Spars.

Mast deck to hounds	21.3	20.9
Topmast fid to hounds	18.6	20.0[4]
Boom over all	26.0	25.4
Bowsprit outboard	16.6	15.8
Spinnaker boom	29.0	27.6
Working topsail yard	13.0	none.
Balloon topsail yard	22.6	20
Gaff over all	18.9	18.6

Dimensions of Spars for Design.

	Inches.
Mast diameter at partners	5¼
„ shoulder	5⅛
„ cap	5
Length of masthead	4.6″
Topmast diameter at heel	3½
„ shoulder	3¼
Boom diameter at dog's collar	5
„ outer end	4
„ inner end	3½
Gaff diameter at jaws	3½
„ end	2¾
Bowsprit diameter at gammon iron	5
„ shoulder	4
„ square at heel	5
Topsail yard diameter at slings	3
„ „ ends	2
Spinnaker boom diameter at slings	3⅛
„ „ ends	2½

[4] The *Naida* had a funnel to topmast to carry rigging, pole, &c., and to permit the topmast to be entirely lowered on deck.

TABLE OF OFFSETS.

	Stem.	Frame. 1.	Frame. 2.	Frame. 3.	Frame. 4.	Frame. 5.	Frame. 6.	Frame. 7.	Frame. 8.	Frame. 9.	Frame. 10.	Frame. 11.	Frame. 12.	Taffrail.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Half-breadth	0 1¾	0 10	1 5¾	1 11⅛	2 3	2 5⅝	2 6⅛	2 7⅜	2 7	2 6⅜	2 5	2 3	2 0⅝	1 3½
1 ft. above L.W.L.	...	0 8¾	1 4	1 10⅛	2 2⅜	2 5¼	2 6⅞	2 7⅝	2 7⅝	2 7	2 5½	2 3	1 10¼	...
Load water-line ...	...	0 6½	1 1⅛	1 8	2 1¼	2 4¾	2 6¾	2 7¼	2 7⅝	2 6⅛	2 3¼	1 7¾	0 1½	...
Water-line 1	...	0 5¼	1 0	1 6½	2 0	2 3¾	2 6	2 7¼	2 6¾	2 4¼	1 10½	0 11¾	...	...
" 2	...	0 4	0 10⅛	1 4⅜	1 9½	2 1¾	2 4¼	2 5¼	2 4⅜	2 0¼	1 5⅛	0 5⅛	...	...
" 3	...	0 2⅞	0 8¼	1 1¼	1 6⅝	1 10⅞	2 1¼	2 2¼	2 0¼	1 7¾	1 0	0 2½	...	...
" 4	...	0 1¾	0 6	0 10⅝	1 3	1 6¾	1 8⅞	1 9¼	1 7½	1 2¾	0 7⅛	0 2	...	...
" 5	...	0 0⅜	0 3⅛	0 7¾	0 11⅝	1 2¼	1 4⅝	1 4¾	1 2½	0 10⅛	0 4⅛	0 1¾	...	...
" 6	...	...	0 2	0 5	0 8⅜	0 10⅝	0 11⅞	1 0	0 10⅛	0 6⅝	0 2⅛	0 1⅜	...	...
" 7	...	...	0 0⅞	0 3⅛	0 6	0 7⅞	0 8¾	0 8¾	0 7¾	0 4⅞	0 2	...	...	..
" 8	...	...	...	0 2¼	0 4¼	0 6½	0 7⅝	0 7⅛	0 6⅛	0 3⅞	0 1⅝	...	...	...
" 9	...	...	...	0 2	0 4	0 5⅞	0 6⅜	0 6⅜	0 5½	0 3½	0 1½	...	...	...
" 10	...	...	...	...	0 3¼	0 5⅜	0 6⅝	0 6⅛	0 5⅛	0 3¼	0 1⅛	...	...	...
Keel	...	...	...	...	...	...	0 5¾	0 5¾	0 5	0 3⅛	0 1⅛	...	...	...
Heights to underside of covering-board	3 0½	2 10	2 8	2 5¾	2 4	2 2¼	2 1	1 11½	1 10½	1 9¾	1 9⅜	1 9⅛	1 9½	2 5
Depths from L.W.L. to keel	...	2 6½	3 6¼	4 3	4 9	5 1¼	5 4¼	5 5¾	5 6	5 6	5 3¾	2 10	...	...

Water-lines are 5½ in. apart, as shown in plan.

Vertical sections 2 ft. 2 in. apart, as shown in plan.

LIST OF BLOCKS AND ROPES FOR DESIGN.

Iron.	Blocks. Double.	Blocks. Single.	Blocks. Size.	Cordage.	Fthms.
Main sheet...	1	1	4	1¾	...
Main sheet lead...	——	2	4	1¾	24
Throat halyards...	1 and 1	Treble	4	1¾	25
Peak halyards	...	5	4	1¾	25
Fore halyards	...	3	3¼	1¼	12
Jib halyards	...	1	3¾	1⅛	16
Main purchase	Swivel	1	3	1⅛	14
Jib purchase	1	1 Swivel	3	1	14
Bobstay tackle	1	1	4	1¾	8
Bowsprit shrouds	2	2	3	1¼	8
Topmast backstay tackles...	...	4	3	1¼	8
Preventer backstay tackles...	...	2 Fiddle	7	1¼	16
Boom topping-lift	...	2	4	1¾	24
Runner tackles	2	2	3	1¼	6
Topmast shroud...	...	4	2¾	1	6
ROPE STROPS.					
Spinnaker halyards	...	1	3	1¼	16
Spinnaker topping-lift[5] ...	...	2	3½	1½	12
Jib sheets	...	...	...	1½	12
Fore sheets...	...	4	3	1½	11
Reef tackle	...	1 Fiddle	7	1½	12
Jack tackles	...	2 Swivel	3	1	4
Deadeyes	...	8	3¼		...
Topmast truck	...	1	2½	...	...
Double flag halyards	...	...	...	...	32
Ensign halyards...	...	...	...	...	12
WIRE ROPE.					
Shrouds, two ...	...	...	1	...	16
Pendants	...	...	1	...	5
Bowsprit shrouds...	...	...	1	...	7
Forestay ... ... Steel.	...	...	1	...	9
Bobstay pendant ...	...	...	1	...	4
Topmast stay ...	...	...	⅝	...	14
Topmast preventer	...	...	⅝	...	14
Spinnaker boom eyes ...	...	...	...	1½	18
Jib topsail halyards	...	...	...	1¼	33
Topsail halyards	...	...	...	1½	27

[5] One of the spinnaker topping-lift blocks should have a swivel and becket.

SCANTLINGS FOR DESIGN.

	Sided.	Moulded.
Stem	3	6½
Sternpost	4	4½ at head.
"	3	10 at heel.
Fore deadwood	5½	7 at throat.
After deadwood	6	18 at throat.
Keel	8	16½
Frames	2½	2½ at heel.
"	2	1½ at head.
Bent timbers	1½	1¼ at heel.
" "	1¼	1 at head.
Planking	⅞ when cleaned off.	
Deck	1⅛	1¾
Beams	2½	1¾ at ends, 2½ at middle.
Plain iron floors	2½ × ½ at throat × ¼ at head.	
Angle iron floors	3 × 3 × ⅜ with 18-inch arms.	

Itchen Ferry fishing-boat, fitted with auxiliary steam-power.—The lines of this boat are those of the ordinary Itchen Ferry type, and are exceedingly well adapted to produce a comfortable and useful craft. The rig is an extremely simple one, and the sails, being small, are easily managed by one hand, while for single-handed sailing there is the advantage, common to the yawl rig, of being able to work the boat under headsails and mizen if necessary, or by stowing the mizen the boat may be immediately put under snug canvas, the jib being either taken off her and bowsprit housed or a small jib set. If used without a boom the mainsail might be fitted with brails, so as to be hauled up immediately whenever desirable; this is extremely useful under certain circumstances, as when fishing, or bringing up for a short time. A boom could, however, be fitted if considered advisable.

With her little engine the boat is of course independent of the wind, and in her trial trip was found to have a speed of about five knots an hour.

The boat was fitted with steam power by Messrs. Simpson and Denisons, of Dartmouth, who give the following description of her. :—

"This design shows a small sailing-boat—24 ft. over all × 7 ft. 6 in. beam, fitted as an auxiliary with a small set of Kingdon's Patent (A size) Machinery—consisting of Tandem Compound Surface Condensing Engine, with one 2′ high pressure and one 5″ low pressure cylinder × 3½″ stroke, fitted with a (outside) Condenser of solid drawn copper pipe—outside the boat, and with a Vertical Natural Draught Boiler with a diameter of 2 ft. and standing 2 ft. 1 in. above the floor boards; so that it will be seen that a very small space is occupied by the machinery in the well of the boat, and the whole machinery when cased-in (with removable cover) forms a table in the centre of about 2 ft. without interfering with the accommodation.

"With this system of machinery, all danger from salting the boiler is obviated, and at the same time no fresh-water tanks are necessary; there is also an absence of all smuts and dirt, so frequently a source of very great annoyance with high-pressure machinery.

"Steam can be raised in half an hour, and the consumption of coal is very small, amounting to about 7 to 8 lbs. per hour.

"For tidal harbours or where a fishing-ground is at some distance, this machinery would, we think, be found most useful, as much of the weather best suited to fishing is often lost from the want of wind to take the boat to the ground.

"Larger boats can, with a proportionate saving in space and fuel, be equally well fitted with the various sizes of this machinery, according to the power and speed required.

"The boiler is also adapted equally for burning wood, coke, or coal.

"The propeller when under sail is either brought in a line with the stern-post or allowed to revolve, and being two-bladed and small does not materially affect the speed of the boat.

	£	*s.*	*d.*
The cost of the boat is about . .	80	0	0
Sails and rigging	15	0	0
Spars, &c..	5	0	0
	£100	0	0
Machinery . .	£107	10	0

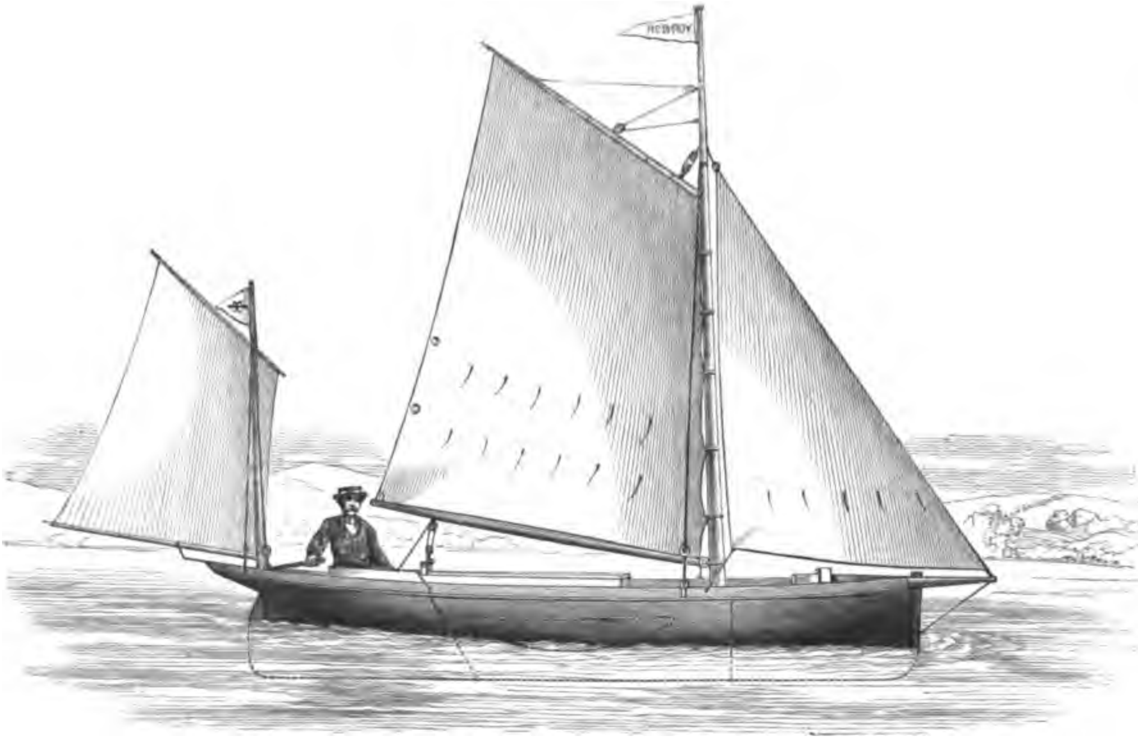
"The above only applies to a boat built to order, such a boat might be bought for much less if second-hand, and the machinery is of course open to be estimated for."

CHAPTER XIV.

SINGLE-HANDED SAILING.

THERE is a peculiar charm in sailing small yachts, a sense of freedom, and the consciousness that everything depends on oneself, which to a great extent disappears with larger vessels, and this perhaps tends to create the feeling that the little craft herself is something more than a mere boat, a pleasant companion in fair weather, and a tried and true friend when the horizon darkens with wind, and the rising waves are tossing their snowy crests in eager anticipation of the fray. Then it is that the boat and her owner as one sentient being sweep forward on their onward course, ready to take advantage of every puff and lull, now running down the steep declivity of some huge sea, and then quickly rising to meet the cresting wave that comes rolling on as if certain to engulf the little craft; but, buoyant as a cork, and kept well up to it by her helmsman, she gaily mounts the watery acclivity, and, pausing for a moment on its summit like a seabird, heels well over to the access of wind in her sails, and shoots away into the valley below; and though the puffs may come heavier and heavier, and a real hard blow come on, yet still the little creature, under her small rag of reefed canvas, dodges away to windward, bowing and curtseying to the unfriendly elements, until the last tack is made, and with her port in view, the sheets are eased, and in a few brief moments the boat and her owner, both dripping with brine, and the latter sufficiently exercised to enjoy the restful change, glide into their destined haven. A few more moments and the little craft with her wings folded is lying gently at her moorings, and the worthy owner in dry flannels is enjoying a well-earned rest, while he superintends those culinary operations which are soon to minister to the well-being and contentment of the inner man; and then to himself, if he be alone, or to his chum if he have one aboard, will he proceed to reconsider and review various little episodes touching the performance of his vessel, or some delicate bit of steering, or how he did what he thinks it would perhaps be better not to do again, or *vice-versa;* in short, he fights his battles over again, until the cabin clock warns him that an early start necessitates his turning-in without delay, and so he retires to his comfortable berth, and soon its dryness and cosiness, all the more appreciated when contrasted with the dusting he has just had, and the easy swing of the little vessel, and the swishing lullaby of the water running past her bows, send him off into that happy cruising-ground where Morpheus reigns supreme.

There are few men who have had an apprenticeship in small craft, but look back with a great deal of half-regret on those happy days, even though they may now be the proud possessors of a "flying fifty," and the contrast is strong between the two. On the one hand, all the comforts and pleasant surroundings which the superior accommodation of the large vessel affords; the spacious saloon, the natty owner's cabin, the pleasure of having a cabin at the disposal of a friend, and the additional charm of being able to enjoy the society of ladies, for whom the spacious after-cabin is specially designed, these are all weighty arguments in favour of the big boat. On the other side you have the fact that you are practically a passenger, and though your skipper may be a worthy man, and consider you to be pretty fair for an "amatoor," still the mere fact that you have a crew perfectly able to pull and haul and do all the work of the vessel without your assistance makes it unnecessary for you to do more than take the helm so long as the skipper thinks fit to trust you with it (there are, of course, many owners who can and do sail their own vessels, but as a general rule the skipper is the practical man, and takes charge when he sees need), and when racing, unless in a Corinthian race, the skipper is almost invariably master of the situation. Again, in a large boat there is not only the boat to be considered, but the crew; you may have a good crew, and you may have quite the reverse, and the same may be said as to the skipper, while in the small craft you have no one to please but yourself, and it is almost impossible for those who have not tried the experiment



THE "ROB-ROY" YAWL.

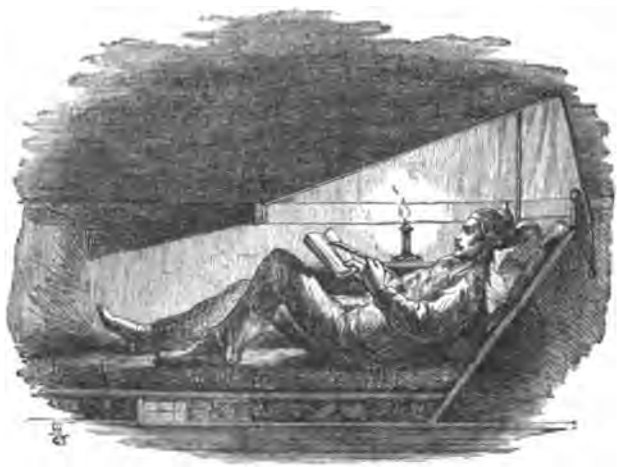
To face p. 303.

to imagine the amount of amusement and health-giving recreation that is obtained by working a small yacht.

There are many small craft that have become celebrated by their owners' adventurous single-handed cruises, Mr. McGregor's *Rob Roy* yawl being followed by *Kate*, *Silver Cloud*, and others, while *Procyon* and *Viper* have also done good work under the able management of their owners.

The general appearance of the *Rob Roy* yawl is shown by the full-page illustration, and the following description of her is given by permission of Mr. McGregor.

The *Rob Roy* yawl, 4 tons, was designed by Mr. John White, of Cowes. She was to be first *safe*, next *comfortable*, and then *fast*. Mr. McGregor's idea as to length was 18 ft., but Mr. White said that 21 ft. "would take care of herself in a squall," which length was accordingly given and never regretted. The *Rob Roy* was built by Forrest, of Limehouse, and was of diagonal construction, with a double skin. She is yawl-rigged, being very much underdone as far as masting and sail-plan are concerned, decked all over except a small cockpit, which is separated from the boat by watertight compartments, the forward one sloping forward to give room for stretching the legs of the owner, while the reverse side made a sloping back for the cabin. She had an iron keel and keelson, and was fitted with watertight compartments, lifeboat fashion. The floor of the cabin is made of thin mahogany boards resting on cross-beams. The boards are loose, so as to be easily removed if necessary; the bed was of cork, about 7 ft. by 3 ft. On this, for it *was* rather hardish, Mr. McGregor put a plaid and then a railway-rug, which being coloured had been substituted for a blanket, as the white wool of the latter insisted on coming off, and gave an untidy look to his boating jacket. One fold of

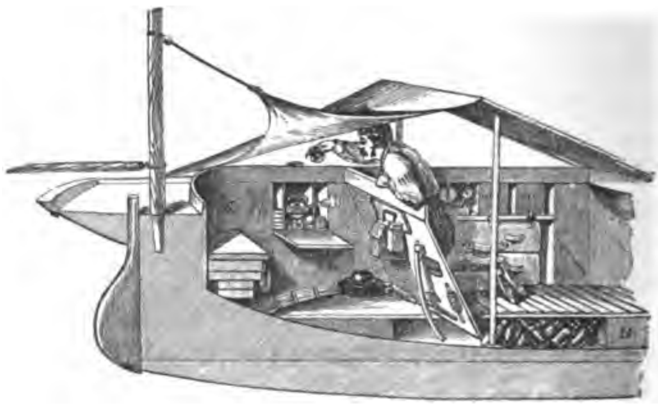


" The cabin," Rob Roy Yawl.

the rug was ample covering, and the owner never once was cold in the cabin. A large pillow was encased by day in blue (the uniform colour of all decorations), and was stripped at night to be soft and smooth to the cheek of the sleeper. Putting under this some coats and a regulation woven jersey, the pillow became a most comfortable cushion, and the woodcut shows the captain and crew reclining in the best position for reading or writing, as if on a good sofa. On the right is a candle-lamp with a very heavy stand. It rests on a shelf which can be put in any convenient place by a simple arrangement.

"The sketch shows the interior arrangements of the *Rob Roy*, the hatch being raised, and a tarpaulin rigged to cover the cockpit. The water tank is on the port side, concealed by the figure of the owner. A large hole in the top of the tank allows it to be filled at intervals through a tin dish, while a long vulcanized tube through the cork to the bottom has an end hanging over. Water is drawn by applying the mouth for a moment with suction, and the clear stream flows by syphon action into a strong tin can of about 8 in. cube, which holds fresh water for one day. By means of this tube, the end of which hangs within an inch or two of my face when turned in, I can drink a cool draught at night without trouble or chance of spilling a drop. On the tank top is soap and a clean towel, on the left shelf of the cabin are two boxes of japanned tin, each about 18 in. × 6 in.; below the shelf is a portmanteau with clothes. One of the tin boxes holds 'Dressing,' another 'Reading and Writing.' On the other side are two boxes marked 'Tools,' and 'Eating,' below which are two large iron cases labelled 'Prog.' In these are cases of preserved meats, soups, and vegetables. In the pantry besides them there is a teapot, cup (saucer discarded), and tumbler, together with a tray holding knife and fork, spoons, salt, in a snuff-box (by far the best cellar after trials of many), pepper (coarse, or it is blown away), mustard, corkscrew, and lever knife for opening preserved meat tins, &c.

"For cooking, the *Rob Roy* cuisine (see Appendix) was used. In two minutes after lighting, it pours forth a vehement flame about a foot in height, which with a warming heat boils two large cupsfull in



Cooking under cover.

my flat copper kettle in five minutes, or a can of preserved meat in six minutes. In the sketch the cook of the *Rob Roy* is represented as he works when rain compels him to shelter himself in the cabin under a tarpaulin, but usually he sat in the well while he tended the caboose. Besides the articles in the well of the boat, already described, there is kept on the right in a locker with a watertight door the bread store wrapped in mackintosh, which makes the best of table-cloths, as it may be laid on a wet deck, and can be washed and dried again speedily; then there is the butter keg, and a box of biscuits, and a flask of rum, the 'storm supply,' only to be drawn on when things of sea and air are in such a state that to open the main hatch would be questionable prudence. Here also are ropes, blocks, and purchases, as well as a fender. Above these odds and ends is the 'Spirit-Room,' a strong reservoir made of zinc, with a tap and screw plug, and internal division from which is served out the fuel which is to cook for the whole crew. One gallon of the methylated spirits, costing 4*s.* 6*d.*, will suffice for this during six weeks. Above the spirit-room will be found a blue light to be used in case of distress, and a box of candles, so that we may be enabled to rig up the mast-light if darkness comes when it will not do to open the cabin. This shiplight is therefore carried here. It is an article of extreme importance, having to be strong and substantial, easily suspended and taken down, and one that can be trusted to show a good steady light for at least eight hours, even when blowing hard, and however roughly it may be tossed about."

"From the sketch of the yawl previously given, it will be seen at once that she was under-masted and under-sailed. She could bear a spread of canvas double of that she carried; but for safety, for handiness, and for comfort, we must be content to sacrifice some speed.

"The shrouds were of iron rope. This is affected by heat and wet, but not so much as cordage is. The screw links to tighten the shrouds seldom had to be employed; a copper rope from the truck to a shroud acted as a lightning conductor.

"The bowsprit is on the starboard side, for this allows you to use the right hand with the chain cable in the bitts. The jib has a foot of nine feet in stride. Its tack is on a rope round an open hook at the bowsprit end, so that in reefing you can get it in without danger of falling overboard while reaching out to detach it; then it is hooked on the stem. An iron bobstay we discarded, and an iron forestay, as difficult to keep taut; but, after trials with no bobstay at all, we found it advisable to replace this, although it is a troublesome rope in dealing with the anchor.

"The gunwale has an opening of half an inch all round, and this was enough for scuppers.

"The forehatch is thirteen inches square, so that I can readily squeeze down into the fore-cabin.

"I painted about a foot of the chain-cable of a bright red colour, at ten and at twenty fathoms, which was useful in telling how much ran out with the anchor. Fenders I got in Paris, very neatly made of line net-work, over canvas bags of cork.

"The iron sheave on the stem for the anchor-chain was large, with a high cheek, and the comfort of this was well appreciated in weighing anchor at night or in a swell. The jib-sheets led aft, and the position of the cleats for these was most carefully chosen, as they are more worked than any part of the rigging; yet this position was twice altered, and the best place seems to be on the deck, two feet forward from your breast and two feet to the side.

"The strain on these sheets in rough weather was greater than had been anticipated, and at last I had to put a tackle on the port jib sheet, as that is the one less conveniently placed for belaying.

"The peak halyard was fast to the gaff, then through a single block on the mast and one on the gaff, and again one aloft. The throat halyard was fast to the mast, and through a block on the throat, and then aloft. Both these halyards came down on the starboard side, and to separate cleats, but I found it generally more ready to haul on the two at once and belay them together.

"The jib halyard had a block on the sail, and then, with the topping-lift, came down on the port side. A jib purchase I soon cut away—one learns to be economical of action when alone. Each of these four ropes then passed through a sheave on deck, two on each side, in an iron frame, properly inclined to give a clear lead.[1]

"Sisterhooks are troublesome things. Some much better plan as a substitute has to be invented, but I

[1] The fall of each halyard was coiled and put under the taut part. A small coil looks neatest, but the fall of it is sure to kink if coiled close, being wet and dry ten times in a day. Before nearing harbour, or in preparation to lower sail "handsomely," I found it well to cast the coil loose on the hatch, else a kink would catch in the leading sheave.

used for their 'mousings' india-rubber rings, which answered perfectly well, and were easily replaced at six for a penny.

"Stocking and re-stocking the anchor were the only operations when I felt the want of another hand, either to do the work at the bow or to give that one touch to the tiller at the critical moment, which an infant could do when near it, but which is hard for a man at a distance. The anchors were on deck, one at each side of the bitts, and fitting securely within the gunwale.

"The hatch of the well was in two parts, and one of them, a foot in breadth, had chocks on each side, so that in rain and dashing spray it was fixed up at an angle before me, and thus only my eyes were above it exposed, and by moving my head down about one inch below the position shown in the sketch, I could see the compass and the chart. A tarpaulin of one-faced india-rubber over the sloping board and under the horse, had its loose folds round one of my shoulders to the weather side, so that even in very rough water not much could get into the open well.

"The main-boom had a ring working between cheeks and carrying a double block with a single block below. To reduce the long fall of the sheet I altered the upper block to a single one; but in the first heavy weather afterwards it was found to be too small a purchase. The force of the wind is underrated if you reason about it in fair weather.

"The sheet block was fast to a strong, plain, copper ring, as a traveller, and after much trouble and expense about a horse for this, trying first an iron one, then a copper rope, and then hemp, I found that a rounded inch bar of red iron-wood straight

Prepared for Squalls.

across and about two inches above the bulkhead of the well, answered to perfection.[2]

"The oars were stowed one on each side of the

[2] This is shown in the sketch; the bar presented a very smooth surface for the bottom of the dingey to run over when it was shipped under the hatch, or hauled out in a hurry. Moreover, the wood was convenient to stride across in getting from the well to the cabin, and it was far more pleasant and *warmer* than metal to hold on by during violent lurches of the sea.

hatch combing with blades aft, and looms chock up to the gunwale at the bows, so as to be seldom moved by a rush of sea along the deck, and yet one or other or both could be instantly put into the iron crutches always kept ready shipped, and so placed that I could row comfortably while in the well and facing the bow. The boat-hook had its handle-end always near my right hand, and this saved me many a run forward in awkward times.

"The tiller of iron-wood was well wedged into the rudder-head. Of course any joggling or slackness here is like a broken front tooth, or a loose steel pen. No plan that I heard of, or saw, or could devise yet, is entirely satisfactory for enabling the tiller to be set fast in a moment, at any angle, and yet to be *perfectly* free in ordinary times. I used a large piece of rough cork as a wedge to set the tiller, and a cord loop at each side of the gunwale, to keep it 'hard down' when going about. At night, to stop the vibration of the rudder, I knocked in a brass wedge between its head and the iron bushing of the rudder hole.

"Every bit of iron above water was galvanized ; but this operation weakens small pieces of iron unless it is carefully done. However, the only part which carried away was my small anchor-stock, and this took place at the first cast of it into the Thames."

SEA DRESS.

After six long voyages alone, a few remarks may be made on water toggery.

Flannel all over to begin with. One grey flannel suit of "Norfolk jacket" and trousers lasted for three trips, but at sea the blue colour answers. Straw hat in sun, red woollen cap in wind, sou'wester in rain, thick boating jacket, and the life-belt over it, and above that an oilskin coat with overall trousers of the same, will defy wind and water. Woven waistcoat expanding limitless. Shoes and not boots for work, white canvas boots with spring sides for show in port. No braces. Blue seamless yacht jersey a bore, though smart. Collar only with a calico shirt, and on Sundays, when that cylinder of discomfort, a black hat, is exhumed. Watch hanging in cabin, never on the person afloat. Purse with keys in the shelf. Knife and etceteras in leather pockets of the boat. So clad ye shall be ready to sail or to swim.

Procyon is rather a large boat for single-handed use, and as far as she is concerned, it must be remembered that her owner, Mr. McMullen, is an old hand, and one who is not afraid of hard work. As far as model and rig is concerned, the *Procyon* is a splendid craft, and for power and sea-going qualities is far ahead of most single-handed boats. She has a considerable amount of freeboard, a long fine bow, and when owned by Mr. McMullen was rigged as a lugger, with her mast stepped right forward and a mizen aft. She has now changed hands, and is rigged as a yawl for greater convenience in tacking in narrow waters; under either rig she is a fast and powerful craft. Mr. McMullen worked her single-handed, and his idea of cruising may be gathered from the following extract from a letter received by the author:—

"In 1880 I was a month on the coast between Dover and Brighton without going into port, finding the best shelter I could according to the appearance of wind and weather. Late one afternoon I reached over to the French coast from Sandgate, expecting to find smoother water in Ambleteuse Roads near Boulogne, but was mistaken, and returned next day. The wind was strong from east on the English side and north-east on the French. I was four hours from Sandgate to Cape Grisnez under the stormsail."

Procyon was built for Mr. McMullen in 1867, and lengthened 5 ft. by the stern in 1870 by Holloway of Whitstable; the sails were by Lapthorne, her entire cost was 217*l.* Dimensions, length 28½ ft., extreme breadth 7¾ ft., average depth from gunwale to top of keel 5 ft., draft 3 ft. aft, 2 ft. forward; her height as she stands on the ground with a 6 inch keel is 5 ft. 10 in. forward and 5 ft. 2 in. aft. The extra height forward, which completely answers its purposes, being given to counteract the effect of the extra weight occasioned by the mast being placed so near to the stern.

She is decked forward, with waterways and a small deck aft, the height of the cuddy being 4 ft. and its length 12 ft. On each side is a low bench fitted up as a locker, these might be used for sleeping accommodation, but Mr. McMullen preferred to swing a hammock between the mast and main-beam. The space under the after-deck, which is 5 ft. long, is protected from the weather by a bulk-head and doors fitted up with capacious shelves; the stowage here is considerable, even the space under the floor and down to the deadwood being utilized for articles not liable to injury by water. Ballast all told a little over two tons. Under the lug rig, the main-mast was stepped 18 inches from the stem and was 21 ft. above the gunwale, 6 in. diameter at deck, and about 5 in. at the sheave in masthead; weight, including iron work and gear, 1¾ cwt. The mizen-mast was 13 ft. above gunwale, stepped just inside the transome, there being a draft of 26 ft. between the masts. The mainsail was No. 5 double 2 ft. canvas, split, in form, a working lug with an upper tack tackle hooked into an extra cringle above the third reef for peaking the sails, and a lower tack tackle at the fore of the mast for trimming it. When the lower tackle is braced up, the sail works clear over-head, enabling one to work forward on deck with safety. The length of yard was 13 ft., head of sail 12 ft., and foot 18½ ft. The weight of yard and sail when dry was 92 lbs.; the stormsail only differs from the mainsail in size, being 6 ft. head, 13½ ft. on foot; the hoist is the same, and its weight, with yard, ½ cwt. It will be seen from these particulars, that the weights are considerable and involve a great amount of hard work, particularly in a breeze. The ground tackle consisted of 30 fathoms $\frac{5}{16}$ chain, a bass rope 40 fathoms and another of 25, besides sundry pieces of manilla to supply deficiencies and for

13 ft. on leach; three reefs and balance reef in mainsail and one in mizen and jib.

The *Silver Cloud*, in which the owner, Mr. Forwell, accompanied by his son, a lad of fourteen, sailed from Dundee to France and back, was built under his inspection at Montrose. She was of the type of a Scotch fishing-yawl, with the exception of having a square stern, which was an undoubted advantage in such a small craft, giving more room aft and greater buoyancy, enabling the stern to lift to a following sea; the general type of Scotch boat having a sharp stern with fine quarters, and such boats, if heavily loaded and caught in a breeze, frequently founder bodily, being overrun and filled by the following sea. The *Cloud* was 19 ft. on the keel, 7 ft. 9 in. in beam, and rigged with a lug sail, set on a mast carried well forward, while a small jib was set on a short bowsprit. The boat was decked forward, giving ample sleeping accommodation, and she was also fitted with air tanks, lifeboat fashion. The cabin or cuddy forward was 7 ft. × 7 ft. extreme, but being in the bows of the boat there was only about 4 sq. ft. in which one could sit straight, and even then the owner considered he would be better without his legs. The hatchway was in the roof, and served both for door and window. At first starting the lug was fitted with a simple dead-eye arrangement for the sheet, but it was soon found that some better purchase was required, and it was replaced with two blocks which gave the requisite power. A mizen was afterwards added to *Silver Cloud's* sail-plan, and after experience of the disadvantages of a boat only partially decked during the cruise, the owner decked the boat completely in at Margate before working back to Dundee. Two anchors were carried, and about forty fathoms of chain, two life-belts, compass, barometer, charts, book of sailing directions and tide-tables, with a sextant and Nories navigation, which latter were never needed. For cooking, Mr. Forwell purchased a Russian lamp, costing 4*l.* 6*s.*, as used by *Rob Roy*, but did not find it suit his requirements. He says that for tea, coffee, boiling eggs, or frying ham in a hurry, the *Rob Roy* "cuisine" is perfect; but his objection is that being a blast flame it is too quick, and for a continuous boil too strong, exhausting the spirit supply in ten or fifteen minutes, and for the cooking of anything like a dinner is too expensive. When, therefore, he felt it desirable to depart from bread, tea, &c., and boil for a change such an article as rice, he laid aside the expensive Russian lamp and used a common spirit-lamp, costing 4*s.* 6*d.*, and with a great saving of spirit produced the desired dish.

Another little boat which has done some good work is the *Undine*, R.P.Y.C., owned by Frank Cowper, Esq. Besides a considerable amount of single-handed cruising on the English Coast, Mr. Cowper sailed the *Undine* across the Channel from the Isle of Wight to Havre. The outward trip took fourteen hours, the distance (Cowes to Havre) being not much less than 100 miles. Coming back, the first part of the trip was a mere drifting match; until being some twenty-four hours out, and about fifteen miles from Cap de la Héve, a breeze sprang up, and the boat was laid on her course for the Nab light; later on, when closing in with the land, and after sighting the Nab, a heavy sea boarded the *Undine* and put out the binnacle light (one of Dent's patent spirit compasses, with small lamp attached). Making the best of the matter, Mr. Cowper stood in, expecting to fetch the Warner light; but after keeping on his course for about half an hour and no sign of the light, he began to get rather anxious, fearing he might be out of his course, and thought of running back for the Nab and lying there all night, when suddenly the starboard light passed over a black and white thing in stripes. Knowing at once where he was, and what a risk he had run, the boat was at once put about and the chart consulted.

The ghostly object shown by the green light was the Bembridge Ledge Buoy, and in another minute the *Undine* would have left her bones on the reef that has occasioned the wreck of many a good vessel. The reason for the boat being so far out of her course, was that the wind had backed to the S.E., and, as the binnacle-light had been put out, the change had never been noticed. Soon after this incident, the Nab being passed, the Warner was made, and the lights of Ryde opened; with a fair wind right over the taffrail the *Undine* ran past the Noman Fort in the pitch darkness, nearly running down the Sturbridge East Buoy, and in

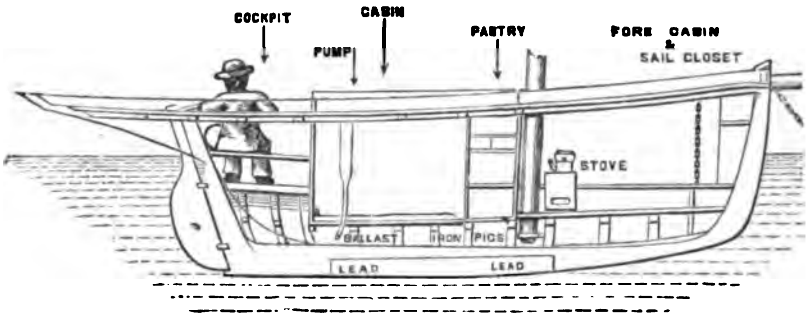
"UNDINE" RUNNING THROUGH THE SWATCH CHANNEL—OFF POOLE.

To face p. 321.

another half-hour the little craft was riding at anchor, a little to west of Fish Bourne creek, under the shelter of the Motherbank.

Sleepy and tired, the worthy skipper and owner was not long in getting into dry flannels, and after taking some food, was soon sound asleep. In the morning, the darkness and rain giving place to bright sunny weather, the *Undine* got under way, and in another half-hour was riding at her moorings off East Cowes. The trip home took forty-six hours in all, but then twenty-four were spent in drifting in a calm, and of the remaining twenty-two the *Undine* was at anchor for six hours. Mr. Cowper gives the following description of his craft.

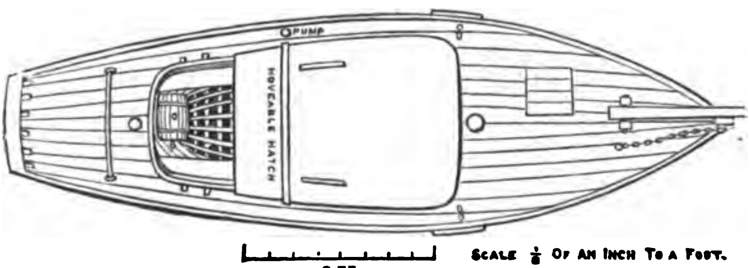
"*Undine* is a small cutter of just 6½ tons; her measurements are 23 ft. 6 in. on the load water-line; her greatest beam is 8 ft. 6 in.; and her draught of water 4 ft. 6 in. She is a perfect little model, and in a seaman's eye just exactly right and proper; perhaps for racing she is rather too broad, and not quite deep enough, but for my purposes I could not find anything better. Her rigging is the same as that of any other cutter, only the sheets of the foresail and jib come aft, and make fast round cleats placed on the outside of the combing of the cockpit, ready to hand while I am steering. The internal arrangements of the hull may be of interest. The diagrams will help to explain the construction. First, to take a sectional view of the boat. Here you see the relative size of captain and ship; he is seated in the cockpit, which is 4 ft. long by 5 ft. wide, and contains a stand for the water-breaker, which holds about four gallons of water, drawn off by a spigot at one end. From the cockpit I get into the cabin by lifting up the movable hatch that forms one end of the roof of the cabin, and step in over a fixed bulkhead. This renders the boat absolutely safe from danger of swamping as the only part that can get filled with water is the cockpit, and thence the water can only



Section of *Undine*, showing interior arrangements.

run down below if I draw a cork that fits into the floor, to allow it to trickle down into the hold or well, and get pumped out when necessary. However, in all the bad weather I have been out I have never had more than two inches of water in the cockpit, and this only about twice.

"The cabin is 6 ft. 6 in. long, by 8 ft. 4 in. wide at the widest part, and 7 ft. 8 in. at the narrower end, giving plenty of room on each side for a very comfortable berth, which I have contrived to make do as bed and seat combined, by having part of the boards of the seat removable, and lacing a canvas sacking over underneath, to act as spring bed to the cushion I lie on at night. The height of the cabin is 4 ft. 6 in. from the floor; below is the ballast in half cwt. pigs; on the keel is eight cwt. of lead, so that the little vessel is very stiff; next the cabin is the pantry; and on one side are shelves for the tea-things, stores, &c. The pantry is 2 ft. by 8 ft. 4 in. From the pantry the entrance to the fore-cabin is over a slight elevation in the floor, caused by the ballast being stowed abaft the mast. The cabin contains my cooking-stove, one to burn paraffin, and very excellent in every way, giving out no smell,



Undine (Deck-plan).

and producing a good heat. Here are my spare sails arranged on a rack on the starboard side, and bunks to contain bottles or stores.

"I keep here my sea-boots and waterproof clothing, and mops, brushes, &c., and spare anchor and gear; while in a bunk at the end is a box for stowing away the anchor-chain, which passes up through a pipe in the deck. I get out on deck here through the fore-hatch, which I generally leave open, or half-closed, at night when at anchor, to ventilate the cabin, and also to allow me to get up on deck quickly. I keep all my bedding and spare clothes in the pantry, and above all things keep everything tidy and ship-shape down below. The cabin is roofed in by a light wooden deck, which I have had covered over with canvas and painted, as it is impossible otherwise to prevent decks in small boats leaking; all the rest of the deck is boarded with stout planks, and well caulked. The cabin is lighted during the day by the movable hatch when not raining, and when wet by removing a sliding-panel above the fixed bulk-head; and at night by a lamp."

The sketch shows the *Undine* running into Poole during another single-handed cruise.

The one-ton class of small yachts, of which a few have been built, are more to be regarded as models than as the best class of boat that can be produced for the expenditure; they are too narrow to give any comfort, and too deep to take into any place where they risk touching the ground. They are, however, pretty little vessels, and are uncommonly fast. One of this type, the *Jumbo*, built by Harris, Wivenhoe, was extremely fast for her size, and a perfect yacht in miniature; she had almost standing room under her deck, but was exceedingly narrow; she was a composite built boat. Another of the class was built by McWhirter, of Erith, and a third is the *Tit-Willow* type, by Dennes of Sunderland, of which particulars are given.

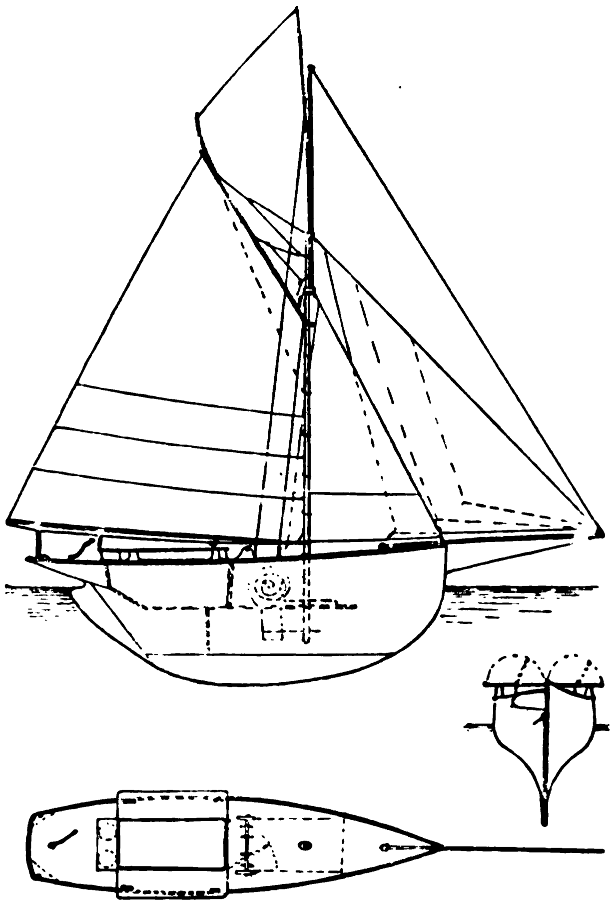
Description of Tit-Willow class single-handed *cutter yacht.*—Length from stern to counter overall 13 ft., beam extreme 3 ft. 2 in., depth amidship 3 ft. 6 in.; total weight about 9 cwt.

The vessels are built either carvel or clinker, with solid oak and steamed Am. elm timbers, alternately spaced 5″. The keel is galvanized cast iron, secured to hull by eight 3/4 steel bolts, and weighs 6 cwt. The well of the vessel is exceptionally strong, and being watertight, any water coming into it may be either baled out, or run into the bilge by the sounding pipe. At the fore end is a door, faced with rubber and opening inwards, to allow the bed to roll on to floor of well; when shut it is held by a bolt and thumbscrew. The two lids or flaps which cover the well, open outwards and rest at their outer edges on the oak chocks which carry the rowlocks. Any water coming on deck passes *under* the seats; in bad weather the lee lid may be shut, an apron at the fore end of well covers the knees. The lid forming the after seat lifts up to get at the oil cooking-stove, washing-basin, and pump.

There is a fife rail with the belaying pins just within reach of the seats, where all ropes are belayed; all sail can be set and taken in from the well, There are but two shrouds, one on each side. adjusted by swivel screws, and no forestay, the mast being sufficiently strong without. The running gear is soft white cotton rope, specially made by hand; the ends of the principal halyards, &c., are dyed different colours for handiness in picking them up.

The helm is held in any position by friction.

The planking of the vessels is either English



The *Tit-Willow.*

larch or oak, decks yellow pine, seats and general fittings mahogany, spars spruce and bamboo.

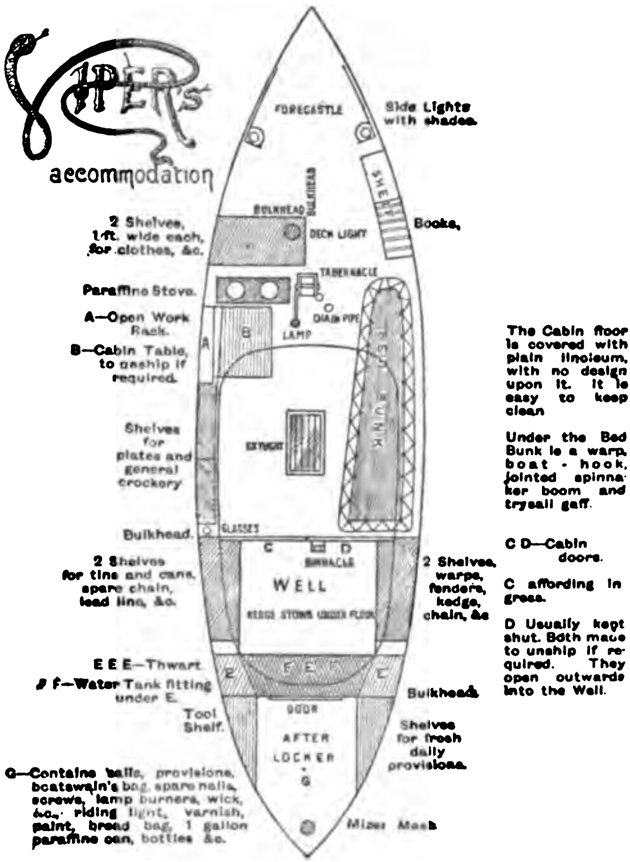
The hulls are either painted or varnished to taste. These little boats are made in the following sizes, 13 ft., 15 ft., 18 ft. and 20 ft. In the two latter sizes there is a cabin forward of the well, with two upholstered sleeping couches.

It may be stated that these vessels may be dropped into the water keel uppermost, from a crane and slip hook, or over quay, and they immediately right themselves, and so long as they are not *holed* they are unsinkable.

In running, the bowsprit can be swivelled and rigged outboard athwartships, and the jib set as a spinnaker. There is a small fresh-water tank under the floor, and the water is raised by a rubber ball syphon. This vessel is of convenient weight and size to be moved about by rail, as in these days there is a crane at every railway-station capable of lifting half a ton, and a cart or trolly can convey the boat to the seashore, lake, or river, as required.

The cost of a boat of the above type is about £30.

When down at Cowes during regatta week a year ago, I had the pleasure of looking over *Viper* by the kind invitation of her owner, H. Fiennes Speed, Esq. She is a good little sea-boat, and has a fair amount of accommodation, a large amount in fact for her size; but I think that for the same amount of money a more useful all-round craft could be built and one too that would have more speed under canvas. As the *Viper* has a deep keel, and must therefore draw a certain amount of water, more than *Una* or *Tit-Willow*, there would appear no reason why a better midship section should not be adopted, making the boat and



keel more in unison; as it is, there is simply a big keel tacked on to an almost flat-bottomed boat, giving a large amount of skin resistance without any compensation in the way of displacement. Still although she may be capable of improvement, there is no doubt but that her owner has done a great deal of successful cruising in her, and she has the great advantage of being easily sculled in a calm. Mr. Speed gives the following description of his craft, which will speak for itself; in the latter part he explains the reasons why he prefers the flat-bottomed type. The deep keel is of course an indispensable adjunct for sailing purposes unless a centreboard were used.

Viper.—Two-ton canoe, built in 1881 (August) by McWhirter of Erith, for H. Fiennes Speed, Esq.

The *Viper* is one of the tribe of "Big Canoes" or "Canoe Yawls," or enlarged "Mersey Canoes," and she was designed and built with the object of being—

1. A small boat.

2. A boat capable of being easily worked by one hand.

3. An absolutely safe boat, in fact practically a life-boat.

4. Uncapsizable.

5. Roomy enough to live on board of, with some pretensions to comfort.

6. A boat inexpensive to keep up.

Her dimensions are as follows :—

Length, extreme, 20 ft. 2 in.

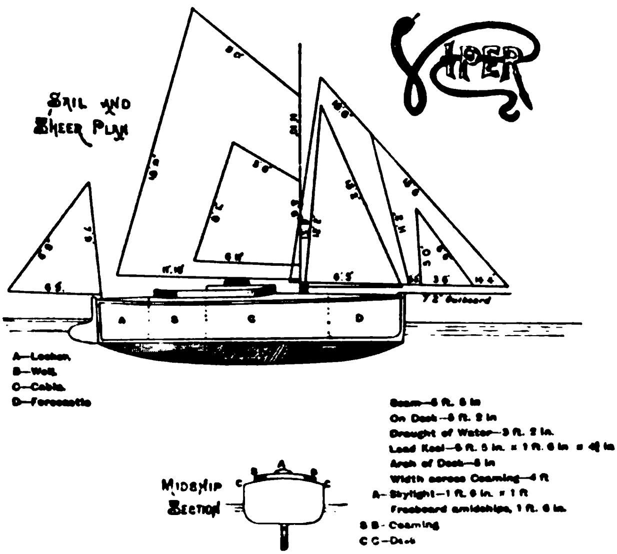
Beam, extreme, 5 ft. 5 in.

Depth, sheer streak to garboards, 2 ft. 6 in.

Arch of deck, 5 in. at forward end of cabin.

Sheer, 5 in.

Well, 8 ft. long × 4 ft. wide, extreme, the forward part of which is fitted with three barge hatches, which unship if required, each 1 ft. 6 in. wide, with folding doors; these form a comfortable cabin, in which a bed bunk is fitted on starboard side and cooking-stove, table, shelves, racks, &c., on the port. The hatches are seldom removed, the middle one is fitted with a skylight, 1 ft. 6 in. × 1 ft. A cover of



duck is tightly stretched over all the cabin top, and is dressed (as are also the sail covers) with Berthon flexible paint, which does not chip off and is most excellent for cushions, covers, &c.

Ballast on keel 19 cwt. 2 qrs. 19 lbs. Inside, for trimming, 2 cwt. 1 qr. 18 lbs., and an iron keelson of about ¾ cwt., through which the bolts of the lead keel pass, and are screwed up with large brass nuts. The bolts are gun-metal.

Keel is very much rockered, and is 4½ in. thick (full); its depth is 1 ft. 9 in. outboard.

Draught of water, 3 ft. 2 in.

Skin, elm with sheer-streak of mahogany.

Timbers all grown and joggled in, four stout floors and six heavy timbers amidships take the strain of the lead keel. As there is not space in a keel 4½ in. sided for cross bolts, *Viper's* keelson is fitted thus:—Between the timbers, on the top of a hogging piece of elm, are filling pieces, flush with the throats of the floors and the heels of the overlapping midship timbers, on the top of these rests the iron keelson. When the keel-bolts are screwed up, the whole is bound together very strongly, with no possibility of anything shifting.

The boat being of true canoe model, has a flat floor, so that her centre of buoyancy is high; she therefore does not require so much ballast as a deep boat of the same length and beam, and does not take an excessive heel when under canvas, but soon comes down to her bearings; this gives the crew much comfort.

Deck is of ½ in. pine, covered with unbleached sheeting stuck down with varnish and painted white. At the end of her fourth season it is perfectly intact and perfectly watertight and raintight, it is the only thing that can be depended upon for this latter.

Mast is fitted with a tabernacle, which is convenient occasionally, but requires more rigging than one housed in the usual way.

Freeboard, 18½ in.

Rig yawl, with two head sails and jib-headed mizen.

Extra sails, large balloon jib used as masthead spinnaker on jointed boom, spitfire jib, trysail.

In choosing a boat for working single-handed, one cannot be too careful as to the amount of gear involved, and the whole matter should be looked at not as it is in ordinary weather but how it would be in a hard blow, and the strength, knowledge, and activity of the owner is a great factor in determining the size of the sail and the weight of the gear. In any case, it is much better to be undersparred and canvassed to start with, and when you see what you can do with the boat it is easy enough to make any requisite alterations. For any ordinary work the type of small yacht used by the Munster Club, of which lines are given, appears to be a most sensible one—a fair amount of beam and depth, considerable accommodation for the size, good sail-carrying power, and a high rate of speed. At the same time, these little boats, owing to their yacht-like bottom, small sail-plan, and low centre of gravity, are practically uncapsizable, and are perfectly safe in any weather that such small craft should ever be out in.

Another type of craft is Mr. Charles Livingstone's *Dabchick*, built by himself, and which has proved an admirable little sea-boat, and very fast and handy; both types are far better to put money in than the narrow "plank-on-edge" 1-tonner. If, however, such a boat is desired, the following dimensions are suggested:—Water-line 16 ft. 8 in., beam 4 ft., draft 4 ft. 6 in., siding of wood keel amidships, 9 in. to a foot, lead outside 15 cwt. to 1 ton., according to displacement; length of counter 3 ft., straight stern, least height freeboard 1 ft. 3 in. from covering-board to load-line, which would allow of yacht heeling over to 35° before putting deck under water; least freeboard situated 11 ft. 6 in. or 12 ft. abaft from end of L.W.L., freeboard at stem 2 ft. 1 in., from end of counter to water-line 1 ft. 8 in. or 1 ft. 9 in., mast abaft fore end of waterline of cutter rigged about 6 ft. 9 in., i.e. to centre of mast-hole, mast (deck to hounds) 14 ft. or 15 ft., hounds to truck, if a pole-mast, .5 to .55 of lower part of mast; if a lower mast with topmast, masthead .23 of length of mast (deck to hounds), topmast (heel to truck) .9 of length of lower mast (deck to hounds); main boom, extreme length, 15 ft., in gaff, 10 ft. 6 in. to 11 ft.; working gaff, topsail yard, .95 of length of gaff, spinnaker boom equal to length of lower mast (deck to upper cap), bowsprit, outside stem, 7 ft. to 8 ft., according to position of centre of effort of sails. The steering well or cockpit should be circular, about 1 ft. 6 in. to 1 ft. 9 in. in diam., according to size of owner. This boat would be carvel built and completely decked, entrance being given to cabin by a sliding hatch raised on a long coaming, the fore part of the coaming carrying a skylight. The great objection to such a craft is that in any breeze the occupant is always wet, and there is no room to turn round; an extra foot or two of beam makes all the difference in the world. At the same time these little models are very pretty, sail remarkably well, and are exceedingly stiff under canvas, if the bilge is carried well down. There is no need to give an excessive rise to the floor, as the boat is so narrow that you want all the body you can get to give buoyancy and accommodation. There are only a few places round the coast where it is advisable to keep such long-legged craft; in most places it is almost unavoidable to beach the boat at times, or at all events to allow her to ground, and this particularly applies to small craft which are used for running in and out of all sorts of places where it is not always easy to keep them afloat, and in many places it is impossible to keep a boat at all unless she will take the ground. The *Una*, designed by Mr. Fife, is a first-class example of a shallow draft keel boat, and a boat could be easily built on similar lines, with the addition of a centreplate if required, which would perhaps help the boat in a seaway when beating to windward. Such a boat could be fitted with a broad metal keel outside, so arranged as to allow the C.B. to descend through it. I would have this keel of extreme dimensions, as far as breadth is concerned, especially amidships, so that the boat could easily take the ground. If the wood keel were not wide enough to take it, it might come out to the garboards, and filling pieces being fitted, all bolted firmly together. Another useful type is the *Puffin;* both this boat and the *Itchen Ferry* type being more suited to amateur requirements than deeper and narrower craft.

In selecting the type of boat, the intending owner will have to be guided by the nature of his requirements, as it is impossible to have a craft perfect in all points. There are, however, many points which a good boat should possess, and before discussing them I would say a few words as to a favourite mode of procedure with amateur yachtsmen, which is, buying an open boat and converting it (or trying to do so) into a yacht. This is about the worst way of going to work, for many reasons. In the first place the boat was probably designed and built for rowing, with little or no rise of floor and heavy quarters, so that however she may be altered aloft by her topsides being raised and a deck given her, she remains a mere makeshift, and at the same time will probably cost more before she is finished than a yacht of about the same size. There are certain advantages in this description of craft—i.e. good beam, roomy cabin and capability of taking the ground, against which you have shallow draft—insufficient lateral resistance unless with a great keel, and no head-room.

Such boats, too, being brought down by ballast to waterlines they were never designed for, have to carry a great press of canvas to get them along at any rate of speed, and instead of dividing a sea, spank it, sending up showers of spray, while in a short chop they are almost useless; in a long swell, and with the sheets slightly off, they get along fairly well; but from beginning to end they are boats with no pretensions in form or ability to yachts. For a single-handed yacht, what is wanted is the greatest amount of speed obtainable under *small canvas.* This means ease to the owner and satisfaction in sailing, and is seen in the Munster boats, the *Dabchick*,[3] *Puffin*, and Mr. Clayton's design. Such boats are little ships, comfortable, seaworthy, fast and handy. For shallow waters and where a decked boat is not required, the *Una* offers a splendid type of keel boat, while *Moss Rose*, of which an illustration is given, is a good example of a half-decked clinker-built C.B. boat, and I am sorry that her lines were received too late for insertion. This little craft, the property of H. Wallis, Esq., was built by Bedwell and Goldfinch, of Whitstable, and has been a marked success; with her centre-board up she draws only 14 in., and can run over the sands which abound in the Thames estuary; with the board down she draws about 3 ft. She has a very flat floor, rather full quarters, above the water-line and a good long, full bow, with no hollow in the water-lines; her length is 20 ft. 4½ in. by 7 ft. 2 in. extreme beam, and 5 ft. 3 in. across square stern; for her size she is remarkably fast, and has won a great many prizes.

The mizen is only used when racing, and she is fitted with a patent reefing boom, which turns round, rolling the foot of the mainsail up as required. This boat has been taken single-handed to the French coast, and her owner is constantly in her

[3] For cost of *Dabchick*, *Una*, &c., see Appendix.

single-handed between Whitstable and Wivenhoe. When alone, a long tiller is used, which enables one to steer while sitting almost amidships. About 7 ft. forward is decked-in, affording room for shelter and sleeping accommodation for one, comfortably, or two at a pinch; narrow waterways run round the boat with a short deck aft, leaving a large open space panelled in, and with a seat running right round, with the exception of the part forward where the cuddy is situated.

It is a pleasure to sail this little boat, as she is as handy as a top, besides being a good sea-boat and very dry, and for the type of boat she represents it would be hard to beat her.

For small craft I should prefer no counter, the stern to be either square or sharp, as in a whale boat; in the latter case the quarters should be fairly full and the beam carried well aft. Such boats make better weather when running before a following sea than those with a counter, and are cheaper to build; the counter of course adds to the boat's appearance, and affords more room on deck, but for choice, between two boats of the same length over all, the one with no counter should be the more powerful boat.

One of the great difficulties in small boats is to get a clear deck, free from omnibus tops and other such unsightly and lumbering encumbrances, and at the same time obtain decent headroom in the cabin, and this is particularly difficult when the boat has to be of light draft. I once observed a very ingenious way of getting over this difficulty. We were lying in Ramsgate Harbour, and close to us was a handsome little craft, about 26 ft. in length and 7 ft. beam. She was sailed by her owner and one hand, and taken out in almost any weather. The cabin was to all intents and purposes, a watertight tank, the only access being from deck. The forecastle was another compartment with a watertight hatch on deck forward, and the cockpit was separated by watertight compartments, not only from the cabin, but from the after part of the boat, so that she had really four watertight compartments, and should a sea be shipped in the cockpit, no water could drain into the cabin or after part. But the most distinctive feature in the boat was her cabin-top; with a flush deck she would not have room to sit down comfortably, and yet her owner detested a cabin-top when cruising. So he adopted a happy medium, and had his cabin-top in harbour and doused it when at sea: and this is how he managed. The cabin-table was supported at each end by two large screws (one working within the other), which also took the beam at the cabin-top, and were secured there; when these screws were turned, the cabin-top quietly ascended or descended as required, and so that no weather could annoy the inmates, the sides and ends were fitted with prepared canvas which expanded as the roof went up, and shut into wrinkles when it came down; from the appearance of this canvas we christened the boat the *Concertina*, but though we had our joke on the subject, there is no doubt that it was a real good idea, giving a comfortable cabin with a couple of feet extra head-room, and yet having a snug deck when at sea.

Rig. What is the best form of rig for a small boat is not an easy question to answer off-hand. If for an open boat or for smooth water sailing, it is best to have all the canvas in one sail if possible, and this may be either a gaff sail, like *Una* in sketch, or a balanced lug. The advantages of such a rig are simplicity in gear and great efficacy of sail power, as the more the sail-plan is cut up the less result is obtained from it. The disadvantages are that while craft under such rig are very handy and close on a wind, they are inclined to steer wild and sheer heavily when running free, while for sea-work, if the craft is of any size, the one sail becomes difficult to manage in a breeze. Of the two, the balance lug is better off the wind, and for small boats perhaps no better rig can be devised. The standing lug, shown in sail-plan of *Una*, is also a useful sail, and has more lifting and less pressing tendency than an ordinary gaff sail. For a small sea-boat a very handy rig is that of the Thames Bawley boat. These craft are cutter-rigged, but carry no boom, and have great hoist to the mainsail, the foresail being narrow on the foot, with a good-sized jib. The gaff is long, and a plumbline from the end would fall on the taffrail. A good-sized topsail is carried, which is cut something of the same shape as a jib-header, except that the head is cut so as to take a short yard about 3 or 4 ft. long. They are generally called "jacky" topsails. The halliards are made fast to the short yard, and halfway down the luff a cringle is fitted to take a bowline, which steadies the topsail to the mast, and obviates sending a hand aloft to lace it. The mainsail is fitted with brails, and the canvas can be reduced in a second if required. These little boats are about 25 or 27 ft. long, 8 or 9 ft. beam (some have even more in proportion), with a bold sheer forward, but aft they have little freeboard. They have a good rise to the floor, draw about 4 ft. of water, extreme, and are very fast and handy, and good sea-boats. For speed there is no rig better than a cutter for sea-work, and if a trysail is carried, the boat can be made as snug as it is possible to make a craft; but a cutter-rigged boat is heavier to work than one rigged as a yawl, and for this reason many small boats are yawl-rigged. For getting under way easily, and for tiding down a river when there is no hurry, a yawl is charming, as it is not necessary to set the mainsail at all, but a smart little cutter will work almost as well under her head sails, and if a balloon foresail is set, the cutter will work as well as the yawl with her mizen added. Under all sail, the yawl's mizen is always getting a back draft out of the mainsail, and never does half the work it should do. The great benefit derived from it is that the main boom is kept in the boat, and I believe if a good boat were rigged as a cutter with a short boom, she would be better for sea-work than a yawl, particularly if she carried a balloon foresail sheeting well aft, to work under when reaching, or when it was not desired to set the mainsail. On the other hand, there are certain advantages in a mizen, such as luffing the boat in a squall, but in a blow with any sea on, the mizen is almost the first sail to stow, as it can as a rule only be carried with large jib set. When this is shifted for second jib, the mizen is reefed, and with a small jib stowed altogether; it will be readily understood that the reason of this is, as diplomatists say, "to keep up the balance of power;" and though from its low centre of effort the mizen does not heel the boat much, it must not be forgotten that in a breeze it is requisite to have commanding canvas set, and this must be of sufficient hoist to keep the boat going, otherwise when in the trough of the sea she loses her way. For this purpose all small boats should have a trysail storm-lug, or some storm canvas with good hoist, and suitably fitted with strong double sheets. In a blow a foresail is a very pressing sail, and the boat is greatly eased when it is doused. A small jib set on reefed bowsprit, and no foresail, will often enable a little craft to make good weather when with the foresail, even if it were reefed, she would be buried. Of course, if it is necessary to make tacks, and the boat won't come round without her foresail, it must be carried. The following hints on getting under way and sailing generally, may be found useful.

Getting under way with wind same direction as tide, with no tide, or at slack water:—

To set mainsail.—Take a pull on topping-lift

Pull up main and peak halyards until main is nearly up ; belay peak and set main up until the luff of mainsail is quite taut ; belay and coil down main halyard ; then take in slack of peak and set up until the sail is slightly wrinkled in throat. Belay and coil away peak halyards haul out main outhaul, slack down lift.

To set topsail.—Bend on halyard, sheet, and tack ; always set topsail on weather side. Hoist up halyard, taking in slack of sheet as sail goes up.

If this is not done, the sheet is apt to take a turn round gaff end, and that means lowering mainsail or going out to clear it.

Set halyard up chock, give a good swig on it and belay. Then set tack down hard with the tackle until the sail wrinkles up a good deal close to the mast.

Then set out sheet, and if it is a good topsail it ought to be, as the saying goes, "as flat as a card." Now go forward and set down bobstay until the bowsprit has a slight kink down. Unhook jib halyards and sheets from bowsprit traveller, and for the time being hook jib halyard block on forestay. Get the jib along the deck and hook the tack on to the traveller.

Haul on jib, outhaul until the traveller is well out of the bowsprit end. Belay on bits and then toggle on jibsheets, unhook jib halyard block from forestay, look aloft and see that there are no turns in the halyards. Get hold of jib luff rope, see that it is clear, and hook block on to head. Leave plenty of slack in the jib sheets and hoist away. Set up until you feel a slight slackness in forestay, then belay.

You are now ready to get the anchor. Look how the chain leads, and tell whoever is at the tiller to "port" or "starboard" in order to bring the chain fair to the hawsepipe. Get in chain until the boat is right over the anchor. If you want to cant off on starboard tack, tell the man aft to haul taut on starboard jibsheet, and at once when you see the sail come aback break out the anchor.

It is a good plan to ease off mainsheet a little at same time, as it lets the boat gather way quicker. Get anchor up as fast as you can, and when it appears above water get hold of it and lift it into its place inside the rigging, with the flues flat on deck and the stock over the side. The boat will now be fairly under way and you can let draw the jib and put her on her course. Next uncover staysail and shackle on sheets, hook on halyards and hoist up taut, taking care that the tack is fast before you do so. Boats over three tons generally have foresail tack tackle, which is got down after halyards are set up.

Getting under way wind against tide:—Loose mainsail and pull up topping-lift, leaving on your peak tyer. Get jib out on bowsprit with halyards and sheets bent on ready for hoisting. Heave short, set jib and get anchor. If you have room, let her come up, and set mainsail as she comes round; if not, ease up mainsheet and set sail off the wind. Always remember when hoisting the mainsail to guide the gaff end between the two topping-lifts.

Getting under way wind across tide, is done in the same manner as with wind against tide.

To get topsail off.—If it blows fresh and the boat won't carry the topsail, you must stand by to take it off her. If possible, always get it down on the weather side. If it is got down on the lee side, the yard is very apt to foul, and with the boat laying over, it is wet and difficult work to get it in properly. If the topsail is on the lee side and you can't come round to get it down, go aloft and pass the tack over, clear of the peak halyards, and the sail will then come down on weather side. Be very careful not to let the tack go in passing it over, or there will be a balloon to get hold of that won't be easy to catch. When the tack is down on deck on the weather side, ease up topsail halyard and sheet, and take in on tack as sail comes down. When you get it on deck, unbend halyard and sheet, and belay them in their places.

To shift jibs.—Get smaller jib ready on deck forward, let go outhaul, and get jib in on bowsprit; let go halyards and get sail in on weather side of forestay, haul down and unhook. Hook the jib you intend setting on traveller, toggle on sheets, haul out and set up halyards.

To reef mainsail.—Haul weather lift hand taut, slack jib up slightly, and haul foresheet to windward. Ease down main and peak halyards, and haul in on reef tackle till chock down, reeve a line through tack earing and make fast. Set up main and peak, and tie down points. Get jib sheet in, and when she has gathered way slack over foresheet. If you have three or more hands on board, a boat can be reefed and kept going; but with two hands it is better to heave her to, as the tiller can be left to take care of itself, and both men will find plenty to do.

Wearing or gybing in a sea.—If a boat is running heavily and a gybe has to be made, haul up slack of lee lift, and ease down peak.

Get mainsail well on board, put helm over gently, and as the sail comes over, ease mainsheet well off. Set up peak again. Never trice up tack unless absolutely necessary. It is very bad for the mainsail, as it puts all the strain between clew and throat, and drags the sail out of shape.

Sailing.—The following hints refer to small boats where no tiller-lines are used :—

In the first place never saw the tiller about as if you were trying to send the boat ahead with the rudder acting as a screw. It is bad for the boat, as it stops her going through the water a little, and a man who saws the tiller is a nuisance to his friends who are sailing with him.

On a wind.—In a moderate breeze a boat ought to take some weather helm, so that a hand has to be continually on the tiller, or she would very soon be head to wind.

The best thing for a beginner to do is to watch the luff of his jib carefully, and just keep it "lifting."

If it shakes, the boat is too fine, and if it is quite full she is probably reaching off too much. Never steer by a flag or vane. They are very deceptive, and frequently look as if the wind was coming from the lee and not the weather side, especially when the big topsail is aloft. Watch every puff as it comes along the water, and get all you can out of a slight luff when possible. If you see a free puff coming, don't shove the tiller down suddenly, but let it go amidships, and if the boat is properly trimmed she will luff up of her own accord. Be ready to draw the tiller gently towards you as the puff passes over, to pay the boat off on to the course for the true wind.

If the puff is a very heavy one, "jill" the boat through it, never letting the sails shake enough to take the way off, but keeping them lifting till it passes by.

Sailing by the wind in a sea is almost entirely a matter of practice.

Theory is a poor pilot to get a craft off a lee shore. The two great things to pay attention to are —keep the boat going fast through the water, and watch the seas coming towards the weather bow. If a big fellow looks as if he was going to smother you altogether, ease your helm gently down, and meet the comber fairly, bow on.

The moment the crest of the wave gets under the boat, keep her going again at once, and be ready for the next big one.

The nastiest time to sail a small boat is in a short broken, choppy sea, and almost the best thing to do is to keep her a good full and by, and make up your mind for wet decks forward.

Reaching in a sea is not pleasant work. The boat, when she gets on the top of a big wave, always gives the idea of sliding off down the other side.

Watch carefully, and give a little lee or weather-helm, as you see she will take the wave easiest. On a broad reach, that is to say, with wind well abaft the beam, if a very big sea comes along, put the boat right off before the wind and let the sea take her fair under the counter, and as soon as it passes, keep on your course again.

Running before a sea, see that the waves always overtake the boat as nearly as possible at right angles, and be very careful to meet her with the tiller, if she is inclined to run off or broach to. The main boom should always be topped up, so that it is clear of the seas when the vessel rolls.

It requires exceedingly careful steering to keep a boat straight when running dead before the wind with a heavy following sea, as she frequently takes strong sheers, and if not immediately met with the helm, will fly up in the wind or fall right off, in the former case broaching to, and in the latter a sudden gybe will result. In large vessels, when running before the wind, a preventer sheet is generally rove from the boom forward, to prevent, or at all events ease a sudden gybe, which is an exceedingly awkward affair, probably carrying away something, if not taking the mast out of the boat or knocking overboard or disabling some of the hands. Another thing to be considered in a small (short) craft when running before a sea, is the fact that her rudder is frequently out of the water, and it is impossible in such a case to counteract the effect of a sheer given by the passing wave. It is therefore safer under such circumstances to steer a little by the wind and make long reaches, gybing when necessary, instead of keeping the wind dart aft, unless a really good man is at the helm.

If you see that running is getting dangerous, and want to heave the vessel to, watch carefully for a "smooth," put your helm down slowly, getting in trysail sheet at same time, easing up jib sheets to let the boat come up as fast as possible. When she is well up in the wind, pull your jib sheet to windward, and she ought to lie to like a duck.

It is a common thing to heave a fore-and-aft rigged boat to, with her foresheet to windward, and the jib sheet eased up, the mainsheet being hauled well in, and this method of heaving-to is useful under many circumstances, where it is desirable to take the way off the vessel. But when it is desired to ease a boat to the sea, and at the same time allow her to forge ahead, the foresail is simply hauled amidships. Smacks are frequently kept jogging in this way in bad weather, their head sheets being kept amidships. A drogue, or sea anchor, is always an advisable thing to have on board a small craft, as if any accident occurs, or the boat is caught in a stiff blow, she will ride to the drogue for a long time, even in a heavy sea. The drogue, which is something of the shape of a jelly bag, is made by lashing a three-cornered piece of canvas to a triangular wooden or iron framework, the frame being weighted so as to sink, and floated at a short distance under water by a buoy of some kind; a three-span bridle is attached to the frame of the drogue, each of the legs taking a corner, the other end of the legs are spliced to a ring, to which the riding warp is made fast. In a case of emergency, when no regular drogue is at hand, any spare spars or oars lashed together may be used; a bridle must be fitted so as to give a fair strain and keep the spars at right angles to the vessel; in a small craft an iron bucket buoyed and veered out in a line, will keep her head to wind.

Coming to with wind against tide:—

Make up your mind as to where you intend to go. If the wind is strong enough to take you against tide with headsails only, put vessel head to wind and lower mainsail, run up to where you want to let go under headsails, then get jib in, and lower foresail. As soon as the boat loses way, let go the anchor.

Running, wind and tide together:—

Lower foresail, take in jib, put your helm down, and when boat loses way, let go.

Reaching with tide.—Pick your berth, come round against tide, get in mainsail, jib, and foresail, and let go.

Slack water.—Get in foresail, then jib, let boat shoot head to wind, and as soon as she stops, let go.

Practice is the great teacher in sailing. If the beginner is never ashamed to ask questions, and find out how things ought to be done and why they are done in any particular way, he will very soon learn enough to keep him out of danger.

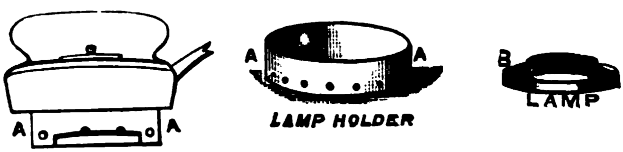
The worst hands in a boat are those who know all about sailing after their first season and never need to learn anything else. These are generally the men who are grand yachtsmen ashore, but when they get on board are utterly useless. It never does to think you are perfect; for a man may be at sea for fifty years and yet find something new to learn every day.

Don't think that because you put on a blue suit that you are the complete sailorman, but work forward every chance you have, and leave the tiller in older hands until you have seen enough to know something about steering.

In all yachting, and especially with small craft, when the owner is also the crew, the arrangements for cooking are an important consideration. Oil-stoves of some description are generally employed in small yachts; they have, of course, many disadvantages; the oil, unless carefully kept and dealt out, being likely to be spilt, causing a most unpleasant odour; at the same time the advantages of oil outweigh the unpleasantness, at all events for summer cruising; in winter or autumn it is necessary, even in a small boat, to have a small coke-burning stove of some kind. If an oil-stove is used, care must be taken to keep the wick clean and trimmed by rubbing the burnt portion off with a piece of paper or rag. It is desirable to swing the stove by trunnions in a box made to hold it, and then if the stove is properly weighted at the bottom, it will take care of itself in a tumble or roll. It is always well to see that all work of filling lamps, stove, &c., together with riding and side-lights and binnacle lamps is done in daylight and before the necessity arrives for use, as such work is generally badly done if hurried, the oil either not to be found or spilt when found, wicks all wrong, and everything troublesome; while, if all is ready when darkness falls, or necessity arises, the lights are at once ready. It is a common thing to mix up to one-third of parafin with the colza used for riding and side-lights, as the light is generally brighter. For small craft a good thick candle affords as good a light as is needed, and has the advantage of burning steady and clearly, while small oil-lamps are often very difficult to keep alight, and nothing is more annoying than to turn-in in uncertainty as to whether your riding-light will last or not. In small boats all lights should be shown as high as possible from the deck, as the light is better seen, and side-lights must be carried so as to be screened aft and show a good light on either bow in a sea-way; such lights should be properly lashed. When sailing at night, all lights from the cabin, &c., should be shut off from the deck, as it is impossible to see anything ahead if there is a light dazzling the eyes. At the same time, some kind of light, lantern or flare, should always be at hand to be shown in an instant if occasion arises, and when a hail is ineffectual; for instance, if a steamer is coming right on astern, it is very improbable they will see you; at all events, if they do not alter their course, it is advisable to show a light, which falling on the mainsail is perceptible to the steamer's look-out, when you will soon find one of her lights shut out.

In cases of sudden emergency a flare is very useful. For instance, I have seen a large barque, showing no lights, run right through a fleet of fishing smacks at night, and as a vessel under such circumstances looms up suddenly and is on top of you before you know where you are, it is well to have a ready means of showing that you exist. The ordinary form of flare is something like a coffee-pot, half-filled with methylated spirit. A piece of wire with some cotton waste at one end is carried in this, the waste being immersed in the spirit, and this when drawn out and lighted gives a bright light for a short time. Besides a flare, a fog-horn and bell should be carried; at all events, the fog-horn. The bell may be done without, though it is not the most pleasant way of spending one's time to have to tinkle on an old frying-pan for most part of the night, as some have had to do when a sudden dense fog setting in and many vessels about made it absolutely necessary to indicate the fact that you occupied a portion, even though an infinitesimal one, of the ocean.

It is a useful thing in a boat to have a small compact arrangement for heating, that can be used for making a cup of tea or some such purpose without causing much trouble. For this purpose I had the following made, which was used in the summer time on a 12-ton yawl when it was too hot to light the fire forward. The lamp (B) cost, as far as I remember, tenpence. I bought it while we were lying in harbour, and taking it into a tinsmith's selected a tin (A A) large enough to hold it, and got holes about ¼ of an inch in diameter bored all round as shown. The whole affair cost about eighteenpence, and was very successful. It was generally used on the cabin table, and it did not matter in the least if the doors were open or not, as no ordinary draught had any effect on the flame. Ordinary methylated spirit was used for this lamp, and if any was spilled it was caught in the tin holder. Another form of lamp (it can hardly be called a



stove) which appears suitable for small boats, is the "Beatrice" lamp stove. This is of English manufacture, strongly made, about nine inches high by seven wide at the bottom, the wick being four inches. A small window in the side gives light, and the top is arranged to receive any vessel, such as a kettle or saucepan. A great heat is given considering the size of the affair, and altogether it is a cheerful and useful little cooking apparatus, and very inexpensive.

While discussing the cooking arrangements, the question of catering naturally comes before us, but this must be settled by individual appetites and tastes. I have always found tea not so desirable as cocoa when the water is brackish and otherwise bad. When I use the term bad, I mean bad for tea-making purposes, such as hard water from chalky districts, and water as obtained at Yarmouth and other east-coast places. Cadbury's or Van Houten's cocoa essence is always useful, and a very good way of using it is to mix the required quantity into a paste with condensed milk, and then add boiling water. When making tea, a very good plan is to make it exceedingly strong, and then give a small quantity in each mug or cup, each person diluting it with hot water to his taste. In this way a small tea-pot does for a good many people. A friend who is very fond of cruising in small craft gives the following as his idea of provisioning.

"The question of catering is a very wide one, and depends so much upon the tastes of different people, that I hardly like to say anything about it, but if a friend and myself were going to start for a week's cruise I should probably put about the following stores on board :—

"Small cooked leg of mutton or lamb, 2 lbs., chops 2 lbs., steak 6 or 8 lbs., bread 6 lbs., potatoes, a couple of lettuce, and possibly a couple of small cabbages, 4 lbs. bacon, 1½ dozen eggs, 1 lb. butter, 2 small pots of marmalade, 2 pots of jam, 1 lb. tea, 1 lb. coffee, 1 oz. pepper, 1 lb. salt, 3 tins sardines, 2 tins (small) tongue, 1 tin biscuits. If beer is taken, it should be in bottles.

"Bread, meat, and vegetables can be got almost anywhere, and not more than three days' supply should be taken in at one time.

"Of course some of the above tinned stores would probably not be used, but they keep perfectly, and are always handy to have in the boat, as they may be needed at any time. At any rate, it is always better to err on the side of having too much, as it is very annoying to run short."

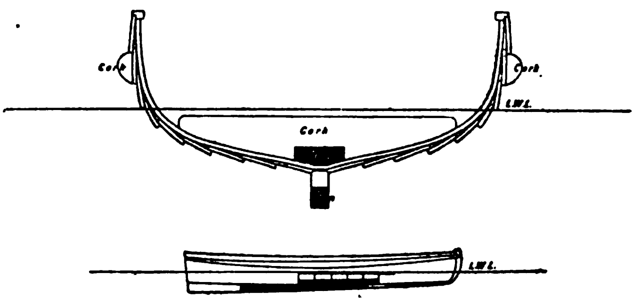
With regard to tinned stores, it is advisable to see that they are of first-rate quality. In the cruise of the *Falcon* the owner attributed sickness on board to the effect of some of the tinned provisions. Of course this was an extended cruise, and the sickness may have arisen from the insufficient use of anti-scorbutics. I have found fresh green peas, prepared at home and packed in bottles or jars, very useful to take for a few days' cruise. For small yacht stoves a very useful joint is a half-leg of mutton. If it is desired to salt part of a piece of fresh meat, a simple plan is to boil it in brine made of water in which salt is added until a potato will float in it. If a regular stove (not oil) is used, care must be taken to see that it will burn coke freely; coal should never be allowed in a yacht, if it is, you may bid "a fond adieu" to spotless decks and snowy sails, for a whole cloud of minute particles of soot will soon be carefully distributed over your craft and her sails and gear. Personally, I prefer a small range or stove burning coke to any alternative oil arrangement. If the weather is hot, cold meat can be used and tea or cocoa prepared by a small spirit-lamp, by which I would always supplement the stove proper. If the weather is at all chilly, it is very pleasant to have the stove going, and the nights are often chilly enough in this climate even in the ordinary yachting season. I very well remember ice on the deck at Easter in the Thames, and should have been exceeding glad to have exchanged two expensive oil-stoves which were on board for the smallest coke-stove procurable. Possibly, in a very small boat as, say, *Dabchick*, even a good-sized lamp burning when hatches were closed would give sufficient warmth. I am speaking of a much larger boat, and am certainly of opinion that all boats of any size should have a proper yacht range fitted not only for cooking purposes but for airing the boat when required.

One of the most difficult matters to settle satisfactorily is the kind of boat or dinghy for a small yacht; it is almost impossible, even in the smallest yacht, to do without one, and it is a great nuisance to tow a boat wherever you go, while a small craft cannot carry her dinghy on deck. In the *Rob Roy* yawl a tender of special form was designed by Mr. McGregor; she is shown in dotted lines in the full-page sketch of the yawl. This little dinghy was of canoe form, but, as it were, compressed, being exceedingly short, and with great beam, while she was completely decked and cased-in with the exception of a well in which the occupant sat. She proved a perfect success in every way, and when not in use was stowed as shown in the drawing. The Berthon boat gets over a great deal of the difficulty of selection, in fact the owners of small craft are almost confined to Berthons unless they like to tow an ordinary dinghy, which, in addition to the nuisance it creates in a sea-way, getting half-full of water, getting adrift, &c., &c., is a perfect nightmare when lying at anchor in a tide-way; just when you are in the most interesting part of a sweet dream, you hear the bump, bump, of the wretched dinghy, and jump out and haul her up and fix up something or another to try and keep her off, but no sooner are you well turned in again and feeling nice and warm, after perhaps a slight drizzle on deck, than another series of thumps and bumps turns you out again, to find that nothing will give you a sound night's rest short of hauling the little brute out and stowing her somewhere across the deck. All this may of course be obviated if your bowsprit is long enough, as then you can make the dinghy fast under it, in which case she can't come aboard unless she breaks adrift. By the bye, when anchoring in a tide-way it is always as well to bring up on two anchors and moor the boat; one way of doing this is to let go one anchor, and supposing you intend riding at ten fathoms, pay out twenty and drop the other anchor, then haul in ten fathoms of the first chain paid out, you will then ride to one anchor as long as the flood runs, and when the tide turns and the boat swings, she will ride to the other anchor and cannot foul either. If you ride to one anchor, you should always be careful to see that it is clear if you ride by it more than one tide; you can tell this fairly well by giving the boat a sheer or otherwise putting a strain on the cable, when the boat will generally show some signs of dragging if the anchor is foul; and when riding to single anchor on a tide-way, a hand should always be on deck at the turn of the tide to give the boat a proper sheer and see she does not foul her anchor in swinging. It is sometimes advisable to sight the anchor at slack water if several turns have been taken, as it is nearly certain to be foul, probably with the chain round the stock, or worse still, the flues; in which case the boat is only riding by the weight of the anchor and chain. When fitting out, the nature of the cruising-ground should be known, if possible, and an anchor selected to suit it; for instance, for a muddy bottom a big-palmed anchor is best, and for the hard ground a sharp small palm, but in any case an anchor with a long shank and good-sized stock should be picked out as more likely to hold well, and as heavy an anchor as can be handled should be carried; in fact, attention to ground tackle is time well spent, as you never know how much may depend on it.

Where a heavy anchor is used and only one hand on board, it is sometimes useful to have a tripping line to cant the anchor and haul it out of the ground. This may be rove through a ring in the crown of the anchor, so placed that the anchor shall not be weakened. The end of the line (which in length need only be a little over the depth of water, as it can be bent to the chain, and unbent when hove short), is brought on board and made fast anywhere handy clear of the cable. In anchoring it is always necessary to remember to give sufficient scope of chain, about three times as much as the depth you are riding in. For instance, if you anchor in four fathoms, pay out twelve, and if it comes on to blow you must give more scope; in fact, in bad weather the more scope a boat has in reason the easier she will ride. If you find the anchor is dragging and it is blowing hard, it is generally best to get under way and clear out, but if you cannot do this you may be able to bring the boat up by letting go another anchor or kedge. This should be taken out in a boat, and placed in the best position to help the craft. It is best to use a guess warp (i.e. a warp taken in the boat and the distance guessed). A good way, supposing a dinghy is used, is to get the kedge ready stocked, with the warp bent, and place them in the dinghy; then take some spun yarn, pass the kedge aft into the water over the dinghy's stern, with the warp passing in the notch usually cut there for sculling. When you see the kedge is swinging all clear with the stock below the boat's keel, take the spun yarn and stopper the chain or warp to the ringbolt aft. If it is a guess warp, see that the end is fast to a thwart or somewhere aft, and that the coil is all free for running, then take the sculls and pull off, and when you get where you wish to let go, take your knife (which you have put opened on the thwart by your side), and snick the spun yarn—the anchor will go all clear—and you can pull back and make fast the warp, that is, if you have "guessed" the distance correctly. With a light kedge no such preparation is requisite; simply run out and chuck out the kedge, seeing that it goes clear and that you have the end of the warp fast; but when a guess warp is not used but a kedge taken out from the yacht, the end of the warp being aboard, it is by far the best way to sling the kedge or anchor as described, as when the length of the warp is reached it acts like a spring, and the instant you stop pulling hauls you back, so that not a second should be lost, but the instant you boat your sculls the anchor should go, and that clear, which is not easy to do unless all is previously arranged. If you have only a light kedge, it may be necessary to back it with something heavy, as ballast, &c., lashed to the shank. Another method of bringing up a boat that is dragging is to send some heavy weight (ballast lashed together or something of the kind) down the chain or warp you are riding by; the weights are sent down by a bowline, and when on the ground help by their weight to bring the vessel up.

When a dinghy is used and it is necessary that she should be towed, it is not a bad plan to have a cover made of duck or some light canvas fitted to her; this cover must be fitted with eyelet holes, and is laced round below the gunwale, provision being made to lace it to; before putting the cover on, the sculls or some spar should be placed fore and aft and lashed at each end to make a ridge for the cover; when so fitted it is almost impossible for the boat to ship water, and being free she will tow a great deal better and cause less anxiety.

One way of keeping a dinghy clear of the yacht when brought up is to buoy the anchor and run the dinghy out to the buoy by an endless line rove through a ring or bull's-eye secured to the buoy, and with small craft, particularly when only leaving for a day's sail, the dinghy is frequently left to buoy the anchor,[1] or at the moorings, if any.



SAILING GIG

For the cushions of a small craft I should be inclined to use the waterproof Willesden canvas—the colour is not bad—a light green, and it will stand hard wear and soaking better than serge, which I

[1] In which case a second anchor should be carried in case of need; it is hardly necessary to say that in no case should a yacht get under way without one anchor and chain (at least) of sufficient size on board.

think is the next best thing. Cork beds are first-class things for small boats; they are made of some preparation of granulated cork, and are covered with American cloth; when not in use they roll up into small compass, and when using them, one never feels the effects of any dampness there may otherwise be. A novel method of ballasting open boats has been suggested by the Rev. S. Penrose. The diagram shows the idea, which is that the ballast should be in separate pieces of lead of a suitable size and weight, each piece of ballast being attached to a piece of cork sufficiently large to float the lead. In this way, so long as the ballast is loose, if the boat should capsize the ballast floats up, and there is no danger of the boat going down. Very much the same effect is obtained as by the water-ballast in breakers half full, used in service cutters. An objection that occurs to me is that if a boat so fitted, under sail, shipped a sea, the ballast would float up, and she might capsize, when with ordinary ballast the water would be pumped or baled out. There is no doubt that the other part of the idea, that of giving a life-boat belting of cork round the boat is extremely useful, and adds largely to the stability and safety of a boat so fitted.

APPENDIX.

COST OF "DABCHICK," "UNA," &c.

Dabchick.—Mr. Livingstone is unable to give the exact cost of this boat, but would put it down at about 95*l.*, allowing 20*l.* for lead, he considers that any first-class builder could turn a boat like her out, fitted complete, for 100*l.* From his experience of the boat, Mr. Livingstone would give larger sail area if he were refitting her.

Una.—The cost of this boat complete, carvel built, with racing and cruising sails, was 48*l.* 10*s.* If racing was not contemplated, and cost was an object, a clinker boat on the same lines could be built for considerably less money, and would be quite as useful for ordinary sailing.

Mr. Clayton's Design.—This little 20 ft. cruiser could be built complete for 120*l.*—possibly for less, say 115*l.* with iron keel, or 130*l.* with lead, complete. The plans show a 2¼ ton iron keel, which would cost 18*l.* or 20*l.*, and if lead, 16*l.* or 18*l.* more, with copper bolts. The sails, blocks, and rigging complete, if by a first-class firm, would cost about 27*l.* to 30*l.*

Viper.—The owner writes: "As near as I can remember, the cost of *Viper* was as follows:—

	£	s.	d.	£	s.	d.
Hull and *spars*				46	0	0
Lead, at market price, added to cost of working up, as near as may be				20	0	0
Sails.—Mainsail	3	8	0			
Foresail		14	0			
Jib	1	1	0			
Mizen		10	0			
Masthead spinnaker . .	1	15	0			
Trysail	1	5	0			
Storm jib		6	0			
				8	19	0
Anchor and 30 fathoms chain				2	10	0
Carried forward				£77	9	0

	£	s.	d.
Brought forward	77	9	0
Kedge and 20 fathoms chain	1	5	0
Mop, Running gear, warps, wire, rigging, bracket, canvas, blocks, brushes . .	3	0	0
Lamps.—Gimballed cabin		10	0
Copper reading		18	0
Copper side	1	8	0
Double paraffin *cooking-stove* and utensils, saucepan, frying-pan, kettle	1	5	6
Plate.—2 spoons, 1 large do., 2 forks, 1 large do., 3 knives, 3 tea-spoons . .	1	16	6
Crockery.—Teapot, 3 cups and saucers, 3 plates, 1 large do., 3 tumblers .		6	3
Bed, bunk and bedding, 2 blankets, 1 rug, 1 mattress (these form seat by day), extra 2 blankets for passenger	4	0	0
Two 3 ft. cork mattresses covered with duck and painted with flexible Berthon paint .		14	0
Linoleum for cabin floor		8	0
Water-tank, galvanized iron		15	0
Waterproof bedding-bag		6	6
Two 1 gallon cans for paraffin		4	0
Pair of oars		15	0
Boathook, brass and teak		10	0
Brass crutches		6	6
Ventilating screw decklight		9	6
Binnacle	2	7	6
Red ensign and burgee		13	0
Cabin fittings below, at time of building .	6	0	0
Further fittings in cabin and well (teak shelves, bulkhead, floor timbers, &c.) .	14	0	0
Berthon dinghy	8	0	0
	£127	7	3

This list is fairly accurate as far as it goes, but it does not include such things as tools, clock, aneroid, binoculars, and such things, which are almost indispensable.

CALCULATIONS.

To show the method of working out displacement, a rough sheet is given showing the calculations of the three-ton design by the Rev. S.

DISPLACEMENT SHEET.

REV. S. PENROSE'S THREE-TON DESIGN.

No. of Sections.	Multipliers.	Waterline No. 1.		Waterline No. 2.		Waterline No. 3.		Waterline No. 4.		Waterline No. 5.		Functions of Half Areas.	Vertical Sections.				Metacentre.	
		Multipliers.											Multipliers.	Mulipliers of Functions.	Levers.	Products for Moments.	Cubes of Ordinates.	Products by Multipliers.
		1		4		2		4		1								
1	1	·00 ·00	·00	·00 ·00	·00	·00 ·00	·00	·00 ·00	·00	·00		...	1	...	0			
2	4	·00 ·00	·00	·00 ·00	·00	·00 ·00	·00	·50 2·00	2·00	·83 ·83	3·32	2·83	4	11·32	1	11·32	·51	2·04
3	2	·00 ·00	·00	·00 ·00	·00	·42 ·84	·84	1·25 5·00	2·50	1·50 1·50	3·00	7·34	2	14·68	2	29·36	3·37	6·74
4	4	·00 ·00	·00	·25 1·00	1·00	1·00 2·00	4·00	1·75 7·00	7·00	2·08 2·08	8·32	12·08	4	48·32	3	144·96	8·0	32·00
5	2	·00	·00	·50	1·00	1·42	2·84	2·16	4·32	2·33	4·66							

2·8 Longitudinal Interval.

4048
1012

C. of buoyancy 14·168 abaft No. 1 Section.

·23 Displacement per inch at W.L. 5.

Longitudinal Interval between Ordinates ... = 2·80.
Vertical Interval between Waterlines... ... = 1·50.

[*To face page* 365.

Penrose; it will be seen that the results differ slightly from those given by Mr. Penrose, but not more than is to be expected in two calculations made by different persons, each taking their own measurements. The general idea on which the calculations are based is that the half-boat is treated as a solid, and first divided into portions longitudinally as water-lines, each of these planes having a straight base bounded by an irregular curve. The base is divided into an equal number of parts and perpendicular ordinates erected, which will necessarily be odd in number. The ordinates are then measured, the even ordinates added together, as 2, 4, 6, 8, and the sum multiplied by 4. The odd ordinates, 3, 5, 7, &c., are then added together, with the exception of the two end ordinates, and the sum multiplied by 2. To the sum of the products obtained the end ordinates are added, and the whole sum multiplied by one-third of the distance between the ordinates, called the "common interval." The greater the number of divisions made in the plane, the greater the accuracy of the calculation will be. The above rule is called Simpson's First Rule, and may be used to find the areas of various sections, such as water-lines or transverse sections. The result obtained by this process is checked by a calculation of the same kind, taking vertical cross-sections instead of water-lines; and as the volume of the body is the same in either case, the result should be the same if the calculation is correct.

The displacement sheet, besides giving the total displacement, also shows the centre of buoyancy, metacentre, and area of midship section.

In calculating some areas, such as those of jibs, it is useful to know that the narrow parabolic segment, such as the foot of the jib, the base being a straight line from tack to clew, can be estimated by multiplying the base into two-thirds the extreme height. The remainder of the area of the sail can be found by trian gles.

To find the centre of gravity of a vessel complete with all gear and equipment, the weights of each part of the hull and equipment must be ascertained, and the distance of each measured to any common point, such as a horizontal base-line below the keel; this distance is multiplied into the respective weight; the results, called the "moments," are then added and divided by the sum of the weights—the quotient will be the distance of their common centre above the base-line. To find the alteration in the centre of gravity of any body consequent on a portion of the weight being moved, multiply the weight into the distance to be moved, and divide by the whole weight of the body.

CALCULATION FOR CENTRE OF LATERAL RESISTANCE.

THREE-TON DESIGN.

Sections.	Length of Ordinate.	Multipliers.	Products.	Multipliers.	Products.
1		1		0	
2	2·50	4	10·00	1	10·00
3	4·16	2	8·32	2	16·64
4	5·00	4	20 00	3	60·00
5	5·50	2	11·00	4	44·00
6	5·75	4	23·00	5	115·00
7	5·91	2	11·82	6	70·92
8	6·00	4	24·00	7	168·00
9	5·66	2	11·32	8	90·56
10	4·75	4	19·00	9	171·00
11		1			
			138·46		746·12
	⅓ Int. Long. ...	...	·93		·93
			41538		223836
			124614		671508
	Area, I.V.L. Section ...		128·7678	... ...	)693·8916(5·3*
					643·8390
					5005260
					3863034
					1142226

*5·3 × 2·80 Interval.
2·8

424
106

14·84 L.R. abaft No. 1 Sect.

For the centre of lateral resistance below L.W.L., it is hardly necessary to make a calculation, as it can be assumed that the centre is half the mean draught. Thus, length of figure, 28·0; then 128·76 (area of I.V.L. Section) ÷ length, 28·0 = 4·6 = mean draught, of which therefore one half = 2·3 would represent the vertical position of C.L.R.

MODE OF COVERING CANOE WITH WILLESDEN CANVAS.

Mention has been made in this book of the covering of a birch-bark canoe with the Willesden canvas, and it may perhaps be useful to give details of the procedure adopted. The canvas being of the stoutest description, it was not easy to arrange so that it should fit home to the canoe without taking up the slack parts and securing them in what would make unsightly places. After some consideration, and as an experiment, the following method was selected. The canvas being 2 feet 6 inches wide, was measured off from gunwale to gunwale at the various sections, and the parts sewn together with a strong double seam. The cover thus made was then tried on the canoe, and found to fit admirably. That part of the canvas next the gunwale (which had been left sufficiently long to turn over) was then pulled tightly over the gunwale, and a strong batten screwed down along the top of the gunwale over all. The ends of the canvas at the bow and stern were then sewn together over a small rope laid inside to form a neat seam; and to prevent the seam shifting it was also sewn right through the canoe, round a short piece of cane placed in the bow and stern, as the bark itself would not have held the stitches. The superfluous canvas inside the gunwale was then cut neatly away, and the covering was complete. Various minor fittings and arrangements were added, which, however, have nothing to do with the canvas covering, which I think is fully described. The seams being transverse, have of course the effect of stopping the way of the canoe, but they have come down very flat, and as she is only used for punting about, this is of no consequence. The canvas comes better home to the peculiar form of these canoes in this way than any other; but of course if the seams were fore and aft, the resistance to the water would be lessened, though the fit might not be so good.

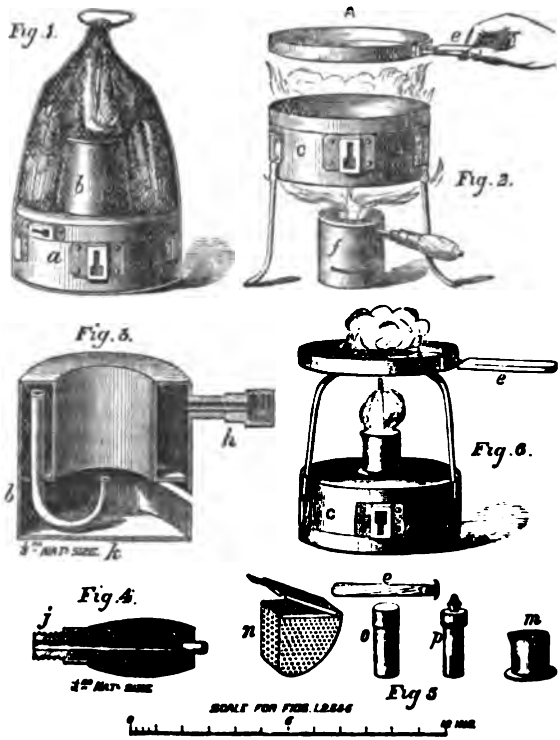
THE "ROB ROY" CUISINE.

Mr. McGregor gives the following description of the cuisine invented by him:—

This has been designed after numerous experiments with the various portable cooking-machines which I could procure for trial, and, as it succeeds better than any of them, and has been approved by trial in five of my own voyages, and in another to Iceland, besides shorter trips, and in the Abyssinian campaign, &c., &c., it may be of some use to describe the contrivance here.

The object proposed was to provide a light but strong apparatus which could speedily boil water and heat or fry other materials even in wet and windy weather, and with fuel enough carried in itself for several days' use.

Fig. 1 is a section of the Rob Roy cuisin as it is made up for carrying. There is first a strong waterproof bag about one foot high, and closed at the top by a running cord. At the bottom is the cuisine itself, *a*, which occupies a space of only six inches by three inches (when of smaller size), and has the various parts packed inside, except the drinking-cup *b*.



Provisions, such as bread and cold meat or eggs, may be stowed in the bag above the cuisine, and if the string of it be then attached to a nail fixed in the boat, the whole will be kept steady.

For use, when it is desired to boil water, the cuisine being opened, the lower part is copper pan, *c*, fig. 2, with a handle, *e*, which can be fixed either into a socket in the side of the pan, or another socket in the side of the lid, as represented in figs. 2 and 6.

Three iron legs also fix into sockets and support the pan over the spirit-lamp, *f*, by which the pan, two-thirds full of liquid, will be boiled in five minutes.

The lamp is the main feature of the apparatus, and it is represented in section in fig 3. It consists of two cylinders, one within the other. The space between these (shaded dark) is closed at top and bottom, and a tube *b*, fixed through the bottom, rises with one open end inside, and another (a small nozzle) curved upwards in the open internal cylinder. Another tube, *h*, opens into the annular chamber between the cylinders, and it has a funnel-shaped mouth at the outer end, through which the chamber may be filled, while a screw in the inside allows a handle, fig. 4 (in section), to have its end, *j*, screwed in. A small hole in the upper surface is closed by a little cork, which will be expelled if the pressure within is so high as to require escape by this safety valve. The hole may be in any part of the annular cover (but is not shown in the sketch), and in such case the hole shown in the handle is omitted.

The outer cylinder of the lamp, being larger than the inner one, has a bottom, *k*, fig. 3, which forms a circular tray of about two inches wide and half an inch deep.

The original form of the lamp which was first brought to notice[1] by the Cook of the Royal Canoe Club, had a detached tray for the bottom, but now, instead of this plan for the admission of air into the lamp, two saw-cuts are made, each about an inch long. One of them is shown below *f*, fig. 2, and thus the lamp and tray are united in one compact piece while still there is access for air.

To put the lamp in operation, unscrew its handle from the position in fig. 2, so that it will be as in figs. 3 and 4. Then from a tin flask (which has been packed with the rest of the things in the pan) pour spirits of wine—or, if the odour is not objected to, methylated spirit into the measure *m*, fig. 5, and from that into the interior of the lamp through the opening at *h*. Next screw in the handle, and place the lamp level under the pan, and pour nearly another measure-full into the interior tray. Set fire to this, and shelter it for a few seconds if there be much wind. I used this always with complete success on the Jordan, Nile, Danube, and many other rivers.

In a short time the flame heats the spirits in the closed chamber, and the spirituous steam is forced by pressure down the tube, and in-

---

[1] The late Professor J. D. Forbes, who used this lamp, says it was introduced into this country from Russia by Dr. Samuel Brown, and that "the jet of burning spirit has such force as to resist the blast of a hurricane."

flames at the nozzle, from which it issues with much force and some noise in a lighted column, which is about one foot in height when unimpeded.

This powerful flame operates on the whole of the bottom and lower edge of the pan, and it cannot be blown out by wind nor by a blast from the mouth, but may be instantly extinguished by sharply placing the flat bottom of the measure upon it.

The cover may be put on so as to rest with the flat bottom downwards, and with or without the handle. If tea is to be made with the water when it boils, the requisite quantity is to be placed in the tea vessel *n*, fig. 5, which has perforated sides, and, its lid being closed, this is placed in the water, where it will rest on the curved side, and can be agitated now and then for a minute, after which insert the handle in the socket of the pan and remove the lamp, allowing the tea to infuse for four minutes, when the tea vessel may be removed and the made tea may be poured out into the cup. The dry tea can be conveniently carried in a paper inside the tea vessel. Salt is carried in the box *o*, and the matches are in the box *p*. Coffee may be best carried in the state of essence in a bottle. An egg-spoon and a soup-spoon are supplied. A flat clasp knife and fork may be had extra.

If bacon is to be fried, or eggs to be poached or cooked *sur le plat*, they may be put into the lid and held by hand over the lamp-flame, so as to warm all parts equally, or the slower heat of a simple flame may be employed by lighting the measure full of spirits and then placing it on the bottom of the upturned pan as shown at fig. 6, where it will be observed that the three legs are placed in their sockets with the convex curve of each turned outward, so that the lid, as a frying-pan, can rest upon their three points.

The spirit-flask contains enough for six separate charges of the lamp, and the cost of using methylated spirits at 4*s*. 6*d*. a gallon is not one penny a meal. The lamp-flame lasts from ten to fifteen minutes, and the weight of the *cuisine*, exclusive of the bag and cup, is about two pounds.

These cuisines, improved by the suggestions obtained in their use, made of the best materials and workmanship, cost about two and a half guineas; or if with tin boiler instead of copper, and brass lamp, 1*l*. 12*s*. 6*d*. Many of much larger size (to cook for twenty men) have been used in Australia.

The lamp above described was used daily in my yawl, but the other fittings were on a more enlarged scale, as extreme lightness was not then required.

The Norwegian Cooking Apparatus of another kind entirely will be a valuable adjunct to the yachtsman's stores. By means of this, meat or pudding after being heated for only *five minutes*, and then enclosed in a box which retains the heat, will be found to be perfectly cooked after three hours, though no more heat has been applied to it.

SAILING RULES, LIVERPOOL MODEL-YACHT CLUB.

I.

Starting—Duties of Commodore and Captain.—The yachts shall start in all matches under the directions of the Commodore, Vice-Commodore and Captain, or Officers acting in their stead, and all heats be started by a gun or whistle. The races to commence punctually at the time stated on the programme. The Captain shall not have power to delay any heat from starting through the non-attendance of members. It shall be the Captain's duty to sail the heats according to the programme, and if any are not present to start when called on, the yacht or yachts shall sail the heat without them.

II.

Sailing over Course.—No member be allowed to sail a yacht over the course for the purpose of practice, after the racing has commenced, and any member infringing this rule shall be disqualified from competing in the race for which he has entered.

III.

Judges.—At all sailing matches the President, Commodore, and Vice-Commodore shall act as judges, or if absent, some other fit and proper persons shall be appointed instead, by the members of the Committee present.

IV.

Starting Stations—Postponement of Matches.—At all sailing matches, the starting stations, course of sailing, and winning flags shall be fixed and decided by the acting Officers of the day, who may alter the same (either during or at the termination of any class match), should circumstances in their judgment render such a course necessary; and should the wind change or die away during any heat, the Captain and Officers of the day shall have the power to stop the race; they have also power to postpone the day of sailing in case of unfavourable weather.

V.

Matches.—All Club matches, and all yachts sailing therein be under the direction of the President, Commodore, Vice-Commodore, and Captain, or other Officers acting in their absence; such directions to be in strict conformity with the Club regulations, and any member or other person having charge of any yacht entered in any match, refusing to comply with the order of the above Officers, the said yacht shall be liable to be thrown out of the race.

VI.

Pushing and Turning—Length of Poles—Protests.—In the starting of yachts for any prize, no member, or other person appointed, be allowed to push his yacht, but on the starting signal being given, to let his yacht go fairly. In beating to windward, no yacht shall be drawn or pushed, but to be fairly turned on the other tack. No pole more than six feet in length over all be used for starting or turning a yacht. Should any owner or starter infringe this rule, the Captain shall at once protest against such conduct, and the offending yacht be thrown out of the race. All protests against improper starting or turning to be made to the acting Officers of the day before the result of the race is made known. No protest will be received except from a member of the Club. All other protests against any yacht shall be made in writing, and handed to the Secretary not later than the day following the race, and all protests shall be decided by the Officers and Committee.

VII.

Rig and Sails.—It shall be entirely at the discretion of every member what number, size, or description of sails he puts on his yacht; but as far as may be consistent with model-yacht sailing, each yacht shall be sparred and rigged in the same manner as a regular sea-going yacht of the same rig.

VIII.

Winning Flags.—At all prize matches, the yachts shall come in between two flags, whose position and distance shall be decided by the acting Officers of the day.

No yacht to be declared the winner of a heat or race until she has sailed clear through the flags.

IX.

Owners' Flags.—Every yacht, when sailing in a prize match, shall have the owner's distinguishing flag flown at the peak.

The size of the flag to be not less than four inches by three inches, except for the 10-ton class, which shall not be less than four inches by two inches.

X.

Loss of Flag.—That any yacht coming in between the winning flags without the owner's flag displayed will not be recognized as in the match, unless the flag has been lost by accident after the commencement of the race.

XI.

Fouling.—No allowance will be made for yachts in the same heat fouling each other, but should this occur, the owners and starters may do the best they can to separate the yachts with their poles, but are not to enter the water for this or any other purpose ; but should any of the yachts in any heat foul each other on the first tack, before all three yachts have completed that tack, or should any competing yacht foul any obstruction other than the yachts sailing in the same heat; and should any of these fouls, in the opinion of the Officers of the day, have interfered with the chance of any yacht of winning, the heat shall be re-sailed.

Should the two leading yachts in any heat sail through the winning flags foul of each other, they (the foul yachts) shall sail over the course again.

Beaten Boats.—All beaten boats shall be taken out of the water when the first boat is through the flags, except in final heats.

XII.

Clear Course.—No yacht after making a tack shall be turned or re-started, unless the course is clear of other competing yachts. In the event of the course not being clear, the yachts shall be detained until the course is clear.

Re-starting.—Should two yachts arrive together on the same tack, the windward one shall be re-started first ; but should the leeward touch the ground first, it shall be started first ; the windward one waiting until the course is clear.

XIII.

Wilful Fouling.—Should any starter wilfully sail any yacht so as to foul any other competing yacht, it shall be considered no race ; the offending yacht thrown out of the race, and the starter, if a member, or, if not, the owner, fined two shillings and sixpence.

XIV.

Trimming.—Each member or his representative shall trim his own yacht on the race-days, and shall be allowed one person only to turn his yacht, and on no consideration will he be allowed to employ more than his turner to trim, adjust, or get sails ready in any way, either on shore or afloat. And it shall be the duty of the officers, or any of the members, to see that this rule is not infringed upon, and to report any infringement of this rule to the

Captain and Officers of the day; and any member, or other person acting in his stead, breaking this rule, shall be disqualified from sailing his yachts for the prizes of that day; and should the race be postponed to a future day, the disqualification will still hold good for that day's races.

XV.

Classes.—The yachts of the Club shall be divided into the following classes, viz. 40 tons, 30 tons, 20 tons, and 10 tons.

XVI.

Measurement.—The mode of measurement adopted by the Yacht Racing Association for 1883, shall be used to ascertain the tonnage of the yacht competing in Club Matches, all calculations being made on the assumption that one *inch* equals one *foot.*

The tonnage shall be ascertained in the manner following: the length shall be taken in a straight line from the fore end to the after end of the load water-line, provided always that if any part of the stem or stern-post, or other part of the vessel below the load water-line, except the rudder, project beyond the length taken as mentioned, such projection or projections shall, for the purposes of finding the tonnage, be added to the length taken as stated; the breadth shall be taken from outside to outside of the planking, in the broadest part of the yacht, and no allowance made for wales, doubling planks, or mouldings of any kind.

Add the breadth to the length and multiply the sum thus obtained by itself and by the breadth; then divide the product by 1730, and the quotient shall be the tonnage in tons and hundredths of a ton.

A fraction shall count as a ton or tonnage—

$$\text{Tonnage} = \frac{(\text{Length} + \text{Breadth})^2 \times \text{Breadth}}{1730}$$

XVII.

Counter.—The length of counter and dimensions of spars shall be optional, provided no counter be less than 3 inches long.

Depth.—The mean depth from the upper side of the deck to the underside of the keel, measured in as many equi-distant places as may be deemed requisite to ascertain the true mean depth, shall not exceed in the 40 tons class, 14 inches; in the 30 tons class, 13 inches; in the 20 tons class, 12 inches; and in the 10 tons class, 11 inches.

Rudders.—In the 40 tons and 30 tons classes the projection of the rudder, abaft the length of the load water-line, shall not exceed 2½ inches, and in the 20 tons and 10 tons classes, 2 inches.

Bulwarks.—The height of the bulwarks shall not be less than $\frac{1}{8}$ inch for the 10 tons class, and not less than $\frac{3}{4}$ inch for all other classes.

Freeboard.—Freeboard for all classes shall not be less than 2 inches from the load water-line to the upperside of the deck at the covering board.

XVIII.

Old Yachts.—These Rules of Measurement shall not apply to any boats built prior to March 1st, 1883, and they shall be allowed to sail in the classes for which they were intended, so long as they remain unaltered. The old four-feet yachts to sail in the 20-ton class.

APPENDIX.

Method of calculating Tonnage.—Members will take notice that by the rule of measurement, they may adopt any length or breadth for their yachts they may prefer, so long as the working out of the figures by the formula does not give a greater result than the tonnage of the class for which the yacht is intended. The mean depth must not exceed that specified by the rules.

The following is an example of calculating the tonnage fully worked out.

Length 68 feet. Breadth, 11 feet.

Length added to breadth—

68 feet + 11 feet = 79 multiplied by itself.

```
                79
               ----
               711
              553
              -----
              6241 multiplied by
                11 the breadth.
              -----
divided by 1730 ) 68,651·00 ( 39·68 or 40 tons.
                  5190
                  -----
                  16751
                  15570
                  -----
                   11810
                   10380
                   -----
                    14300
                    13840
                    -----
                      460
```

The following are examples of dimensions of Yachts of the different classes, but members are not compelled, in any way, to adopt these figures :—

	Length.		Breadth.		Tonnage.
	Feet.	In.	Feet.	In.	
40 Tons . . .	58	0	13	6	39·89 or 40 Tons.
	60	9	12	9	39·81 ,, ,,
	63	6	12	0	39·54 ,, ,,
	66	0	11	6	39·92 ,, ,,
	68	0	11	0	39·68 ,, ,,
30 Tons . . .	56	0	11	3	29·41 or 30 Tons.
	58	6	10	9	29·79 ,, ,,
	60	9	10	3	29·87 ,, ,,
	62	0	10	0	29·96 ,, ,,
20 Tons . . .	46	9	10	6	19·89 or 20 Tons.
	48	9	10	0	19·99 ,, ,,
	53	0	9	0	19·99 ,, ,,
	57	9	8	0	19·99 ,, ,,
10 Tons . . .	35	0	8	11	9·94 or 10 Tons.
	38	6	8	0	9·99 ,, ,,
	40	0	7	6	9·78 ,, ,,
	41	0	7	3	9·76 ,, ,,

INDEX.

A.

AFTER-BODY too full, faults of, 45.
After-sections, disposal of, 51.
Air-cases in life-boats, 144.
Air-tight compartments, 107.
Alteration of lines when vessel is careened, 15.
America, 26.
———, model of, 37.
———, sails of, 54.
American flat-bottomed canoe, 223.
——— outrigged thwart, 247.
——— racing boats, 246.
——— schooners, 25.
——— type suited to their waters, 38.
——— types modified, 37.
Anchor, to get, 343.
———, tripping-line for, 358.
Anchors, 273.
———, how to choose, 358.
Anchoring, care should be taken when at single anchor, 357.
———, plenty of scope necessary, 359.
———, taking out an anchor or kedge, 359.
———, when dragging, how to act, 359.
Artificial stability, 26.
Auxiliary steam 24-ft. fishing-boat, 297; cost of, 299.

B.

BACKBOARD, *Rob Roy*, 199.
Bad forms of vessels, 21.
Balance lug, 107, 250.
Ballasting open boats, novel method of, 361.
Batswing sail, 101.
Bawley boat (Thames), description of, 339, 340.
Beam and depth incompatible 24.
——— effect of, 24.
——— necessary in length, classes 24.
——— out of proportion to length evils of, 21.
Beatrice stoves, 353.
Birch-bark canoe, 180.
Blocks and cordage, *Dabchick*, 273.
———, 3-tonner, 296.
Boat-building, 127, 161.
——— materials, 124.
———, suitable wood for, 123.
———, tools required for, 121, 122.
Boats (raised and decked) unsuitable for yachts, 335-6.
Bobstay, 71.
Body plan, 5.
Boiler for steam canoe, 172.
Bonny Jean (model), 265.
Boom, double jaws for reefing, 228.
——— fitted with roller for reefing, 100.
Booms applied to jib and foresail in models, 66.
Bow and buttock-lines, 14—16.
Bowsprit out of proportion, 21.
Brass shoes for keel, 154.
Bulkheads (canoes), 166.

C.

CABIN fittings, *Dabchick*, 273.
————, *Rob Roy* yawl, 304.
————, *Procyon*, 316.
—— tops, ingenious contrivance for lowering and raising, 337, 338.
Canadian batteau, how to build, 221.
—— canoe, 180.
————, how to build in wood, 209; in canvas, 213; in paper, 216.
————, lines of, 266.
————, paddle of, 219.
Canoe, handling, 248.
—— rig, 248.
—— spinnaker, 250.
—— well, 256.
—— with yacht form, 258.
Canoes, 158.
——, description of, 176.
——, *Mersey*, 250.
——, *Nautilus*, 250.
——, *Pearl*, 250.
——, side-flaps, 246.
——, steering-gear, 253.
——, tabernacle, 251.
Capsizing of beamy shallow vessels, 27.
Captain, loss of the, 27.
Careening alters sailing lines, 16.
Carlines, canoes, 168.
Carvel-building, 138.
Casing for altering position of mast in models, 72.
Casting lead-keels, 153.
Catering, 354.
Centreboard, 232—242.
————, Sharpie, 229.
———— in separate parts, 241.
————, purchase for lifting, 233.
————, safety-springs for, 239.
————, with wide lead-keel, 334.
Chinese battens used to produce flat standing sails, 57.
Cleat fitted on mast, 96.
Clue, 71.
Coamings, canoes, 169.
Co-efficient alters, 32.
———— of displacement, 32.
Cold weather, 356.
Coming to, under different conditions, 349.
Commanding canvas, when required, 341.
Comparative elements, 3-ton design, 291.
Comparison of models, and the vessels they represent, 39.
Converted boats, bad yachts, 335.
Cooking, 350.
—— arrangements, *Rob Roy* yawl, 305, 306.
—— -stove, a small portable one useful, 352.
Coracle, 188.
Cork beds, 361.
Corragh, how to build, 220.
——, Irish, 187.
Counter, 9, 135.
—— not preferable for small craft, 337.
Crew, integral part of canoe, 245.
Crop in deck beams, 145.
Curtsy, dimensions of, 27.
Curve of displacement, 18.
—— of immersion and emersion, 18.
——, unfair, 14.
Cushions, covering of, 361.
Cutters and yawls compared, 340.
—— with short booms, 340.

D.

Dabchick, 336.
————, description and construction of, 267.
Deadwood specially needed in models, 8.
Deck, canoes, 168.
—— beams, 145; canoes, 168.
—— line, 12.
Deep vessels need fine runs, 21.
Defiance (model), 262.
Depth, effect of, 24.
Design for small cruiser, 284.
———— 3-ton racer, 288.
Designing, 2.

Designing, beamy short boats, difficult to get good lines, 42.
Designs, the, 262.
Diagonal and buttock lines, 47.
——— building, 142.
Diagonals, 15.
———, use of, 45.
Dimensions of spars for 3-tonner, 294.
Dinghy, a cover useful when towing, 360.
Dinghys or tenders for yachts a great worry, 356.
Dispersion of water, 15.
Displacement, 31.
———, concentrated, evil of, 42.
———, distributed, benefit of, 42.
———, how disposed, method of ascertaining, 33.
——— sheet, 12, and appendix.
Double canoe, 185.
——— -keeled canoe, 173.
Drag caused by deep heel, faults of, 46.
Dragging, how to bring the boat up, 359.
Draught of water an important consideration, 28.
Drawings, faults in, reproduced in boats, 47.
———, how to commence, 9.
Drogue or sea anchor, 348.
Drop-plate rudder, 253.

E.

Earing, 71.
Easy lines, 41.
English types suited to their waters, 38.
Eskimo canoe, 178.
Euphroe used in model rigging, 74.

F.

Fairing drawings absolutely necessary, 47.
——— the plans, 15, 16.
Falcon, the cruise of, 355.
Fast cruiser (three tons) design for, and full particulars of, 290.
Fastenings, canoes and boats, 165.
———, of built models, 134.
Feathering paddle, 175.
Fishing-boat, single-handed, 286.
Flare, description of, 352.
———, use of, 351, 352.
Flooring, canoes, 167.
Flying proa, 184.
Foghorn necessary, 352.
Fore-foot, excessive, 21.
——— rounded up, 22.
Form of bow, 21.
——— run, 21.
Freeboard, 13.
French curves, 2.
Full lines, benefit of, 23.
—— sections aft, evil of, 52.

G.

Galatea, 25, 26.
Garboard, how fitted, 132—164.
Genesta, 25, 26.
Getting topsail off, 344.
——— under way, 341.
——— wind against tide, 343; across tide, 343.
Good forms of vessels, 22.
Gripe, 21.
Grommet, 97.
Gybing or wearing in a sea, 345.

H.

Half-breadth plan, 5.
Head of sail, 71.
—— rope, canoe, 205.
—— sheets amidships, 348.
Heaving to, when and how to do so, 348.
Heeling alters sailing lines, 16.
High centre of effort of sail, 21.
Hog-piece, 142.
Hollow water-lines, 21, 22.
Horses, 146.

I.

Inclined water-lines, 17.
Initial stability, 27.
Irex, 37.

Paddle, feathering, 175.
Painter, canoe, 205.
Parallelogram of forces, 56.
Pearl type, 250.
Pitching and 'scending, causes of, 62.
———, causes of, 21.
Plan, half-breadth, 4.
Präam, Norwegian, 187.
Priscilla, 26.
Procyon, 303, 313.
———, description of, 315.
Provisioning, 354.
Puffin, 336.
———, 3-tonner, full particulars of, 285.
Puritan, 25, 26.

R.

Racing canoe, 234.
——— yacht, American type, 25.
———, English type, 24.
Rail, 9.
Raking midship section, 5, 11.
——— stern-post, 28.
——— bad for models, 28.
———, effect of, 86.
Reaching in a sea-way, 346.
Reefing gear (canoes), 104.
——— mainsail, 344.
Resistance offered by similar models of different sizes, 40.
——— greater for small models, 41.
———, skin, 40.
Revolving boom for reefing, 100.
Riband carvel building, 141.
Rig, canoe, 249.
———, the best for small craft, 339.
Rigging, *Rob Roy* yawl, 308.
Righting, use of C.B. and air-cases, 239.
Ringleader canoe, 190.
Rob Roy canoe, 189—192.
———, materials for building, 207.
———, cost of, 207.
——— cuisine, 319.
——— yawl, description of, 303.
Rowing-boats, suitable sails for 91—93.
Rudder, American mode of fitting, 229.
———, lifting, 253.
Rules, nature of, to be considered in designing, 23.
Runners, 71.
Running before a sea, 347.
Russian lamps, 319.

S.

Sail and fittings, *Rob Roy* canoe, 203.
——— plan, points to be considered, 63.
Sails, baggy, faults of, 54—57.
———, balance lug fitted with battens, 99.
———, best position of, 62.
———, boats, canoes, &c., 91.
———, centre of effort of, 58.
———, flat standing, benefit of, 57.
———, difficulty of obtaining, 57.
———, lateen, 92.
——— left standing, advantage of, in models and canoes, 66.
———, material and method of making small lug-sail for rowing-boat, 93.
———, centre of effort, method of calculating, 58—61.
———, models, 63.
———, moments of, 61.
———, plan of lug-sail for rowing-boat, 93.
———, relation to C.L.R., 58.
———, spritsail, 96.
———, standing lug, 91.
———, kind of, suitable for rowing-boats, 91.
———, to design, for rowing-boats, 92.
———, vertical height of, 62.
Sailing by the wind, 346.
——— canoe, 191.
——— canoes, 243.
———, variety of form, 274.
———, hints on, 345.
——— in a confused sea, 346.
——— rules, M.C.Y.C., 275.
———, L.M.C.Y., see Appendix.

Sampan, Chinese, 189.
Scantling for 3-tonner, 297.
Sea canoe, 259.
Sea dress, 312.
Shadows, 130.
Shallow boats may have short runs, 21.
Sharpie, American, 223.
———, sail plan, 228.
Sheer plan, 3.
———, bad form of, 28.
———, good form of, 29.
———, importance of, 28.
Shifting ballast, 244, 246.
——— jibs, 344.
Short boom cutters, 340.
Side flaps, canoes, 246.
——— lights, 351.
Silver Cloud, 303.
———, description of, 318.
Single anchor, danger of, 357.
———-handed boat, suitable type, 332.
——— sailing, 300.
——— trip across the Channel, 320.
Skin resistance, 23.
Sliding gunter, 106.
———, modification of, 106.
Small craft, best rig, 339.
——— cruiser, design for, 284.
Sneak-box, 224.
Snotter, 97, 101.
Spars, models, dimensions of, 74.
———, three-ton cruiser, 294.
———, *Una*, dimensions of, 284.
———, *Wideawake*, dimensions of, 280.
Speeds of models, 38.
Spiling, 162.
Spinnaker, canoe, 250.
Spirit lamp, an inexpensive form of, 353.
Splines, 3.
Sprit, 97, 101.
Spritsail, 101.
———, how reefed, 97.
Square stern, 337.
Stability of English yachts, 27.
"Staff," the boat-builders, 162.
Steadiness on the helm, 51.
Steam canoe, 171.
Steaming timbers, 136.
Steering gear, canoes, 253.
———, hints on, 345.
Stopping for, faults in wood, 155.
——— leaks, 137.
Stoves, coke, 355.

T.

TABERNACLE and its fittings, 251.
Tack, 71.
Templates, use of, 47.
Ten-ton design (model), 264.
Thirty-foot racing classes, 27.
Three-tonner, *Puffin*, 285.
———, design for, 288, 290.
Tiller, how fitted to work with mizen, 98.
———, management of, 345.
Timbers for clinker boats, 135.
———, how secured to keel, 139.
Tinned stores, care should be exercised. 355.
Tit Willow, 267.
——— and one-ton class, description of, 324—333.
Tools required for model making, 121.
Topmast stay, 71.
Topping lift, 106.
Topsail, 64.
———, sending down, 344.
———, to set, 342.
To get the anchor, 343.
To set mainsail, 341.
——— topsail, 342.
Transome, 129.
Traveller on main-boom, 66.
Trim, slight alteration affects sailing, 43.
Trimming racing canoes, 247.
——— sheets to be attended to, 43.
Tripping-line for anchor, 358.
Truck, how fitted, 98.
Trysail, importance of, 341.
Tumble-home in stem, advantages of, 289.

U.

U BOW, 182.
Una, 18-foot open boat, particulars of, 283.

Undine, R.P.Y.C., description of, 319—324.
Unfairness of models, 46.

V.

VANGS, use of, 57.
Vanishing-point, 27.
Varnishing canoes, 170.
Vertical cross-sections, 5.
Viper, 303.
——, description of, 327.

W.

WATER-LINES, 16.
Waterproof apron (*Rob Roy*), 201.
Waterproofing paper, 218.
Wave-line principle, 19.
——— -making tendencies, 16, 23.
Wearing or gybing in a sea, 345.
Weather helm, 21.
Weight displaced in tons, to find, 33.
Weights to be considered, 23.
Well (canoe), 256.
—— -cover (canoe), 257.
Western Yacht Club, 283.
Wetted area, 23.
——— surface, least possible, 42.
Wideawake, cost of, 281.
————, M.C.Y.C., description and full particulars of, 274.
Willesden paper, 217.
Wind, apparent force of, decreases when vessel is off the wind, 58.
———————, increases when vessel is close hauled, 58.
——, apparent motion of, 55.
——, effective impulse of, 56.
——, real motion of, 55.
Wren, offsets of, 282.

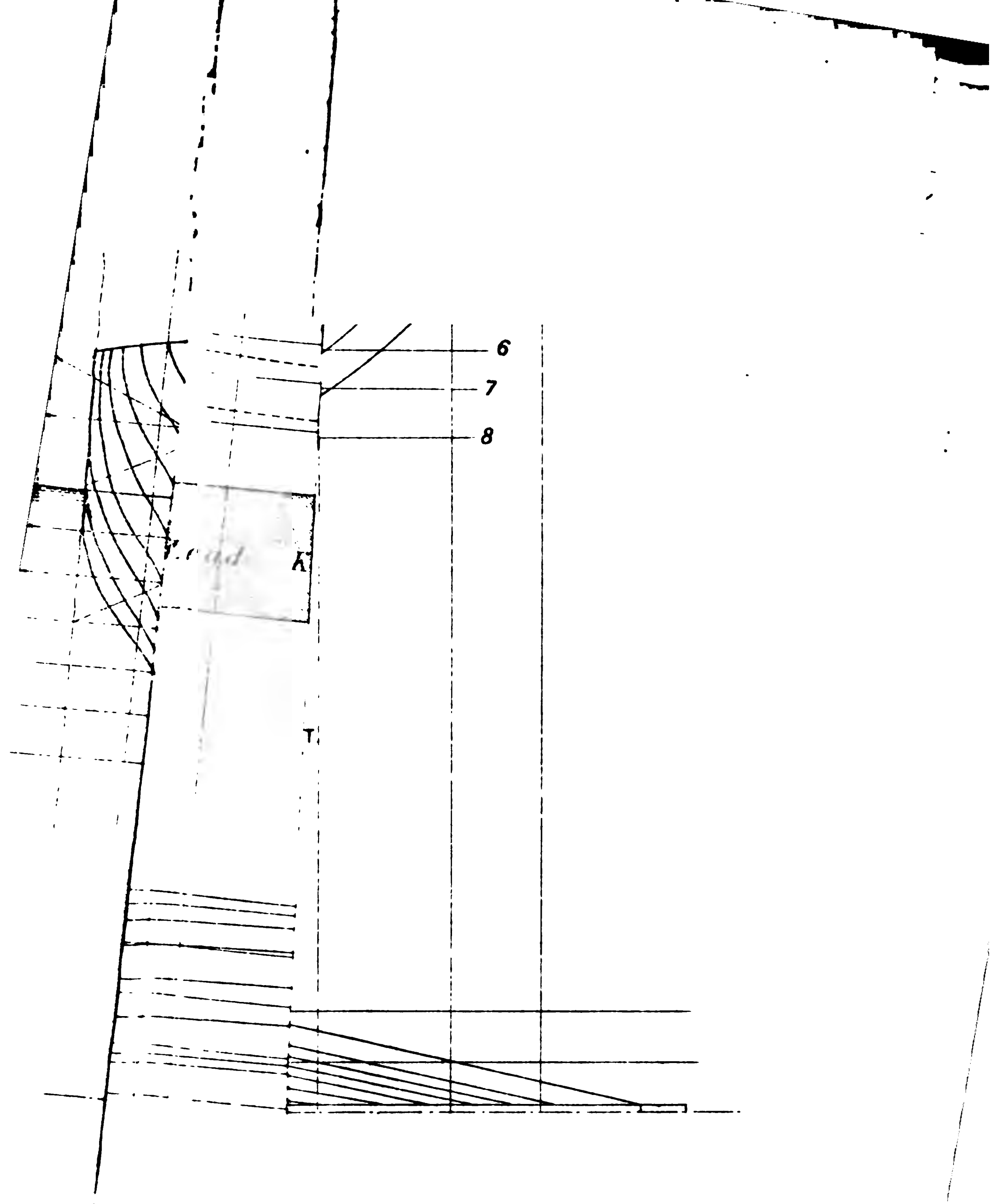
Y.

YACHT, English, cause of type, 47.
———, lines of, unsuitable for model building, 48.
——— range or stove, necessity of, 356.
Yachts and canoes compared, 244.
Yawl rig for canoe, 240.
Yawls and cutters compared, 340.

APPENDIX.

Cost of *Dabchick*, *Una*, &c., 363.
Calculations : Displacement sheet of three-ton design (Rev. S. Penrose), 364, 365 ; centre of lateral resistance (three-ton design), worked out, 366.
Mode of covering canoe with Willesden canvas, 367.
The *Rob Roy* cuisine, 367.
Sailing rules, Liverpool Model Yacht Club, 371.

GILBERT AND RIVINGTON, LIMITED, ST. JOHN'S SQUARE, LONDON.



Length .. 53 feet

Beam .. 9 ..

Digitized by Google

MILLER & SON,

Naval Tailors and Yacht Outfitters,

2, 4, & 6, Canute Road, & 18, High Street, Southampton,

AND

21, Custom House Terrace, Victoria Docks, London,

Beg respectfully to solicit the favour of Orders for Outfits for the Officers and Crews of Yachts, and to assure Owners that all Orders entrusted to them shall receive prompt attention, and their best endeavours will be used to give entire satisfaction. Messrs. MILLER & SON will be glad to arrange for measuring Crews at a distance, either personally or by Competent Assistants, without expense to Owners.

WATERPROOF CLOTHING OF THE BEST DESCRIPTION.

Indian Couches, Folding Chairs, & other Useful Articles for use on board Yachts

---

Beds, Mattresses, Pillows, Sheets, Blankets, Counterpanes, Towels, Table Linen, &c., kept in Stock ready for use.

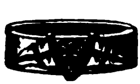
PRICE LISTS ON APPLICATION.

Address for Telegrams—**Millerson, Southampton, & Millerson, London.**

BENZIE'S

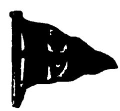
Nautical Jewellery, Crystal, Enamel, and Gem Pins, Brooches, & Scarf Rings.

12/6



£2 15s.

£2 5s.



15/6

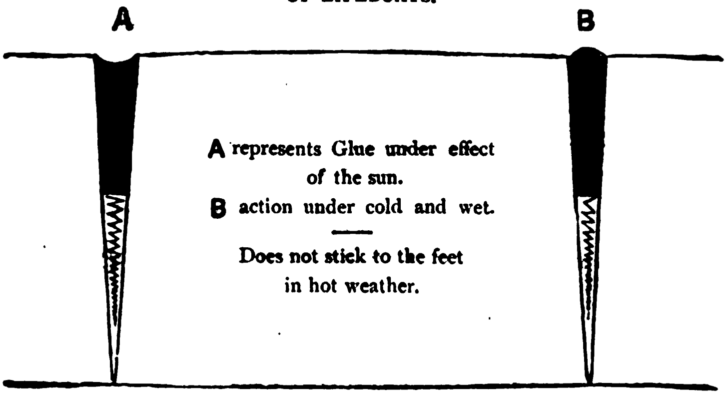
Hundreds of TESTIMONIALS SENT POST-FREE on application to

SIMPSON BENZIE

(By special Appointment),

Jeweller to the Queen, T.R.H. the Prince & Princess of Wales, &c., &c.,

COWES.



A
B
A represents Glue under effect of the sun.
B action under cold and wet.
Does not stick to the feet in hot weather.

EDITED BY G. A. HUTCHISON.

This, the most popular and successful paper for boys of all ages, from 12 to 21, ever published in England, has been the means of crowding out by real interest and high merit much of the pernicious "penny dreadful" stuff that previously flourished unchecked.

Its writers include the names of those who have won places in the front rank, whether for Stirring Stories, Sports and Pastimes, Indoor Games and Amusements, Travel and Adventure, Science and Art.

It has won the highest recommendation from leading statemen and philanthropists, the heads of our great schools, and all sections of the Press; while English-speaking boys the world over uphold and cherish it as essentially their very "own."

Amongst its staff of contributors may be mentioned the Rev. H. C. Adams, R. M. Ballantyne, Paul Blake, George Manville Fenn, Prof. Hodgetts, David Ker, Ascott Hope, Talbot Baines Reed, Dr. Gordon Staples, Jules Verne, Commander Cameron, C.B., Dr. W. G. Grace, Rev. J. N. Malan, M.A., Rev. T. S. Millington, Capt. Abney, F.R.S., Prof. Hoffmann, Cuthbert Bede, Henry Frith, Rev. J. G. Wood, M.A., Dr. Greene, F.Z.S., Dr. Stradling, Dr. Conan Doyle, Capt. Franklin Fox, R.N., Wilkie Collins, G. A. Hutchison, &c., &c.

Its artists include W. H. Overend, Harry Furniss, J. Nash, Gordon Browne, W. Ralston, W. S. Stacey, R. Caton Woodville, W. L. Wyllie, Capt. May, G. H. Edwards, Alfred Pearse, Ernest Griset, and many others.

It is published Weekly, price 1*d*., and in Monthly Parts, with splendid Coloured and other Plates, price 6*d*.

Office: 56, Paternoster Row, London, E.C.

LOW'S STANDARD NOVELS.

In small post 8vo, uniform, cloth extra, bevelled boards.

Price Six Shillings each, unless where otherwise stated.

By R. D. Blackmore.

LORNA DOONE:

A ROMANCE OF EXMOOR.

TWENTY-FIFTH EDITION.

Also an Edition, charmingly Illustrated, 21*s*., 31*s*. 6*d*., and 35*s*.

Alice Lorraine.
Cradock Nowell.
Clara Vaughan.
Cripps the Carrier.
Erema; or, My Father's Sin.
Mary Anerley.
Christowell: a Dartmoor Tale.
Tommy Upmore.

By Thomas Hardy.

The Trumpet-Major.
Far from the Madding Crowd.
The Hand of Ethelberta.
A Laodicean.
Two on a Tower.
A Pair of Blue Eyes.
The Return of the Native.
The Mayor of Casterbridge.

By George MacDonald.

Mary Marston.
Guild Court.
The Vicar's Daughter.
Adela Cathcart.
Stephen Archer.
Weighed and Wanting.
Orts.

By Mrs. J. H. Riddell.

Daisies and Buttercups: A Novel of the Upper Thames.
The Senior Partner.
Alaric Spenceley.
A Struggle for Fame.

By Mrs. Cashel Hoey.

A Golden Sorrow.
Out of Court.

By F. R. Stockton, Author of "Rudder Grange."

The Late Mrs. Null.

By C. F. Woolson.

Anne. | East Angels.
For the Major 5*s*.

By Mrs. Macquoid.

Elinor Dryden.
Diane.

By Miss Coleridge.

An English Squire.

By Rev. E. Gilliat, M.A.

A Story of the Dragonnades.

By Joseph Hatton.

Three Recruits, and the Girls they Left Behind Them.

By Lewis Wallace.

Ben Hur: A Tale of the Christ.

By William Black.

A DAUGHTER OF HETH.

NINETEENTH EDITION.

Three Feathers.
Kilmeny | In Silk Attire.
Lady Silverdale's Sweetheart.
Sunrise.

By W. Clark Russell.

Wreck of the "Grosvenor."
John Holdsworth (Chief Mate).
A Strange Voyage.
A Sailor's Sweetheart.
The "Lady Maud."
Little Loo: a Tale of the South Sea.
A Sea Queen.
Jack's Courtship.
My Watch Below.

By Mrs. Beecher Stowe.

Old Town Folk.
We and our Neighbours.
Poganuc People.

By Mrs. B. M. Croker.

Some One Else.

By Jean Ingelow.

Don John.
Sarah de Beranger.
John Jerome: his Thoughts and Ways. 5*s*.

London: SAMPSON LOW, MARSTON, SEARLE, & RIVINGTON, 188, Fleet Street, E.C.