PRACTICAL HYDROFOILS

A.Y.R.S. PUBLICATION No. 58

Don Nigg's flying hydrofoil

CONTENTS

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EDITORIAL

October, 1966.

The Annual Subscription to the A.Y.R.S. is now due. It remains at £1 of $5.00 as before and should be sent to Woodacres, Hythe, Kent, England. We are thus taking over the distribution of publications for the South African Group completely, as well as the American and Canadian Groups. Australian, French and New Zealand members may either subscribe to their " National Organiser " or to Woodacres, as they wish. If subscriptions are not paid by January 1st, 1967, No. 59 will not be sent. Again, Bankers Orders are enclosed for the convenience of members so that subscriptions will be paid each year without effort.

If anyone has had a misbound or faulty copy of a publication or has not had his full five for this year, will he please let me know.

The Weir Wood Sailing Meeting. This will take place at Weir Wood Reservoir, Forest Row, Sussex on October 8th and 9th, beginning at 10 a.m. on both days.

All further Society details can be got from A.Y.R.S. No. 57. This is a supplementary publication for the year 1965-1966.

PRACTICAL HYDROFOILS

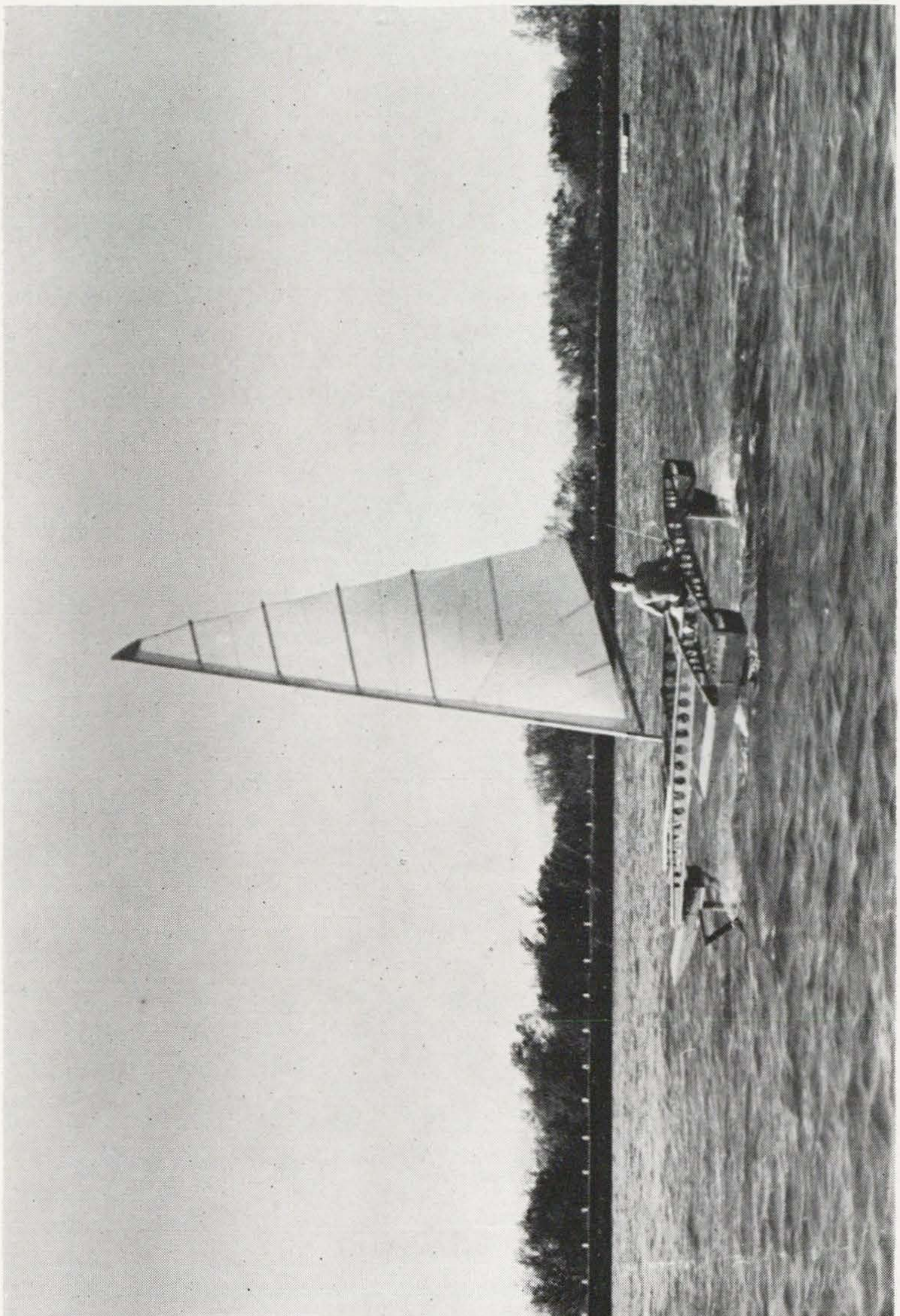
We are delighted again to have a flying hydrofoil by Don Nigg in this publication. As compared with previous flying hydrofoils, this one appears to be easy to get off the water and it is also easy to steer. It therefore looks as if it is a distinct contribution.

An Ayrsfoil Hydrofoil Class. If just ONE person can devise a controllable flying hydrofoil boat, I think the A.Y.R.S. should seize on it and sell the plans as a basis for a " Development Class " of flying hydrofoils. Practical sailors will soon iron out any remaining " bugs " and get all the proportions optimized.

The rest of this publication deals with other hydrofoil suggestions and Paul Ashford's delightful *TRIPLE SEC*, with its Bruce single-foil. The sail articles are interesting, too, and it all goes to the advancement of the art.

Dear Sir,

You will recall that we corresponded on the subject of hydrofoil sail boats in the Spring of 1963. You were kind enough to send me quite a bit of helpful information on the general subject. As you can see from the photograph enclosed, my experiments have been reduced to successful practice. After due consideration of what had been done



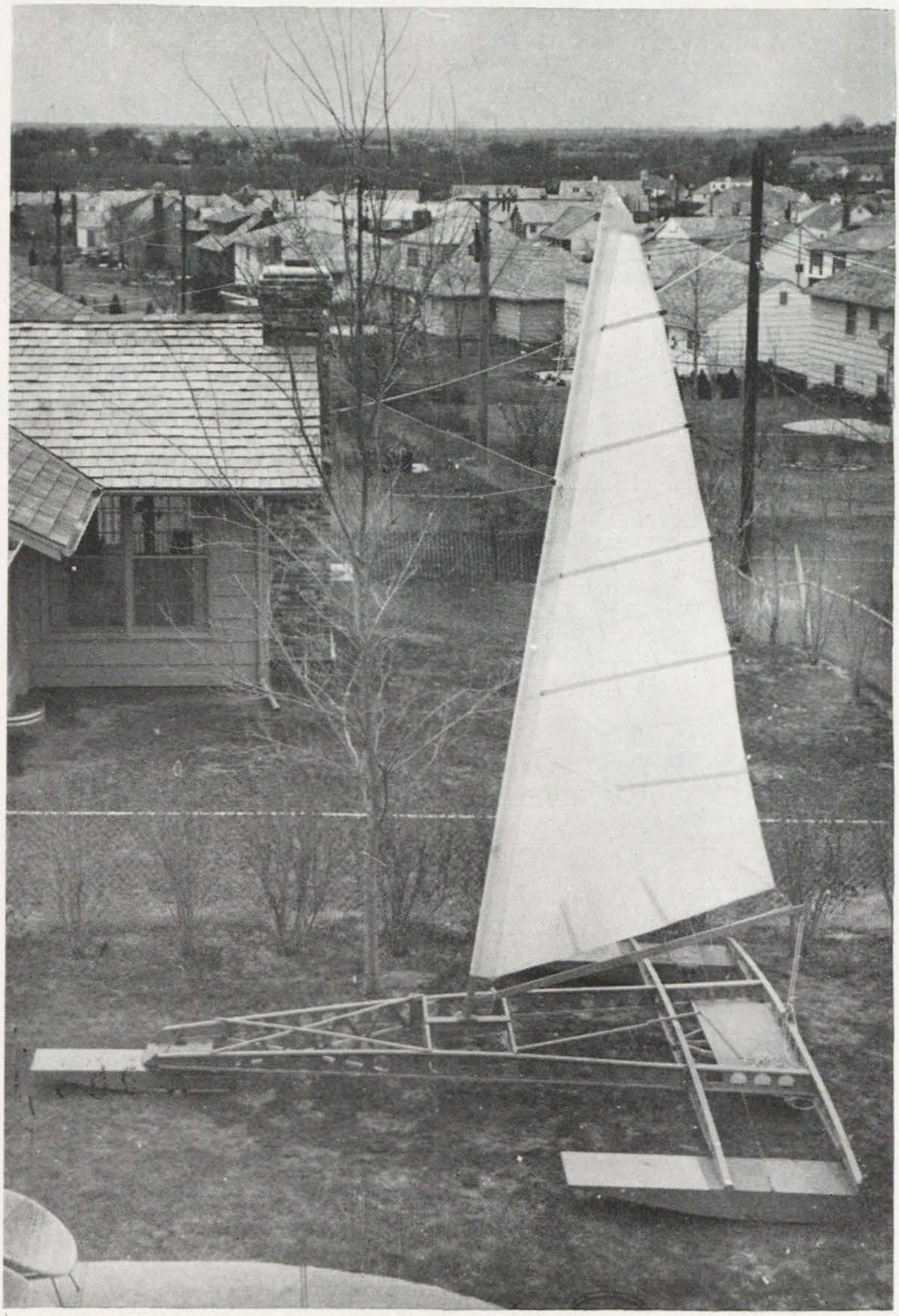
Don Nigg's EXOCOETUS

in the field, I decided to do something a little different than other experimenters had attempted, in-so-far as I know.

The idea of a front steering three point suspension system began to emerge as a challenge early in the study. Iceboaters shifted to this approach some years ago with good success. The two obvious advantages are first, the better weight distribution among the three support points where the skipper must sit in the rear, as he must, to see his sails; and second, the weight of the skipper provides a restoring moment against heeling even when he is sitting on the centre line of the craft. In the case of the rear steering three point suspension, he is sitting on the fulcrum and it is difficult to even hike out to make use of his weight. The most formidable design problem in the front steering approach is the pitch stability and the pitchpole moment of the sail thrust vector. A solution to this was finally worked out on paper and it seems to be proving out in tests. This solution appears to be unique, and is the subject of a patent disclosure at this time. Perhaps a contribution to the art has been made on this point.

The boat, in its first form, flew briefly during the end of the 1964 sailing season. Bow wave problems made it advisable to modify the shape of the front portion of the floats. In the Spring of 1965 the boat was again launched with this one major change. The transition from displacement mode to planing mode to hydrofoiling mode was now smooth and quite satisfactory. The boat took off readily and seemed to be running fine. On the third time up it was necessary to make a rather sharp turn upwind to avoid an obstruction. The strain in torque on the front end was too much and the whole front section literally twisted off. As the nose dropped, it put the rear foils in negative attitude and this tore the rear cross-beam apart. The thing came to rest in three distinct pieces ! A whole new frame was necessary The new frame was not ready until the 1966 sailing season. This time all stresses were calculated and a safety factor provided. The first frame was strong enough at the outset, but after modifying the floats, the attempt to regain the original weight resulted in the removal of too much material and it was just too weak for the high stresses developed in these boats. I might note here that the original foil design and sail design were unchanged in all this. Only the frame was affected.

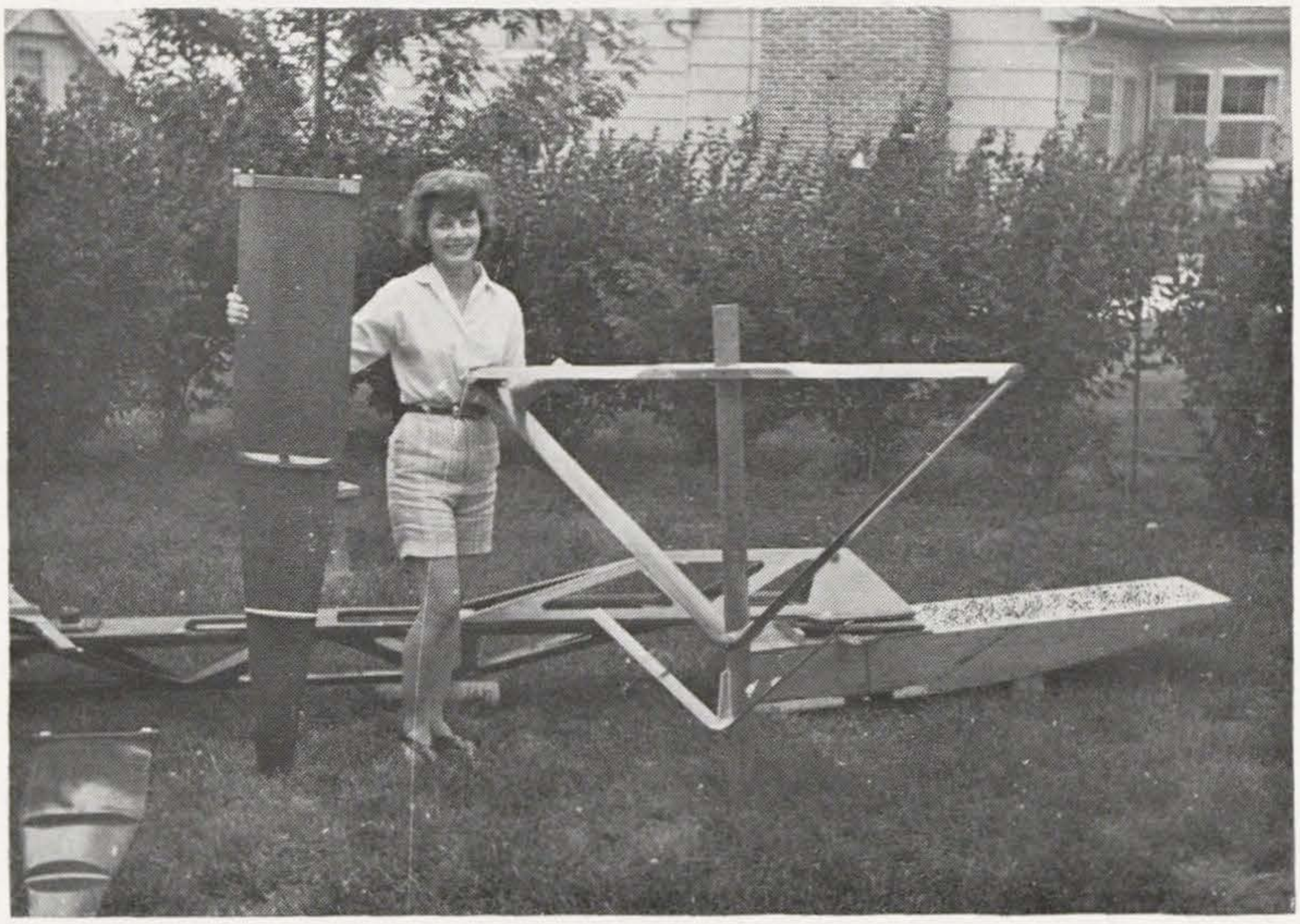
The photo was taken early in May this year, and represents one of dozens of successful flights. In this particular picture, the craft is slowing down for a landing in a cove and is probably going between 12 and 15 knots judging from the height above the water. The original design figures were set up for normal operating speeds in the 20 to 30 knot range. At this speed the boat is a foot or more higher above the water than in this picture. At 25 knots, the calculated rise



The NIGG Hydrofoil frame and sail

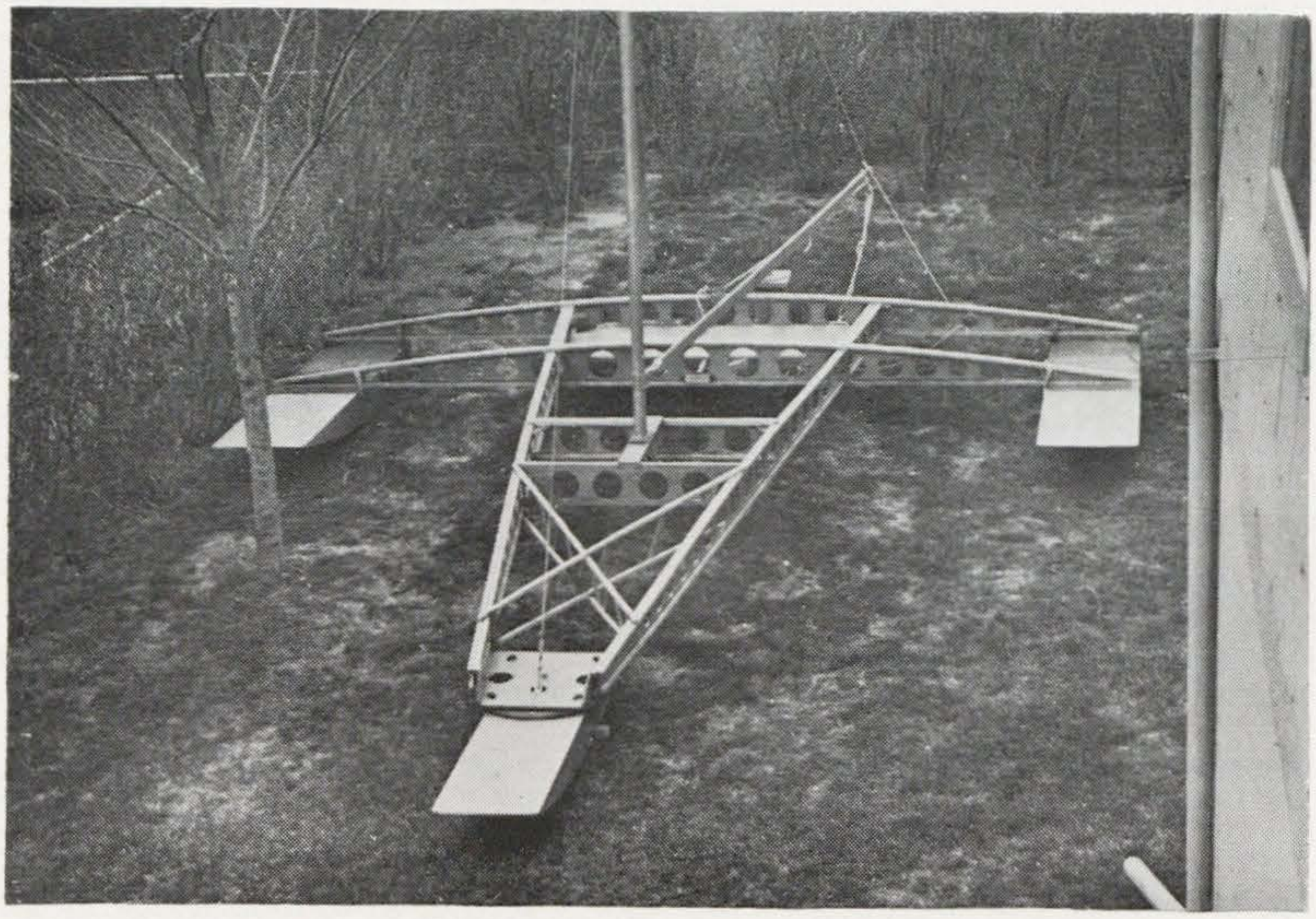
is 30 inches from the rest position. Not visible in the picture is a 90° Vee foil on the front strut that is completely submerged in this picture.

The front foils visible in the picture will rise completely free of the water and the high speed foil supports the front end at full operational speed. It has a ½ span of 16 inches and a chord of 2½ inches. It is made of aluminium, while all other foils are of oak or mahogany. The rear foils are 5 feet long and taper for the bottom three feet to a 3 in. chord at the tips. They have a 11½ in. chord at the root. The total foil area is about 11 sq. ft. to give the relatively low take off speed of 6½ kts., calculated. This velocity can be achieved in a 12 knot wind.



Mrs. Nigg with foils

After the floats leave the water, the drag curve actually has a negative slope between 6½ and 12 knots resulting in very fast acceleration. This is achieved by virtue of the fact that the design provides for foil area reduction and foil angle of attack (drag) improvement that overcompensate for the v^2 term in the drag equation in this velocity range. The velocity term begins to predominate, and at 24 knots the theoretical hydrodynamic drag is again that at take off. See what has happened ? We have a mathematical model that will go 24 knots in a 12 knot wind. This is why I had to build it to see what it would do. The sail thrust exceeds the drag throughout this range. You can't argue with this because all sail calculations were based on the curves in your very good book on the subject ! As a further tribute to this efficient little sail based on your work, yesterday the boat got off the water with two adults aboard. (Gross weight 510 lbs.—really too much for any safety factor in the stress analysis).



Bow view of frame

Statistics for *EXOCOETUS :*

LOA	19 ft.	Beam	16 ft.	Weight	214 lbs.

Foil sections, NACA 66-S209 and plano-conves, 45° dihedral.

Foil loading, 400 lbs./sq. ft. at 20 kts.

Sail, 85 sq. ft., 20 ft. sleeve luff, 7 ft. foot, loose footed, full battens, 6 oz. cotton—homemade.

Thank you for your encouragement.

DONALD J. NIGG.

7924 Fontana, Prairie Village, Kansas, U.S.A.

Dear Sir,

TRIPPLE SEC, which I had at Weir Wood in 1964 (see A.Y.R.S. No. 52) is now sailing with a single outrigger 10 ft. by 10 in. by 10 in. with Edmond Bruce's inclined foil on the float. The main hull and float are about 7 feet apart, centreline to centreline, with Bermudian sloop rig on the main hull centreline.

So, far, she has been sailed on only four occasions. On the first two sails, there was a strong and gusty wind and she was reefed. On the second day, we had one sail with the foil off the float, using the centreboard I put in the main hull last year. This showed the inclined foil to be worth a lot more in stability than a crew sitting well out. In fact, the effect is quite uncanny.

Generally, I think she is greatly improved over last year's trimaran configuration and, when a few teething troubles have been ironed out, I think she will be very fast.

Handling is good. She is very light on the helm on either tack. Tacking toward the float is very easy, the main hull sailing round the float making a lot of ground on the turn and starting the new tack without loss of speed. The opposite turn, in which the float swings around the main hull, can be accomplished with certainty if the jib is kept aback but she seems to lose most of her way, which has to be regained on the start of the new tack. I intend shifting the mast toward the float, which I think may improve this.

I hope to be able to attend Weir Wood this year, by which time we should be getting more tuned up.

The Cruiser possibilities seem most attractive. Congratulations to Edmond Bruce on what I think will prove a great breakthrough and my thanks to you for publishing the good news.

PAUL ASHFORD.

Holly Lodge, Strumpshaw, Norwich NOR 77z.

THE PHOTOGRAPHS. These show the line of action of the foil meeting the mast; the waves from the hull and outrigger intersecting and the way the hull is depressed, when to leeward and lifted when to weather so that the forefoot is clear of the water. The foil is pivoted in a bolt through the outrigger keel member, and restrained from wringing the bolt by timbers which hook over its top edge at the sheer. While easier to construct, Paul thinks that this arrangement produces more drag than would arise from the slot if the foil were housed internally in the outrigger like a normal centreboard.

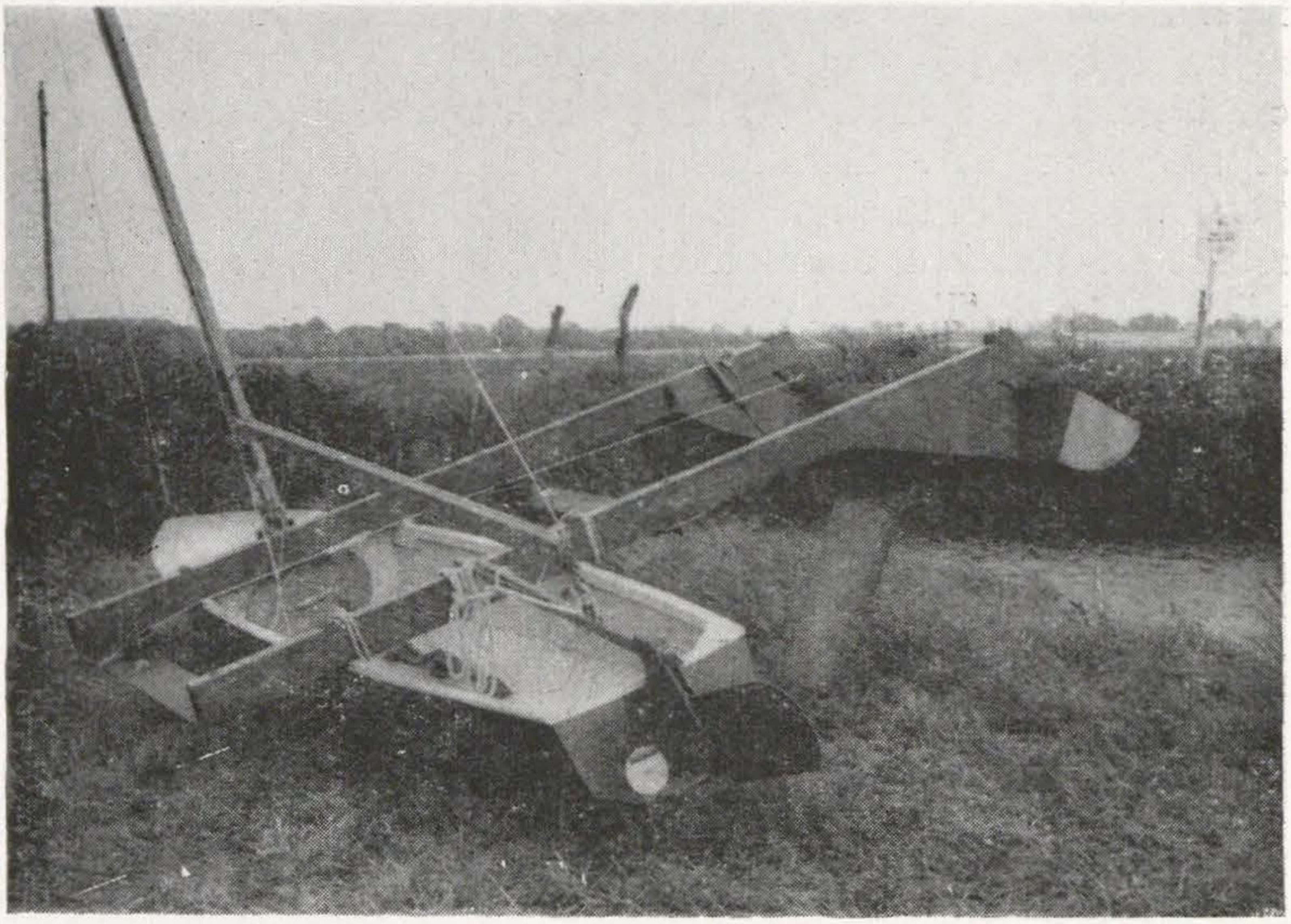
Paul Ashford's TRIPLE SEC—bow lifted

TRIPLE SEC—bow depressed

TRIPLE SEC—note interesction of waves

TRIPLE SEC showing foil and float

TRIPLE SEC showing stern waves



TRIPLE SEC showing cross-arm mounting

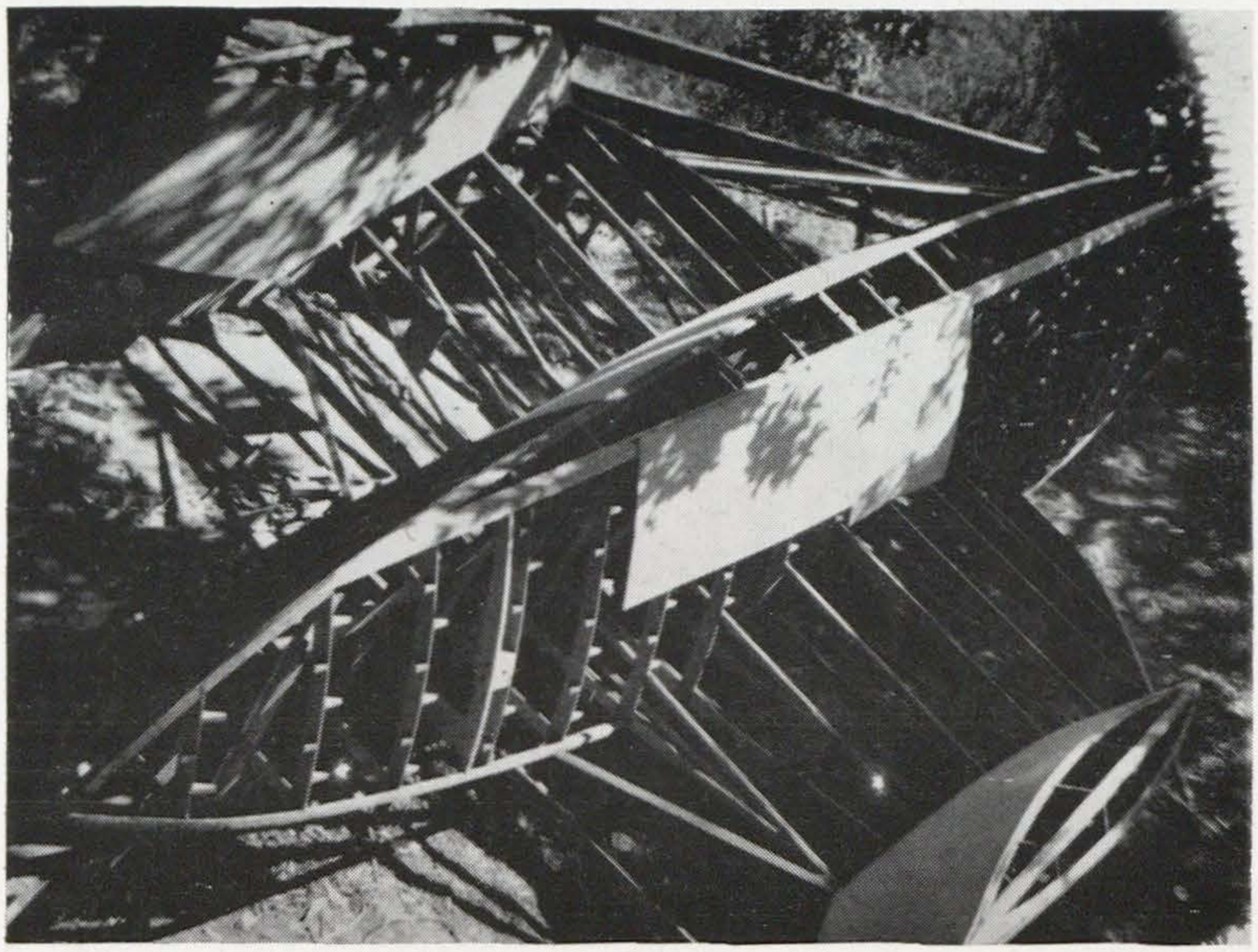
Dear Sir,

I have my hydrofoil sailing yacht design under construction now. I'm in the midst of planking it, and expect to be trying it out sometime this fall on San Pablo-San Francisco Bay, and the rougher waters outside the Golden Gate.

It wasn't until May that I had a particular design that appeared to satisfy the many requirements of such a yacht. In addition to designing a foil system that should give a lift/drag ratio of 14 or 15 at take-off, I had to work out a rigid but lightweight method of construction, and an improved sail rig.

The craft is 31 ft. long overall, and I'm expecting a total displacement of 3000 pounds, including two persons and their supplies. Calculations indicate that a 13 knot wind will be required to become fully foilborne. Lacking that wind, the boat can be operated as an efficient trimaran by retracting the foils. The abbreviated pontoons are located forward of amidships and serve for initial stability and for structural fastening points for shrouds, bow foil and lateral stabilizing foils.

The aluminium foils have a 6 in. chord length, and will be set with minimum dihedral of 30 degrees. The bow foil will span the width of the boat and will thus have a very high aspect ratio. It will be set for a fairly high lift coefficient at the take-off speed of 12 knots. The rotatable stern foil-rudder combination will have lift coefficients considerably less than the bow foil, thus giving submerged foil stability at the lower speeds. Stern foil lift is distributed lower than that for the bow foil, such that as speed picks up, the craft leans forward to reduce lift coefficients to proper values at high speeds. Lateral foils will be inverted 'T's with dihedral to oppose the extreme side forces encountered.



David Keifer's 31ft. Flying Hydrofoil under construction

I have no plans for incidence control of the foils on this craft. I'm afraid of gadgetry at sea, my yachting experience winning out over my " physicist " propensities. Longitudinal stability calculations indicate that sail pitching moment is no problem. Fresh storm waves could turn out to be a problem if one runs straight downwind. However, I've put considerable reserve buoyancy in the bow in order to counteract negative incidence that might occur on the bow foil. Normally, one would tack going downwind to get optimum performance. The highest cruising speeds would be obtained with the true wind just aft of the beam, and the boat synchronized with the waves.

I'm planning on a sloop rig with loose-footed mainsail to allow camber control, and to get hard driving force from the lowest portion of the mainsail. The mainsail will be set close to the wide, clean and uncluttered deck to get maximum efficiency.

I enclose a photograph (bottom view) of the hull construction. Curved frame members and planking are of $\frac{1}{4}$ inch plywood. Angle blocks spaced every 6 in. along the frames fasten frames and planking together. Bottom and transom will be of $\frac{1}{2}$ in. plywood. There will be a thin fibreglass skin over the whole boat.

By the next issue, I hope to be able to report on its performance.

David A. Keiper.

95 Mistletoe Lane, Black Point, Novato, Calif. 94974.

Dear Sir,

I am enclosing a little sketch of a mast and sail arrangement which I propose to use on a 25 ft. foil stabilized sail boat. The designed size of the sail is 300 sq. ft. As you can see from the drawing a cantilever mast is used which is 24 in. across. At the top of the mast, an arm which may swing laterally, is used to hoist the sail. The swing of this arm is controlled by sheets which run through the centre of the mast. The sail is fully battened. It is carried around the mast and zipped up with a zipper as it is hoisted. The battens split seven or eight inches from the mast, one half of the batten going to the left side of the mast and the other to the right. At the foot of the mast is a boom which can be swung in the same manner as the hoisting apparatus.

I have a small model of this arrangement and it seems to work exceedingly well. There are no stays or other appendages which would reduce efficiency and the split batten arrangement forces the sail to take on a smooth curve.

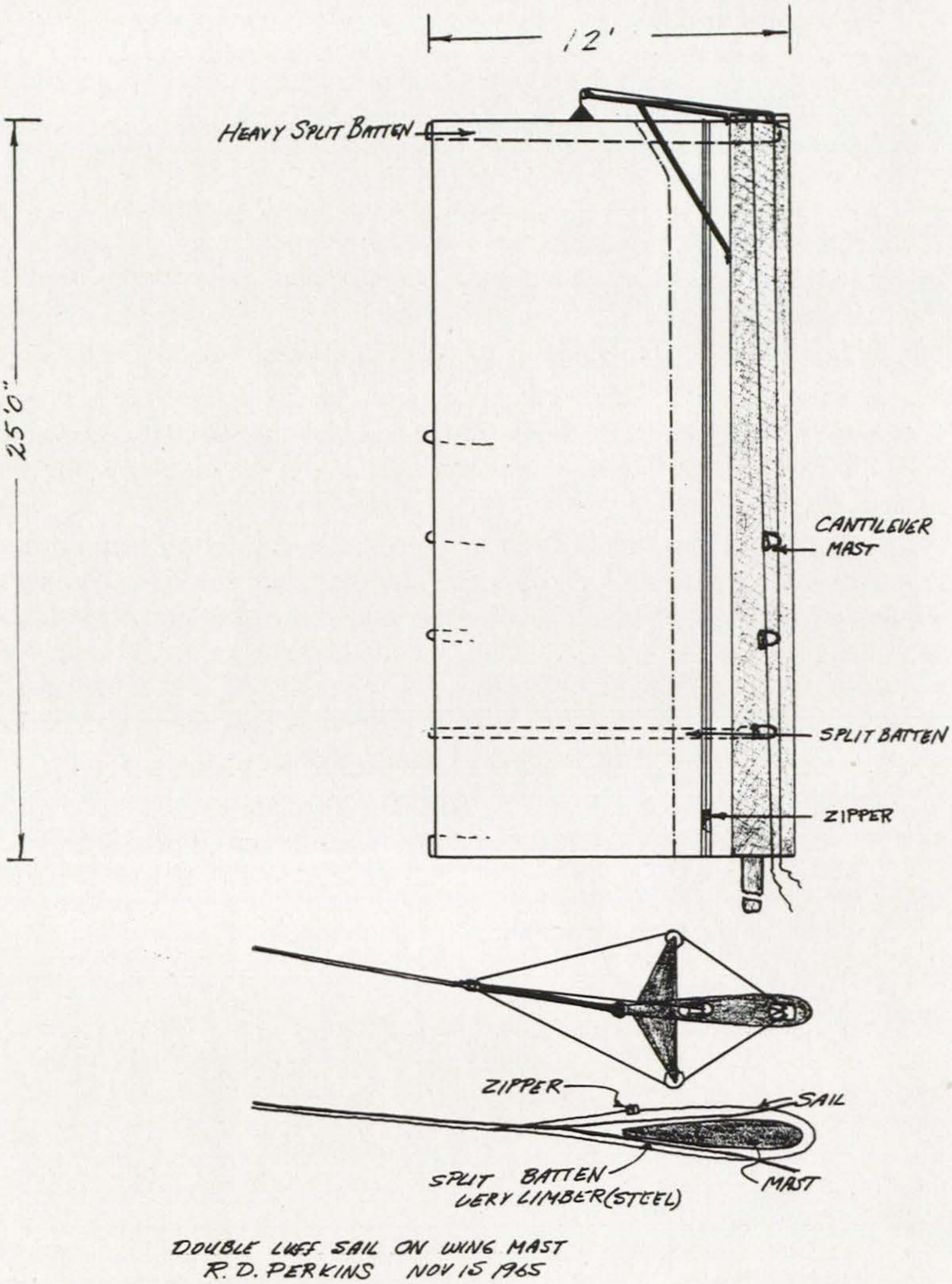
The boat will be stabilized by a single foil out-rigger of my own design which is quite similar in principle to that described in your second last publication.

In construction this craft is essentially a 25 ft. box beam of $\frac{1}{4}$ in. marine plywood. There are no stringers. All joints are simply fibreglass tape. Below the water line the curved bottom sections are made of a block of styrofoam which I am shaping with a cheese grater. The total all-up weight (with crew of 2)will be 625 lbs. This hull is about half finished at the present time. I will send you photographs of it presently.

Could you let me have your comments on this mast and sail arrangement.

Robert D. Perkins.

85 Richmond Street West, Toronto 1, Canada


12'
25'0"
HEAVY SPLIT BATTEN
CANTILEVER MAST
SPLIT BATTEN
ZIPPER
ZIPPER
SAIL
SPLIT BATTEN
VERY LIMBER (STEEL)
MAST
DOUBLE LUFF SAIL ON WING MAST
R. D. PERKINS NOV 15 1965

A METHOD OF USING FULLY IMMERSED HYDROFOILS WITHOUT MOVING PARTS

R. R. A. Bratt, M.A., A.M.I.MECH.E.

Before describing what has seemed to me a useful way to utilise hydrofoils it will be well to state briefly the principles involved.

The dymanic lift of hydrofoils is used to greatly reduce the wetted area and water disturbance of a craft. The reduced resistance makes possible the use of much lower power or an increase of speed or both.

The requirements of a hydrofoil system are that the boat travels parallel to the mean surface of the water in its speed range, and that it is stable, i.e. the boat must not hunt, or porpoise or suddenly dive if the trim is disturbed.

There are two fundamental types of hydrofoil : surface breaking and totally immersed.

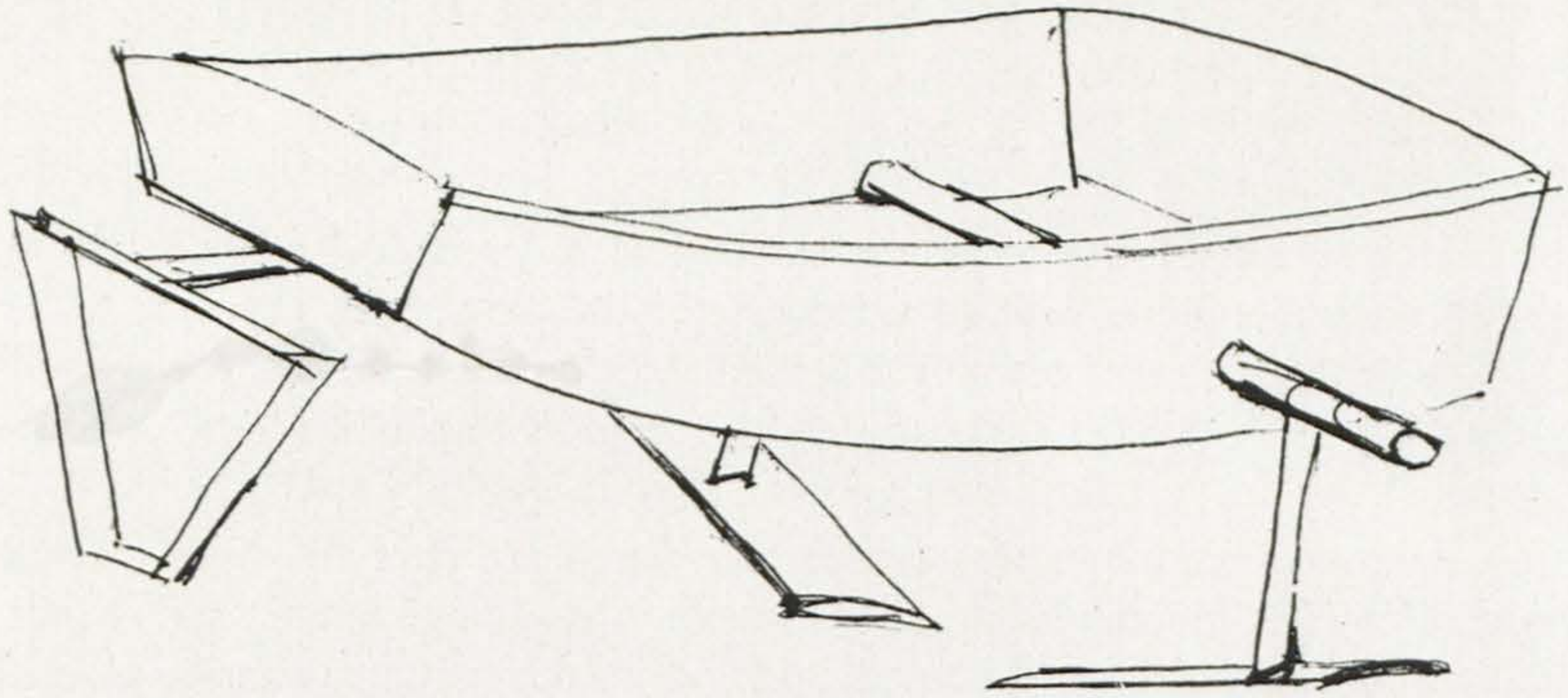
Surface breaking foils follow the surface of the water by rising as speed is increased so that a smaller lift area remains immersed at higher speed.

Totally immersed foils have potential advantages of a smoother ride and less disturbance of the water surface since the lifting surface itself does not anywhere disturb the surface. The lift of a fully immersed foil is precisely comparable to an aeroplane wing and the convenient way to keep the lift constant with varying speed is to change its angle of incidence. The angle of incidence can be changed as in an aeroplane by tilting the whole craft or by just tilting the foil.

To maintain constant depth just below the surface of the water a surface sensing device is required. This is commonly in the form of a sort of water ski which is linked by a mechanism to the foils or control foils. A more or less complicated set of moving parts is involved.

Moving parts are not necessary, however, if the angle of incidence of the load carrying fully immersed foil is controlled by a fixed surface breaking control foil. I successfully tried this in 1960. My eight foot dinghy with me in it towed by a motor boat rode above the surface of the water at about 12 m.p.h. I cannot say that I felt very safe, but that is presumably a matter of development work and not inherent weakness. In any case the dinghy had no rudder or other moving control at all.

The unit consisted of a pair of main foils each 9 in. x 24 in. set at a dihedral of 10° or so each. These were mounted each on a single stalk near its centre. The two foils side by side, with a gap between them, but equivalent to an aeroplane wing. A front surface breaking V foil acted as stabiliser.



The front foil 3 in. x 10 s.w.g. aluminium cambered and formed into a flat bottomed 60° V with 18 in. sides, and 4 in. bottom.

To perform more than my crude experiment it would be necessary either to fit a rudder behind the main foils or make the stabiliser rotatable as a front rudder. It is possible that ailerons would be an asset for turning especially as the centre of gravity is inevitably so far above the lifting surfaces, but if the device is usable it would seem a retrograde step. Careful design should make them unecessary.

A word on stability. An aerofoil or fully immersed hydrofoil can carry a stabiliser either behind or in front. The fundamental requirements for stability when the stabiliser is behind as in a aircraft are (a) that the stabiliser have a small negative angle of incidence and that the centre of gravity preceeds the centre of pressure (b) that the moment of the stabiliser be large relative to the moment of initia of the craft. When the stabiliser is in front of the main foils as in our hydrofoil system the angle of incidence of the stabiliser must be greater than the angle of incidence of the main foils. (b) holds good and of course the stabiliser must be powerful enough to cope with the changing position of the centre of pressure on the main foil as it changes speed and angle, and with the changing position of the centre of gravity if the passengers move.

Consider the mechanics of the hydrofoil system proposed. At rest the V shaped front stabilising foil lies fully immersed in the water at (for the sake of argument) 5° or 6° incidence, the main foil at zero or perhaps 2° incidence. The centre of gravity is slightly in front of the main foil so that only a small load is carried on the front foil which has the double task of stabiliser and surface senser. As the boat gathers speed first the front foil begins to lift because it is lightly loaded and at a larger angle of incidence. As it rises it causes the main foil to present a larger angle to the water, and the main foil will begin to lift the boat from the water. As the speed increases so the main foil will rise. At the same time the front foil will cease to rise or rise less fast as both foils turn to a smaller angle of incidence. It will be seen that the front foil will have a more nearly constant running depth regardless of speed, while the main foil will run nearer the surface at high speed and deep at low speed. The effect of movement of centre of gravity will be to make the craft run higher or lower in the water. In very short or frequent waves the front foil will be back in a trough without raising the bow of the boat. In longer waves the bow will tend to follow the contour of the wave but flatter. As it does so the main foil will change incidence slightly without having time to raise the boat. In large waves the craft would follow the shape of the sea.

As any aeroplane modeller knows, whether the system is inherently stable or whether it dives or porpoises depends on correct proportions and there are known rules to follow.

I doubt if this system would be readily adopted for sailing boats because it will not accommodate big variations of fore and aft overturning moments. I can visualise some potentially useful variations and adaptions.

Dear Sir,

I understand that you have done some research into the question of using hydrofoils, so successful with power boats, to aid a sailing craft, and in particular I seem to remember the idea of building a sort of trimaran using hydrofoils instead of the two outer hulls. I wondered if you had ever investigated the idea of doing just the reverse, that is, replacing the centre hull with a hydrofoil. In particular, has one ever been built ?

This idea seems to me to be preferable for many reasons. Firstly, the fastest racing craft that I have ever heard of are the C Class Cats and this would seem to be a good place to start if speed is required.

Secondly, the outrigger foils had some problems when the craft was operating at low speed when the hydrofoils were not effective. Here, the craft had hardly any more stability than a dinghy, and the question of the the gust which hits you when you have just gone about could be very nasty. In particular, should the craft fail to get about and then gather sternway, the hydrofoils will act in reverse and try to capsize her.

It is evident that, with the foils in the centre and cat hulls outside, the boat would behave somewhat like a cat at low speed, becoming more like a tri as the speed increased. I envisage the foil being placed slightly forward of the C.G. of the boat to avoid both hulls flying, followed by a glorious twin nosedive and torpedo effect. With the controls slightly forward, it could take most of the weight at high speed, at the same time putting the boat in a nose-up planing position. It seems that the gust which strikes the boat at low speed would now be less likely to capsize it owing to the " cat " stability and, as the boat accelerates, she would lift into an early plane, rather than taking an excessive initial heel requiring dinghy tactics of luffing or spilling wind.

L. K. GRIFFITHS.

Fairways, Rhodyate Hill, Blagdon, Nr. Bristol.

Ed.—A V-foil or inverted T-foil with Hook " feeler " placed as in this suggestion might allow the weather hull of a cat to lift just clear of the surface while, at the same time, greatly reducing the load on the lee float. This could be of great speed value but I think the craft would be pretty unstable both in roll and in pitch. It is, however, an experiment which would be fun to try out and cheap to do. Unfortunately foils seem to be banned by the C Class rules.

Dear Sir,

You may remember, about three years ago I wrote to you about a Morwood cat I built and sailed on Lake Nyasa for some time. Since then I have been in Zambia and over 400 miles from the nearest sizeable sailing ground, Kariba.

However, this has not prevented me from thoroughly enjoying A.Y.R.S. publications to which you have devoted so much time, energy and original, but always sound, ideas.

The A.Y.R.S. stimulated my ideas about building a 48 ft. cat on your hull design and, off and on, I have had a lot of fun roughing out ideas and designs. Then Piver developed his very attractive 35 ft. *LOADSTAR* and for a while it interested me. I had a trip in a 45 ft. tri on Lake Tanganyika built on similar lines, unfortunately only under power, in which it was good but did not shine. However, I digress, the point was that it seemed to present a solution to the windage problems arising out of the semi deck cabin of the catamaran (this does not seem to be adverse to the outstanding performance of Rudy Choy's latest craft).

After a lot of thought, I came to the conclusion that the centre hull was too narrow to provide comfortable accommodation for a family without full width cabins over the outrigger hulls; this too presents very big windage, particularly forward, and spoilt the design appearance. It seemed easier to streamline a cat and keep proportions and, anyway, my mind boggled at the work of designing and building three hulls, there is enough work in two.

Then along came your thrilling monohulled hydrofoils and I began to think of monohulls for the cruising family man. I laid down the following requirements :

Length between 35 and 45 ft.

Light and simple construction for the home-builder (round bilged strip planked or hard chine or a combination of both).

Comfort and roominess below decks.

Good carrying capacity.

Full headroom.

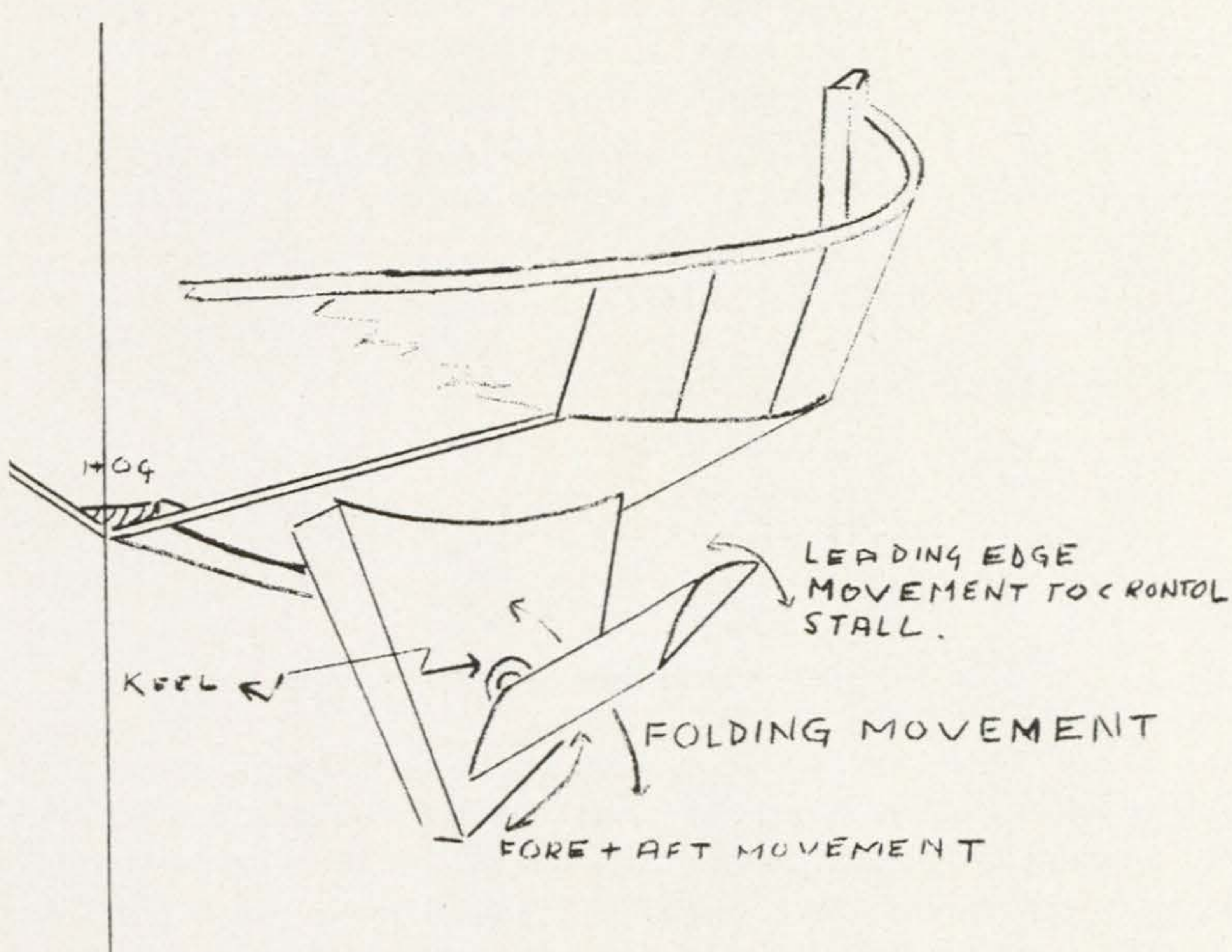
An average cruising speed between 8 and 12 knots.

Sea kindliness.

Beauty of line.

No ballast. Flush decked for simplicity of construction.

Shallow draft and ability to sit upright when dried out.



A dinghy-type hull with its flat floors seemed to meet some requirements—ample beam, stability, roominess, shallow draft, remain upright on the mud. But it ruled out double ended construction (economical and simpler), would pound in a seaway and in a size could be hard to drive to windward, leeway.

Bilge keels would cope with leeway and provide some roll damping. Hydrofoils attached to the bottom of the bilge keels, jutting outboard, would provide lift with added windward ability, and roll damping qualities.

Hydrofoils to be of asymmetrical shape and filled with polystyrene to provide added buoyancy; variable elevation and angle of incidence, able to fold up under the hull when taking the ground. All movements controlled from inboard.

I enclose crude explanatory drawings which reflect no relation of size to each other.

Hull form to have initial stability to compensate for loss of hydrofoil performance at low speeds and to prevent a knock-down in a squall.

I doubt my ability to design such a craft, having no idea how to go about calculating hydrofoil shapes, size, section or the stresses and strains on bilge keel, fastenings and hydrofoils.

Whether such a hull could be made seakindly, weatherly or driven at speeds up to 15 knots I don't know, and I don't suppose I will ever take this configuration beyond the dream stage—" La vie n'est pas si on ne croix pas au chemere."

Would you or any other A.Y.R.S. reader care to comment ?

P. U. Young.

P.O. Box 1205, Chingola, Zambia.

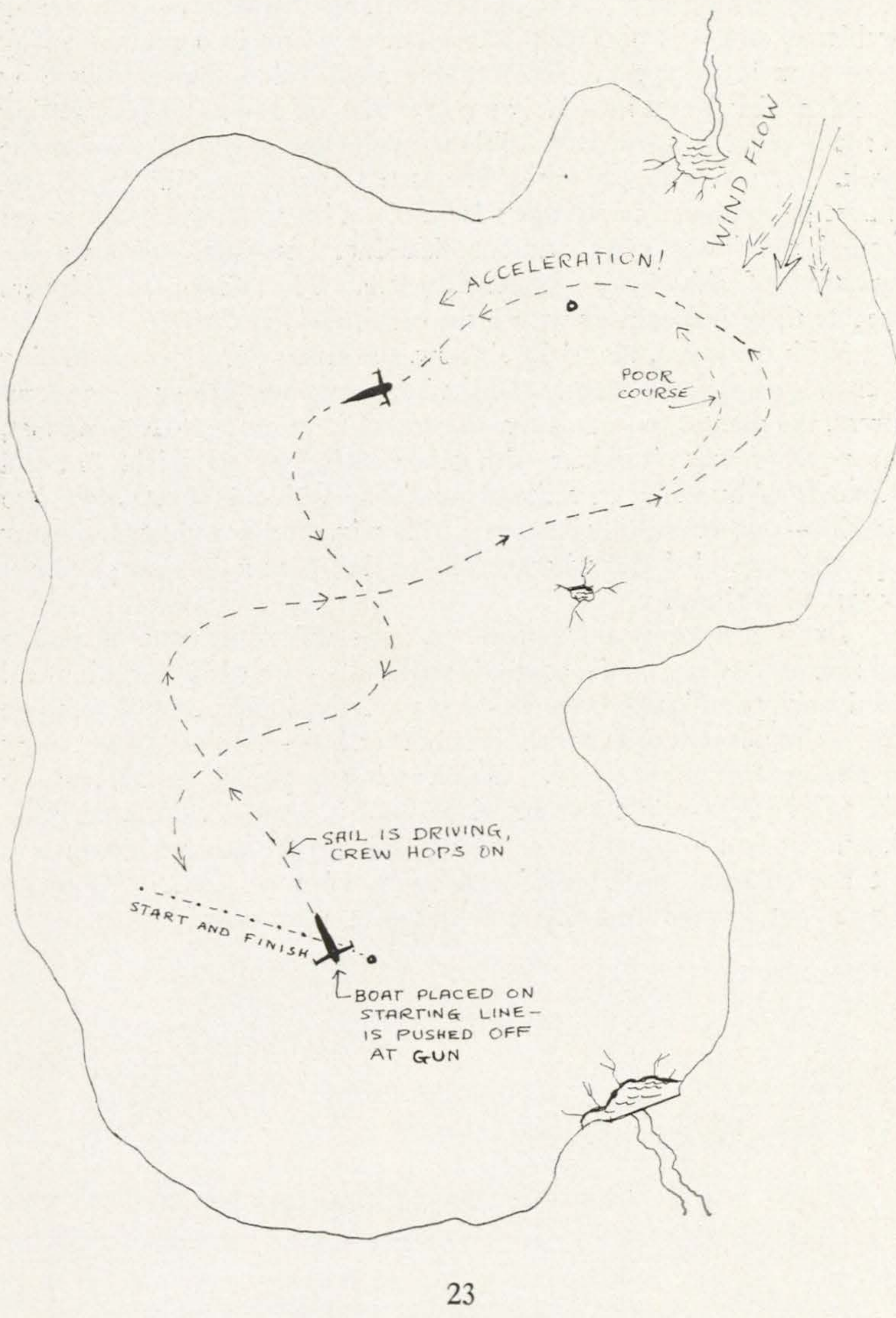
HIGH SPEED SAILING RACES

BY

R. L. Andrews
25, Auduben Drive, Ossining, N.Y. ,U.S.A.

If we in the A.Y.R.S. ever do succeed in developing watercraft able to sail at 40 to 60 knots, then races between such craft will certainly not resemble our present dinghy races but will probably be run off much as ice yachts race today. These craft almost never sail a triangular course, but rather are run on a two-leg arrangement around just two marks which are set in a line as close as possible to the wind direction. The start is made at the leeward end and the race is run straight up-wind and then return down-wind—and on around and around counter clockwise for two or three laps. The finish line is at the leeward end.

Since every boat is always tacking—upwind or down—and some are moving a good deal faster than others—the scene is soon a seeming wild see-sawing of sails whizzing back and forth accross the ice. Speed is all important, so that each skipper concentrates on getting his boat moving fast, and there is very little of bunching up at any point. The most difficult leg to sail is the down-wind one, particularly if the true



wind direction is tending to swing to and fro, for one may find one's craft coasting to a stop in a seeming calm—sail slack—while other craft shoot by fast. Or one may keep going fast but at too wide an angle from the down-wind mark ! Visual air flow indicators are helpful but often one swings around an arc to find the " power angle " again—and there is very little question when one does find it for accelleration is immediate and considerable.

Approaching and rounding the turning marks make interesting problems, and it is obviously important to round in a gradual swing so as to maintain speed. Upwind one might sail a shorter course by pinching a bit, but it invariably pays to drive off and move fast, getting as much boost in speed as possible as one bears offwind in passing the mark. And on a breezy day if one sails a fast down-wind leg, it can almost be necessary to set one's ice brake a bit to slow enough to get around the lower mark without skidding. At such moments the sensation of side forces is considerable. The champion skippers execute these maneouvers with great smoothness and style.

With the speed, the tricky air flow, the racket of runners thumping over rough spots, the lurching of the boat responding to such powerful forces, the mental concentration demanded to keep the boat going fast, the right of way situations with other craft, and the plain physical demands of bundling in a literal hurricane with the sheet while also steering—one can readily become a trifle mixed up as to just how many laps one has sailed and whether this or that boat is behind you or is almost a lap ahead.

But it is exciting and tremendous fun—and at such speeds a three lap race around a two mile course is sailed in a matter of a few minutes ! So the skippers " park " the boats in a cluster, jump out and compare notes, and perhaps tinker with their boats a bit—and then all are ready to line up for another race. Could racing hydrofoil sailing craft be like this ? I have just one question about it, should we ever develop them. Except in a good smart wind, an ice boat takes a hard push to get started—and restarted if one loses drive en route. Have we figured out how we are going to do this with water craft ?

THE *SHINGLE*

BY

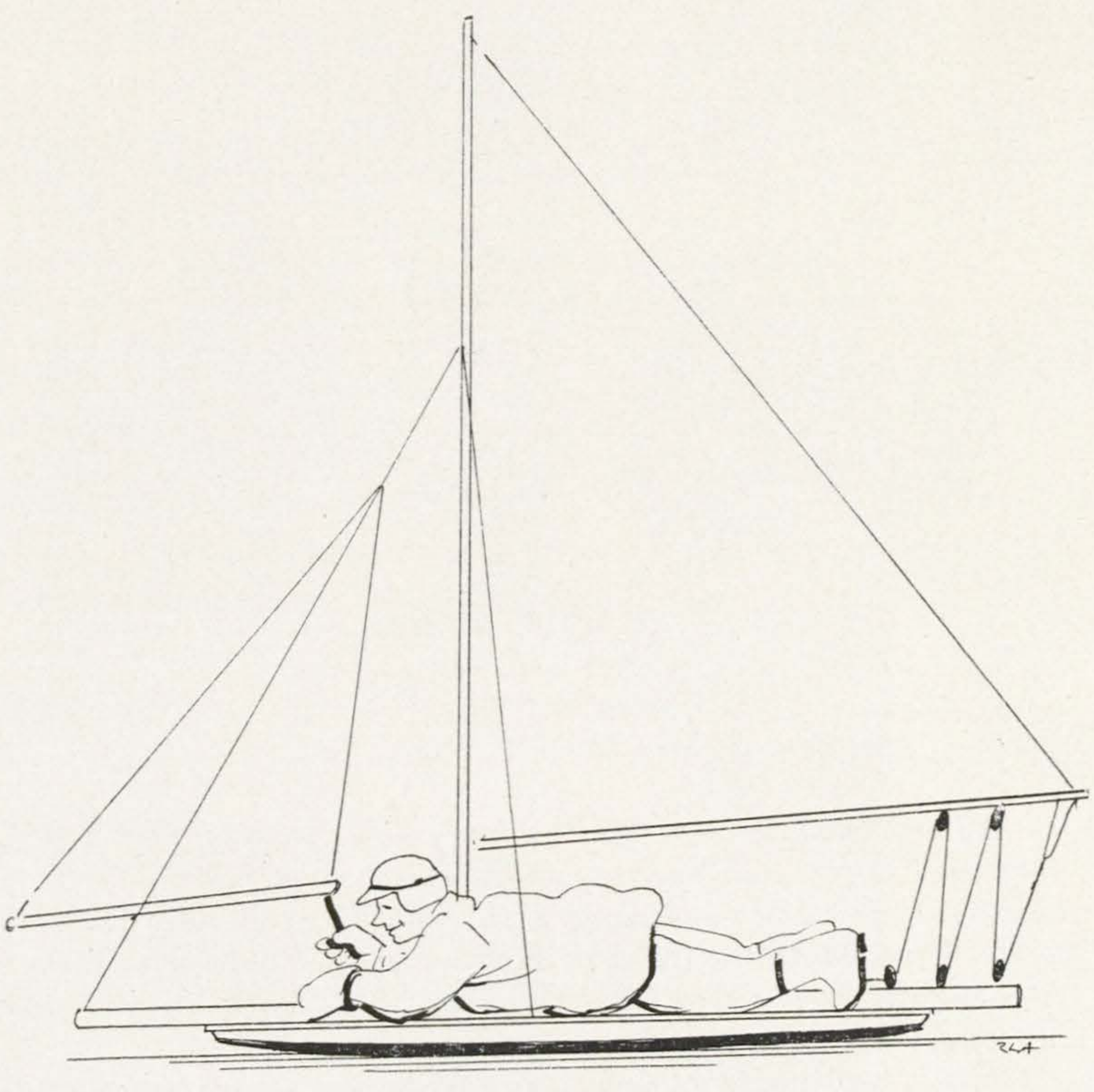
Richard L. Andrews

25, Auduben Drive, Ossining, N.Y., U.S.A.

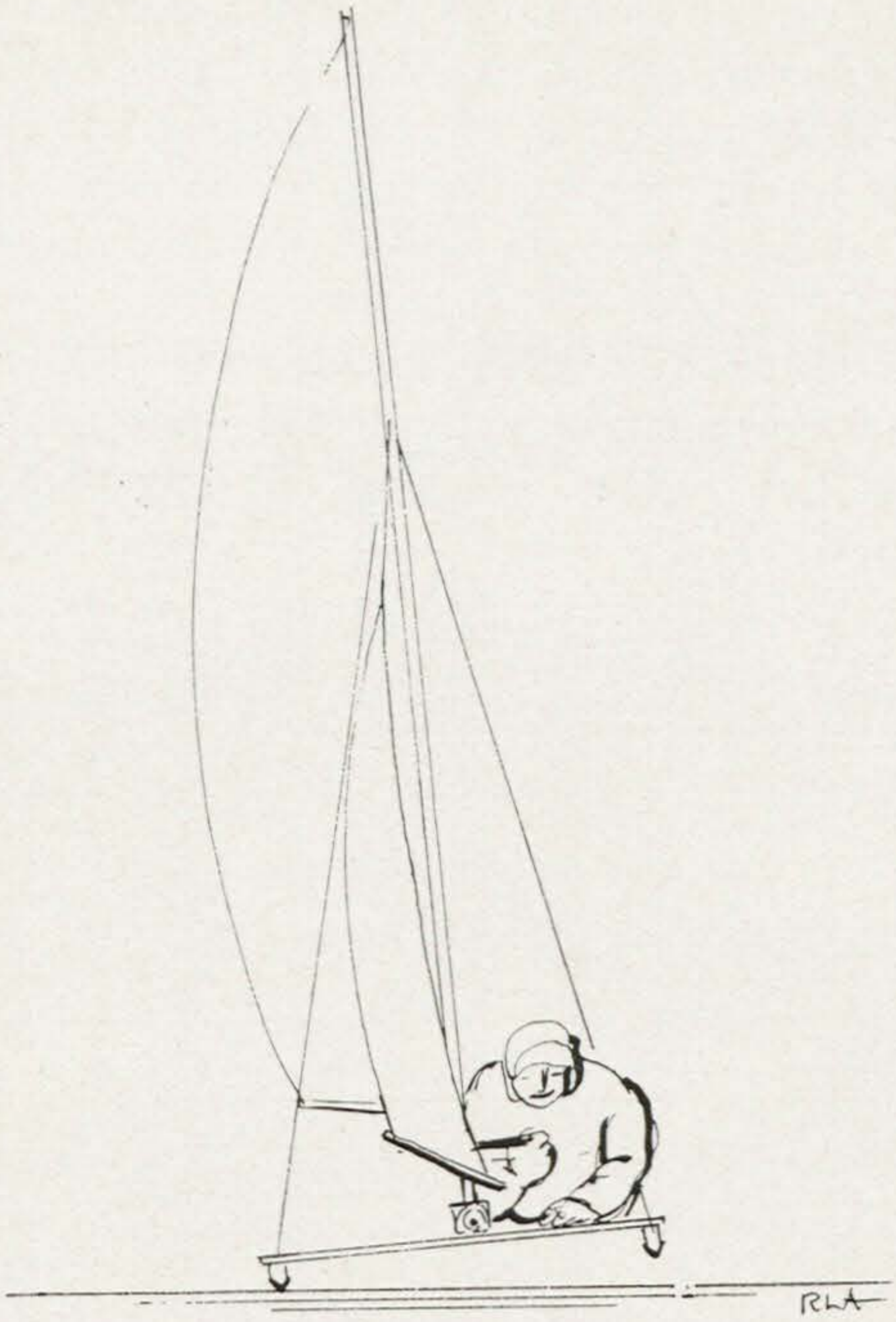
A new type of ice sailing craft on American ponds is the little *SHINGLE*, which might be described simply as a sloop-rigged sledge—

steered by the jib. The two runners are well rockered so that a movement of crew weight forward or aft shifts the balance of centres of the boat; one moves aft to bear off and forward to round up. But steering a steady course is truely done by the trim of the balanced jib and this writer found the steering jib to be sensitive indeed and the little craft great fun to sail.

As this craft customarily sails at speeds up to 40 knots, one is lead to wonder if some catamarans or hydrofoil craft might not handle very well with a " jib rudder "—saving the drag of a rudder blade immersed in water.



The SHINGLE



The SHINGLE

A KITE RIG

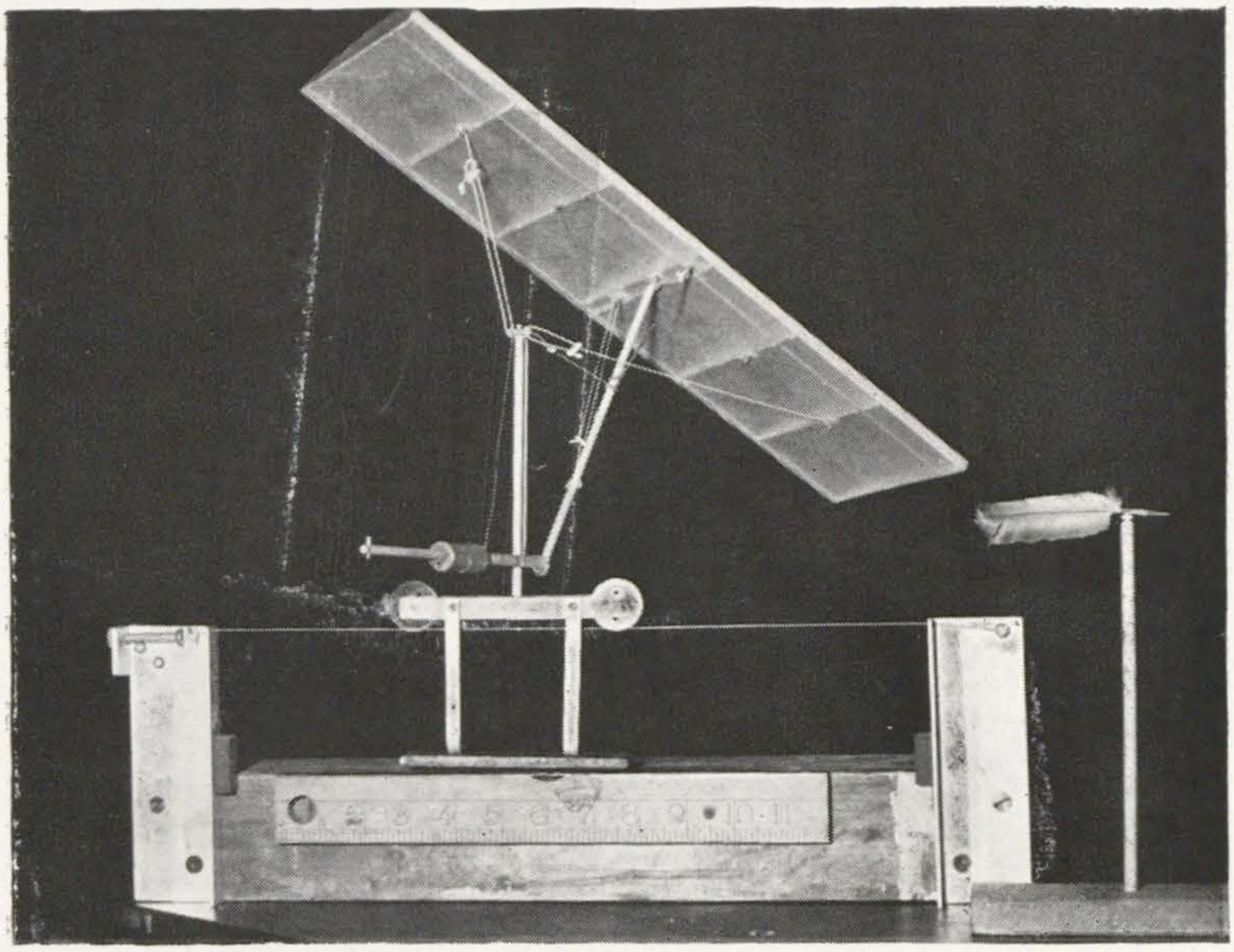
DEVISED BY

GEOFFREY MILES
26, Southampton Road, Fareham, Hampshire.

We have examined several kite rigs of various types in the A.Y.R.S. None have as yet gained acceptance aboard boats at full scale though there would be tremendous gains if one could be made fully practical. Surely, for example, the ultimate in sailing speed would come from a foil supported boat towed by a kite either free flying (which your Editor supports) or a rig such as the one described here.

The first photograph shows an experimental set up using a two wheeled trolly suitably ballasted running along a taut piano wire. This was placed in front of an open window with the upstairs windows on the other side of the house also being opened, thus creating a draught and a primitive wind tunnel. Because the sail is placed to leeward of the wire, there has to be a counter-weight to windward to keep the " boat " upright and the photograph shows this clearly.

Several soft sails and aerofoils were made and tried out. They all drew the trolley to windward but the best results were obtained with a Gottingen 387 section which was chosen because it was easy to make and because it has the convenient characteristic of giving its great lift/drag at zero angle of incidence.



Geoffrey Miles' Kite rig in his "Wind tunnel"

Results. It was proved that, providing angles B and I in Fig. 2 were in their right relationship, it was possible to attain forward motion with angle C (course angle) at 45° and with no heel and the sail would automatically adjust its angle to the boat to suit changes in wind direction. Angle I proved to be very critical. A sudden change in wind direction caused an angle of heel, but only until the sail had adjusted itself. An unexpected result was that when " taken aback," the sail would find a position of equilibrium on the other side of the mast and the whole thing remained stable.

Free Sailing Model Tests. The aerofoil had 90 sq. in. of area so the model was made 12 in. long, giving the same sail area to length ratio as a 12 ft. National dinghy. The rig was now installed in the model, the counter-weight being contained within the boat. The position of the mast and centreboard were adjustable and by mooring the model in a basin of water by threads from a point amidships, all was checked for balance before committing to the open water. The centre of gravity was found to be at deck level.

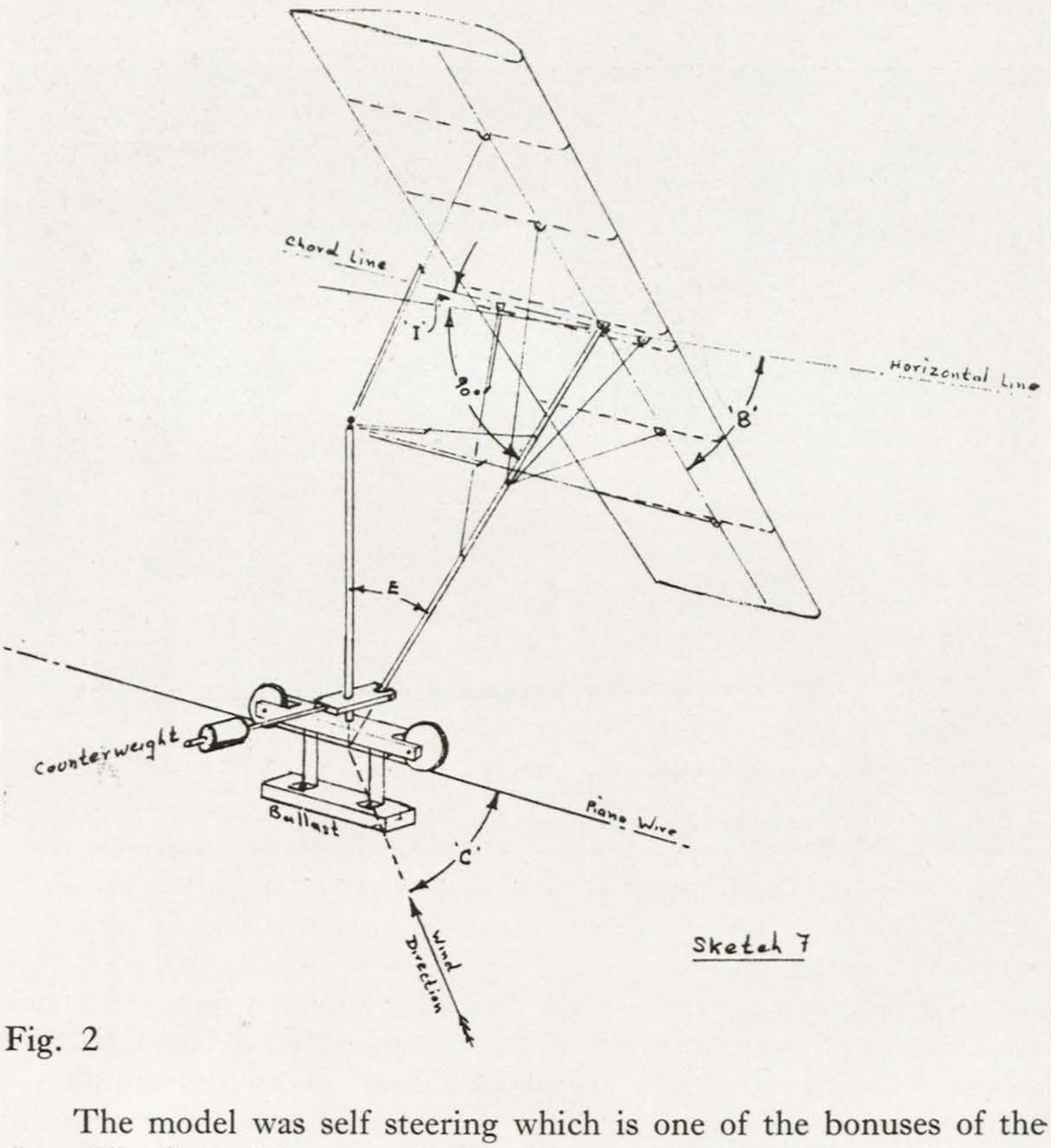
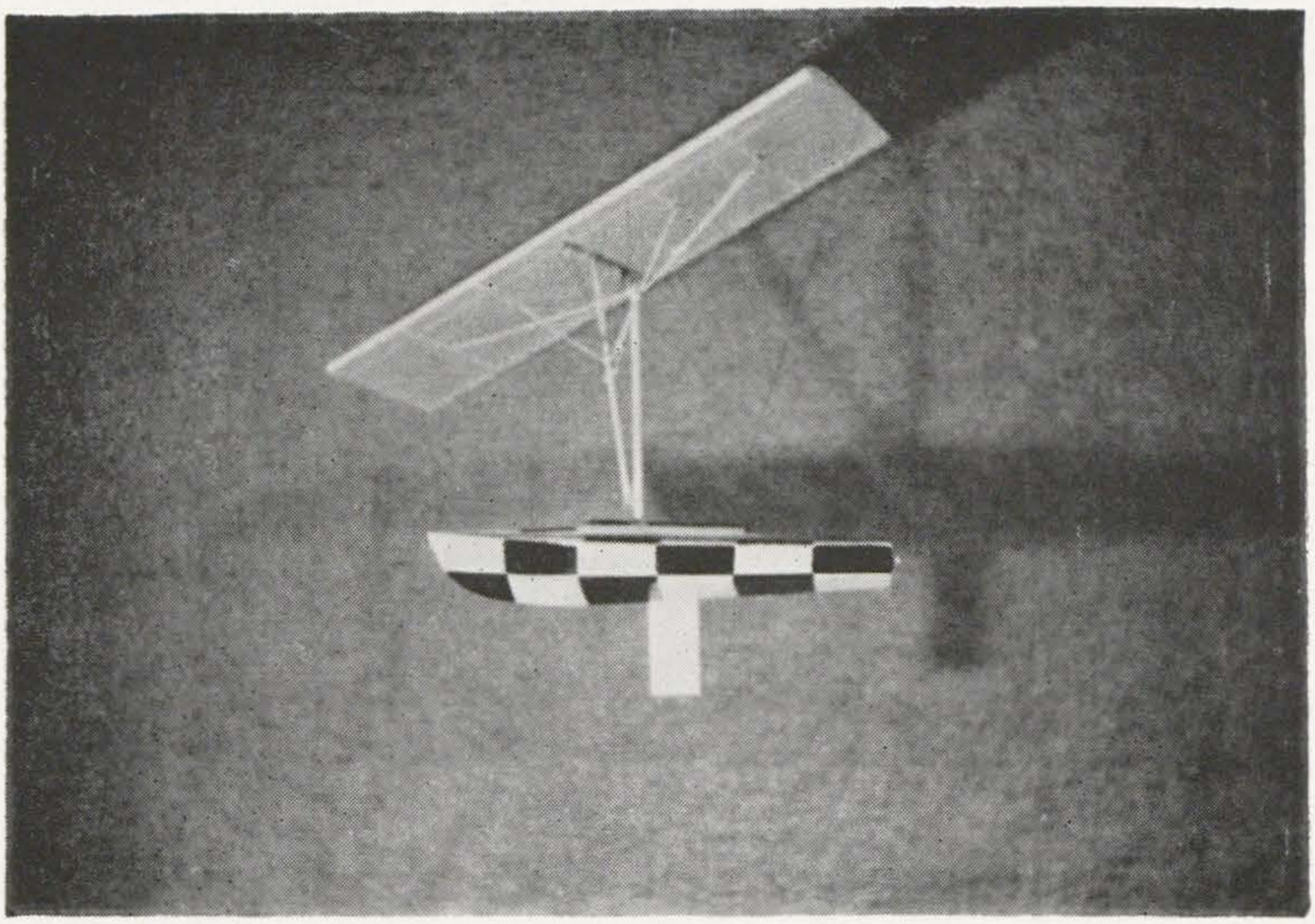


Fig. 2

The model was self steering which is one of the bonuses of the rig. The first trial was made in a light wind and was uneventful; later the wind freshened and her ability to stay upright and to steer a straight course began to be realised. In very strong winds, the ability of the lifting force to reduce displacement became noticeable. She began to plane and in broken water, one could see right underneath the hull between the waves. The only time she was in trouble was when taken aback; usually after being in the lee of a moored boat. She would slowly gather sternway, then swing round violently and either capsize,

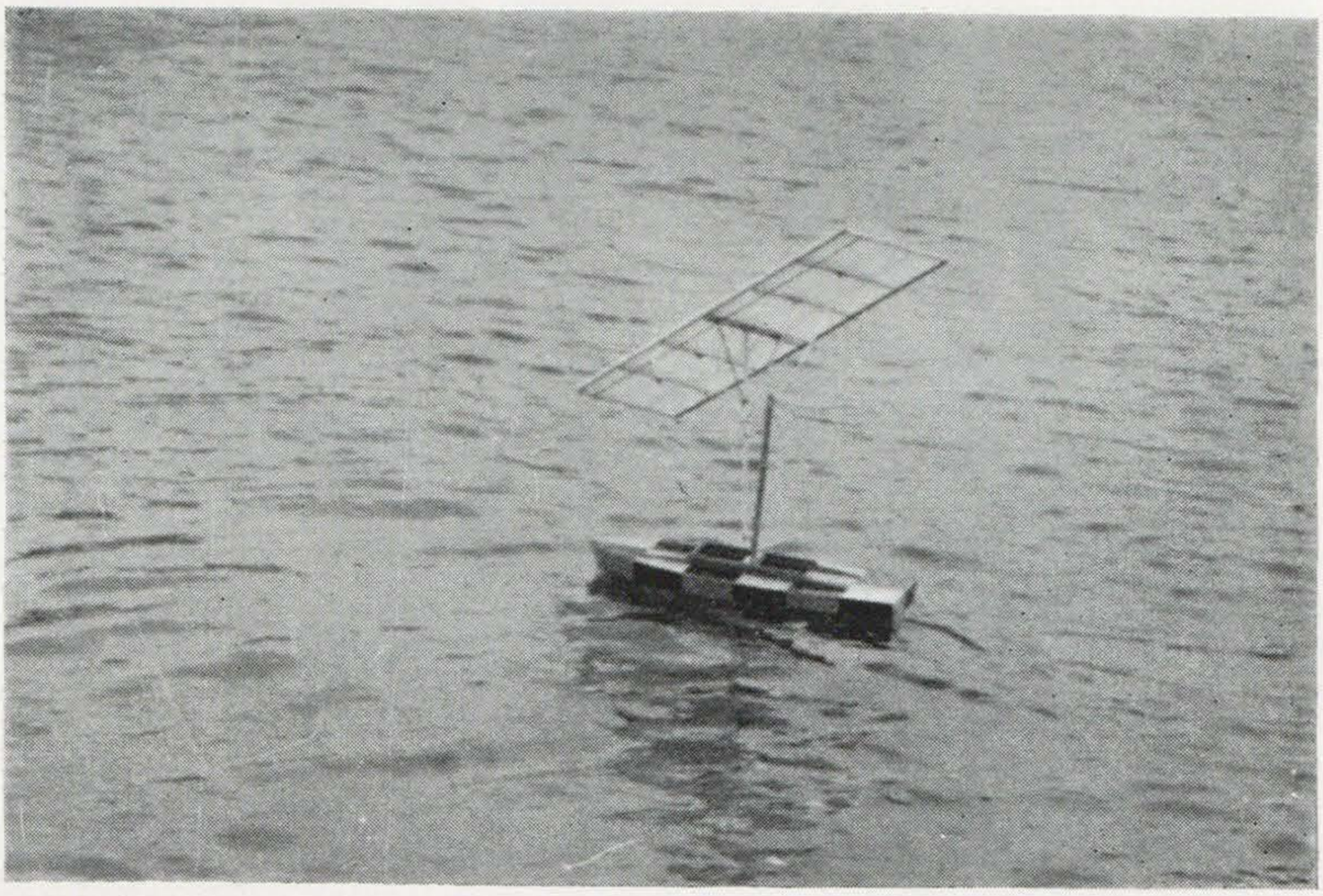


or heel violently before settling down on the right tack, or even continue around and make several revolutions. On a few occasions, after capsizing, she would actually right herself.

Eventually, an attempt was made to sail her in a really strong breeze (dinghies were planing). She was launched in smooth water in the lee of a pontoon. She got on a plane as soon as the wind reached her, lept right out of the water as soon as she reached the first wave and " crashed." Repairs were not completed in time to repeat the experiment.

The Full Sized Design. When we start to design a full sized boat with this rig, we shall meet all sorts of complications not found with the model. Firstly, there is the offset weight of the gear aloft but normally none of the members is highly stressed so that it could all be lightly constructed. Do we use the weight of the crew as the counter-weight ?

The second major problem is what to do with the sail when we take it down. It would, of course, be possible to go back to a non-rigid sail set on a long yard and hauled out by halliards in the normal way but the aerofoil will give the same lift for less area . There is another advantage to the aerofoil in that if allowed to pivot about a point near its leading edge, it will automatically assume an angle of zero lift and



The kite rig—sailing to windward

minimum drag, whereas the non-rigid sail flogs about and gives quite a lot of drag.

The third consideration is that it will demand a completely new technique of sailing; something like sailing a square rigged ship. In going about, for instance, one will have to let go the sheet and the weather brace, put down the helm, then haul in the new weather brace and the sheet. In reaching to windward, one will merely have to steer a course to follow the sail, taking care not to " stall " the keel. Whether this form of sailing will be as emotionally satisfying as the other sort is also an open question.

AERODYNAMIC BALLAST

BY

JOHN MORWOOD

The first system of aerodynamic ballast sent in to the A.Y.R.S. was by Walter Trentin in 1959. This consisted of two aerofoils at right angles to each other, one of which was vertical and the other horizontal. The vertical aerofoil acted as a sail and drove the boat. The other one stretched to leeward and its lift kept the boat from capsizing. At the end of each aerofoil was a short hydrofoil to keep the end of the horizontal aerofoil from dipping in the sea. On putting about, the vertical aerofoil fell down on the water and became horizontal, while the other one now became vertical and acted as a sail. It may be doubted if the system as described would have worked but it is from such ideas that the A.Y.R.S. develops workable systems.

We next had the account of J. S. Taylor's *BOTJE III*—a Micronesian outrigger with a float shaped like an aerofoil and slopping towards to main hull to leeward. Taylor was the first person to our knowledge to use the term " Aerodynamic ballast " and this has obviously, from the letters we have got, aroused great interest. The principle here is that the float when in the water is " stalled " to the windflow over it and therefore produces very little downward acting force. If it rises, however, it should become unstalled and therefore should produce a righting force from the wind flow across it. We have not, so far, had a photograph of *BOTJE III* or an account from anyone as to how she sails so again we cannot say that the system is perfect as drawn.

Possibly starting from these two ideas, General Parham now suggests and has taken to the model stage, an even simpler form of " aerodynamic ballast " by the use of " Anhedral " or sloping down wings which gives a righting moment by increasing the angle of attack of the lee wing and decreasing that of the weather wing.

Having now achieved the basic need for an invention—knowing what is required and how to do it, a host of new applications for the principle of " aerodynamic ballast " come to mind, mostly concerned with making the forces act upwards, rather than downwards. I feel sure that we shall now have some interesting ideas from our members.

THE SWEEP

(A foil borne craft with wingsails)

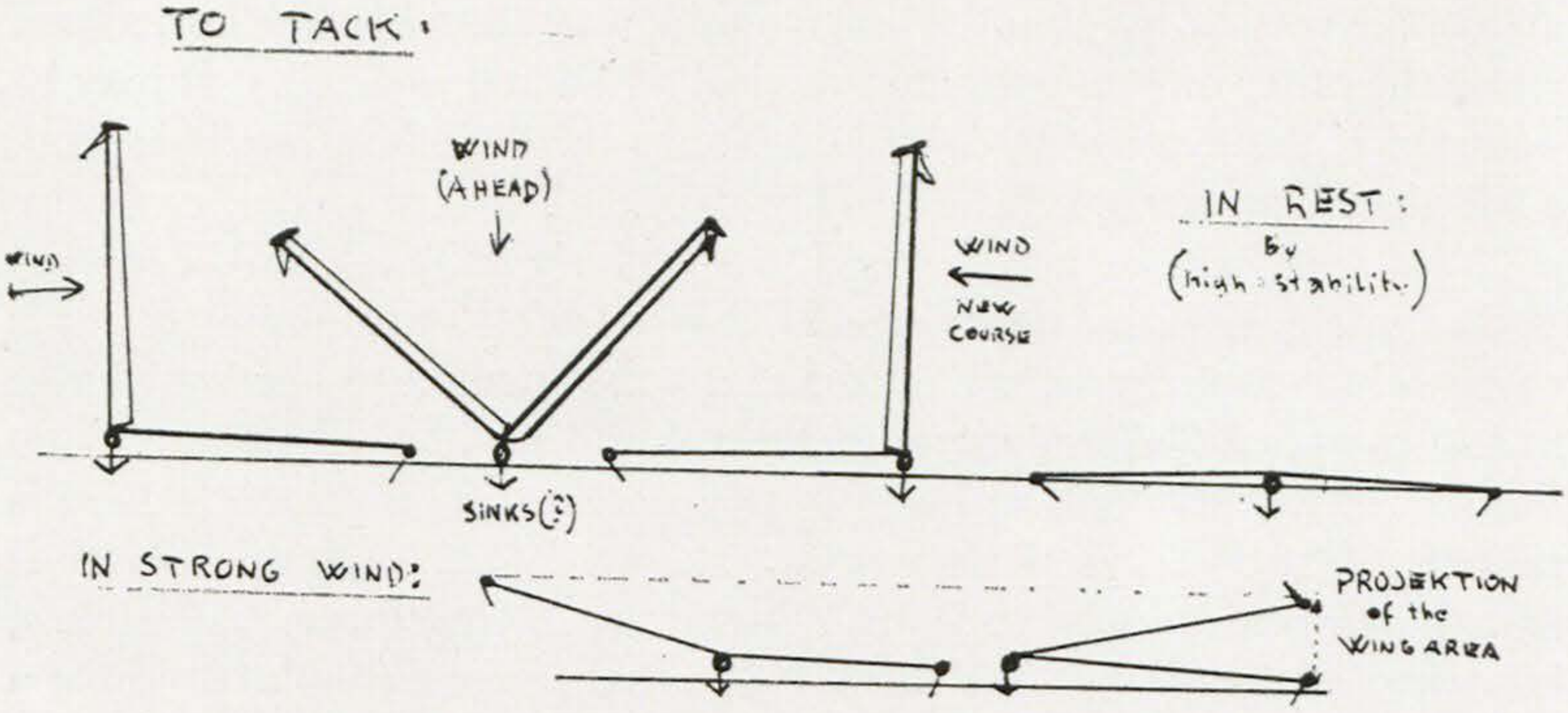
BY

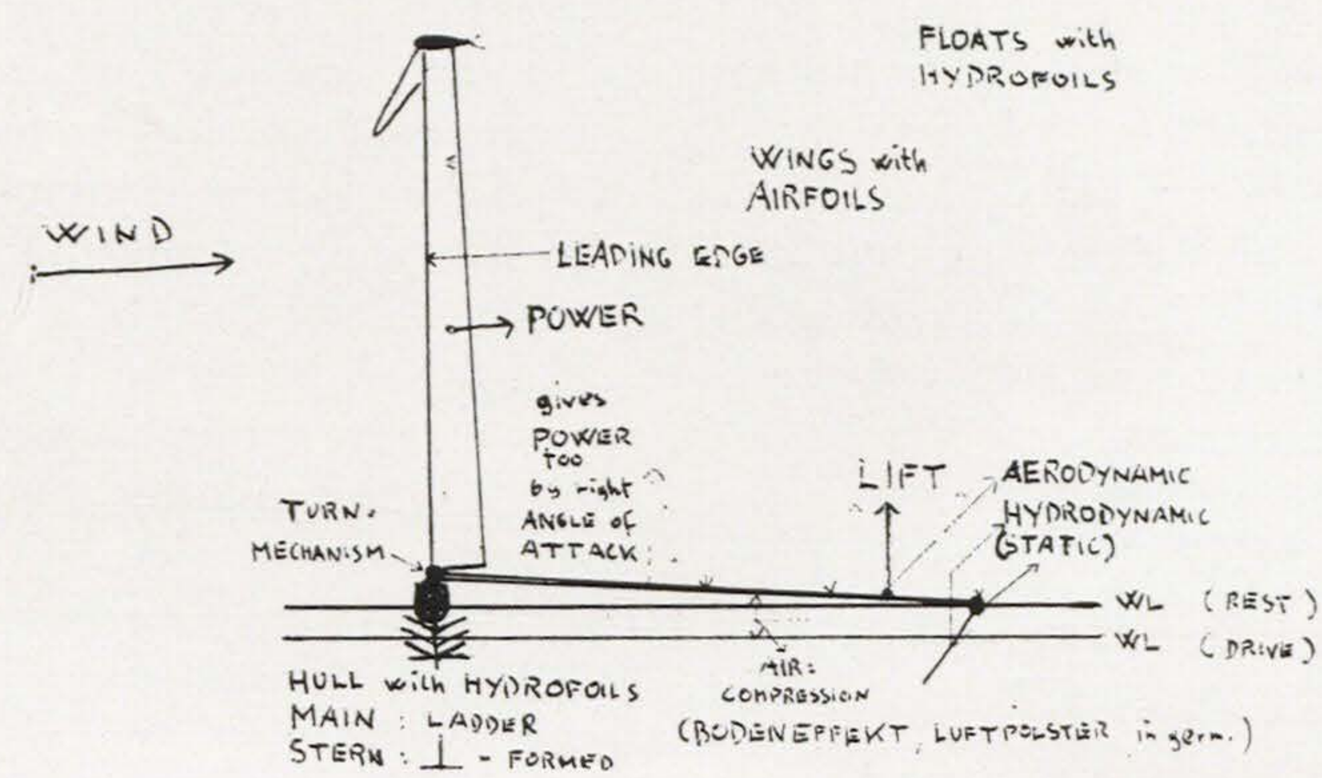
WALTER TRENTIN

Leopoldsdorf/Wien, Oberlaaerstrasse 20, N. Austria.

Ed.—Walter Trentin sent in this article in December, 1959 *but somehow it was not used and was filed till interest was aroused in " Aerodynamic Ballast." This shows* (*a*) *how wrong I was not to have published it at the time and* (*b*) *how ideas can grow from our membership. Perhaps, however, the challenge came from Taylor's cryptical mention of " aerodynamic ballast " and this might have been more stimulating than this article published earlier.*

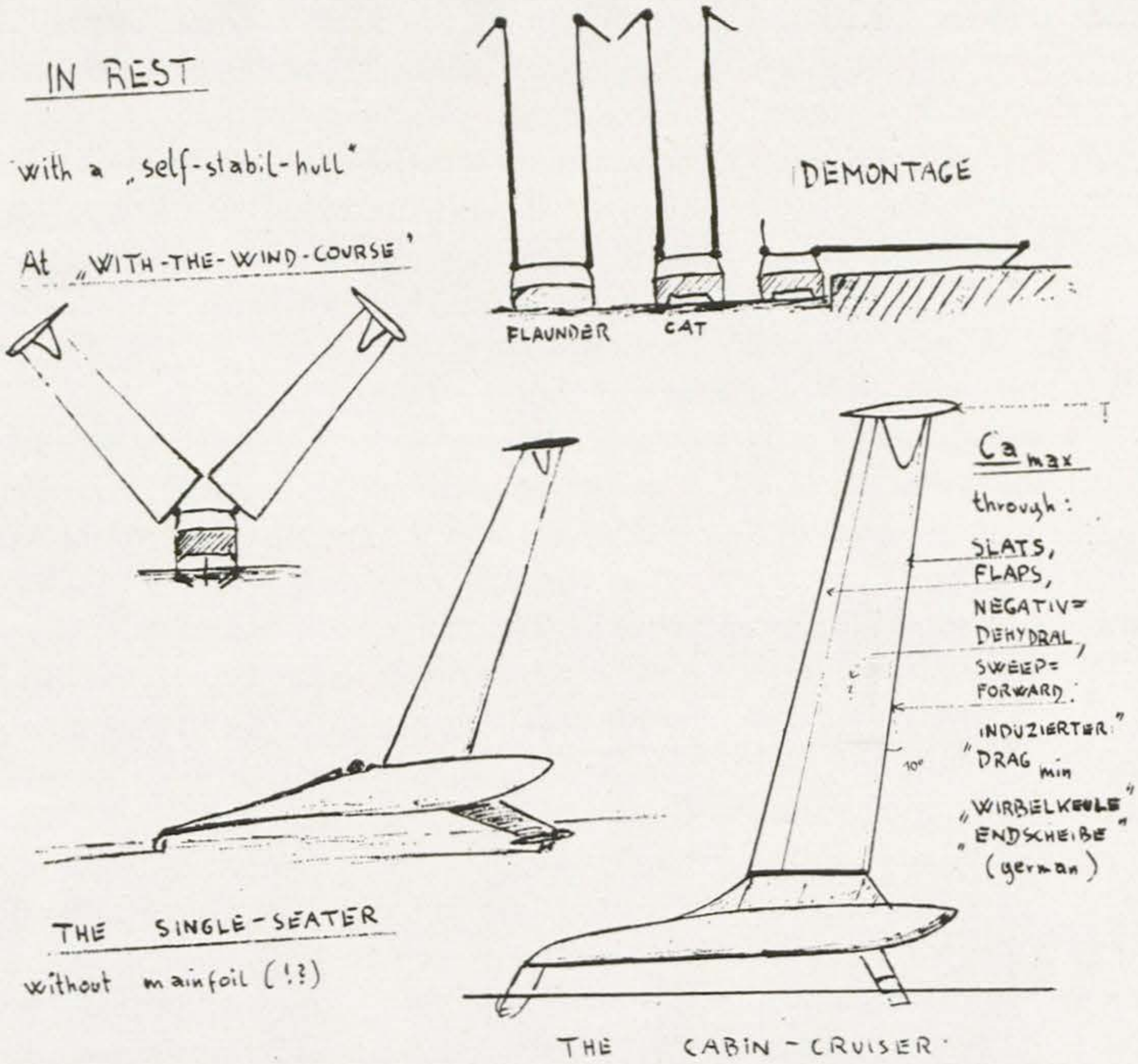
Introduction. To stabilise a sailing vessel aerodynamically is a fascinating thought. The method described as follows is a suggestion only but it is just possible that it could be realised in practice.





The Suggestion. A sailing boat is imagineable which has two stiff wings, each built as an airfoil, thick and asymmetrical. At moorings, such as a craft would have both wings horizontal and look like a glider without a tailplane. Each wing would however, be able to lift up vertically and twist about its long axis.

Sailing. When sailing close hauled the weather wingsail is allowed to rise into the vertical position and produces the power to drive the boat ahead. The horizontal wing produces the lift to stabilize the system. The angles of attack of each airfoil are variable so that the lee righting airfoil might be kept free of the water but a float and hydrofoil placed at its end might be necessary. On tacking, the wings become changed. The wing which was vertical before is now parallel to the water surface while the other becomes vertical and drives the boat.



Advantages.

(1) Very efficient asymmetric sail.

(2) Low windage. There are no inefficient parts in the construction.

(3) Reefing is possible by altering the slope of the driving wingsail as well as by altering the angle of attack.

(4) Highest mooring stability if both wing-tips touch the water. It then looks like a dismasted trimaran.

Disadvantages

(1) Very expensive to develop and to build in the best size.

(2) Problems similar to helicopter wings.

(3) Not handy in harbour.

NEW THOUGHTS ON FAST SAILING

BY

MAJ. GEN. H. J. PARHAM
Hintlesham, Ipswich, England

It has long been known in flying circles that if one flies a low wing monoplane or glider just above the ground, a marked change in flying characteristics occurs. The aeroplane " floats " on, apparently effortlessly for considerable distances before deciding to land. The phenomenon, known as " ground effect," is due to a change in pattern of the airflow over and under the wing caused by the presence of the ground (or water) close beneath it. Lift is increased and drag greatly reduced—and this occurs even if the wing is of very low aspect ratio.

Efforts are now being made to apply these principles to cushion craft (A.C.V.) and these are termed " Ram Wing Craft." Experiments in this field seem to be fairly promising.

It seems that here is a possible way of sailing faster. If one took a long thin hull (say of a C Class catamaran) and laid across it a fabric wing of a span equal to about 2/3 of the hull's length, one would have a light structure relatively free of the high tortional stresses of a catamaran but yet giving a broad base for the attachment of shrouds.

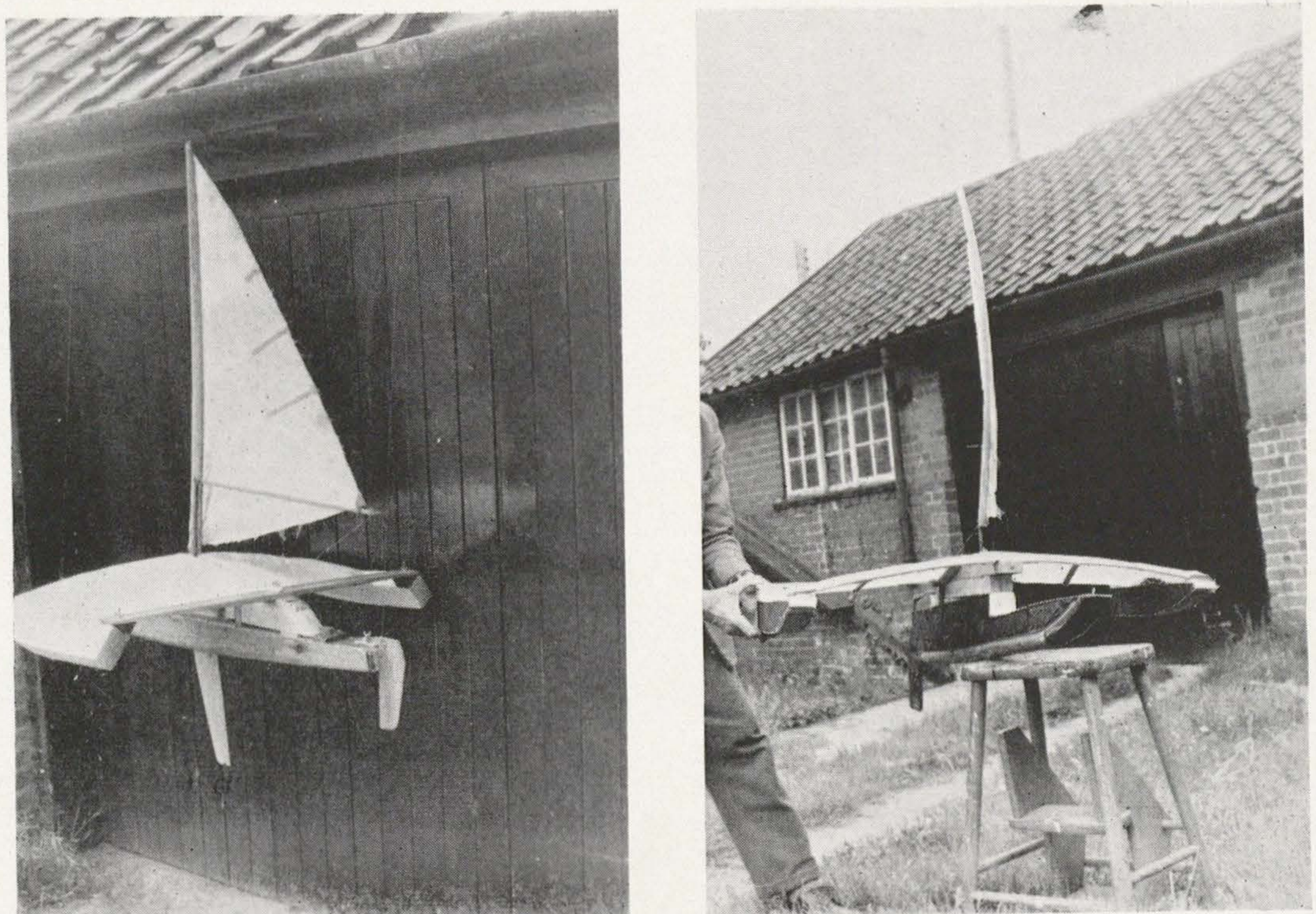
A fast craft, sailing hard to windward in a good breeze w ould be meeting a relative wind of near 40 m.p.h. at an angle of not much more than 20° off the bow. In other words, the " wing " would be yawed 20° off the relative wind.

Now, the old, unflapped light monoplanes (which were so susceptible to this " floating," if one brought them in a shade too fast) landed at about 30 to 35 m.p.h. Their wings were carrying about 6 lbs. per square foot of area. A less efficient, single surfaced, fabric wing, yawed 20° to the wind ought to lift at least 2 or 3 lbs. per square foot in a 30 to 35 m.p.h. airflow.

Given a wing span of 18 ft. and an average chord of 7 ft., the area would be 126 sq. ft. The lift might therefore be around 300 lbs. available to reduce displacement by that amount. Hull drag and wave making would be reduced at the expense, of course, of air drag. But a nicely arched " wing " would probably have less drag than the rather messy bridge structure of a racing catamaran, which produces no bonus in the shape of lift. It would be necessary to have wing tip floats but these would have a beneficial effect on the aerodynamics of the craft by reducing end losses to some extent.

Now, fundamentally we are out to reduce *displacement* and *drag*. Any saving of weight helps greatly and if one can get away with using a lighter crew and if one can sail for considerable periods with both tip floats clear of the water (i.e., a 'tight rope act' on the slender hull) one is in a fair way to going faster.

The second suggestion is therefore to use the wing not only for lift but for balance. One must therefore get the leeward wing to lift more than the windward one. This can be done either by forward sweep which allows the lee wing to meet the airflow at right angles to it while the windward one meets it at a less efficient angle or one can use



Gen. Parham's aerodynamically stabilised trimaran anhedral (or downward droop). The latter is easier constructionally and results in the lee wing meeting the relative wind at a bigger angle of attack than does the windward one. As a result, the total wing lift is offset to leeward of the hull and will help the crew balance the craft by giving an upward force (varying with the wind strength) to supplement the crew's weight sitting out to windward. It should therefore be possible to control quite a large sail with a light crew.

Such then, is the outline of this new proposal. As regards practical work on it, it has not yet got beyond the model stage but results with these are encouraging. The models *will* sail to windward and for periods of some seconds at a time will maintain a horizontal trim with both wing tip floats clear of the water with a weight, representing the crew " sitting out." In this state, there is a noticeable increase in speed. The models are seaworthy on all points of sailing though of course their " raison d'etre " can only show itself close hauled.

The whole idea is fascinating and should be relatively easy to pursue to full scale. The " wing " would, I suggest, be a fully battened Terylene (Dacron) affair and to avoid twist I would myself use the *curved* rather than the straight leading edge spar therefby removing all twist from the wing as I have done for years on my bent mast sails.

The photographs show one of a series of models made and nicknamed T.S.R. 3. They are all 1/6th scale models of a full sized craft based on a 24 ft. C Class hull. One model has already sailed a total of several miles on the river Orwell, pursued by our catamaran *BELINDA ANN.* I am too old to pursue the matter full scale but very much hope that someone else will. I can think of few experiments promising such fun and interest at such a relatively cheap cost in terms of money.

BOTJE III's " AERODYNAMIC BALLAST "

BY

TERENCE SURMAN

36, Wetheral Drive, Stanmore, Middlesex, England.

The following is a possible explanation of the forces acting upon J. S. Taylor's flying proa design *BOTJE III* (A.Y.R.S. No. 47).

When floating in water, the float has a downward force acting on it due to the wind being deflected upwards. However, the " aerodynamically developed ballast " Taylor refers to is, I think, what he means by the vertically downward acting lift force generated from the windward float as it leaves the water which counteracts the heeling force on the sails. But there is also a drag force generated which is tending to heel the boat.

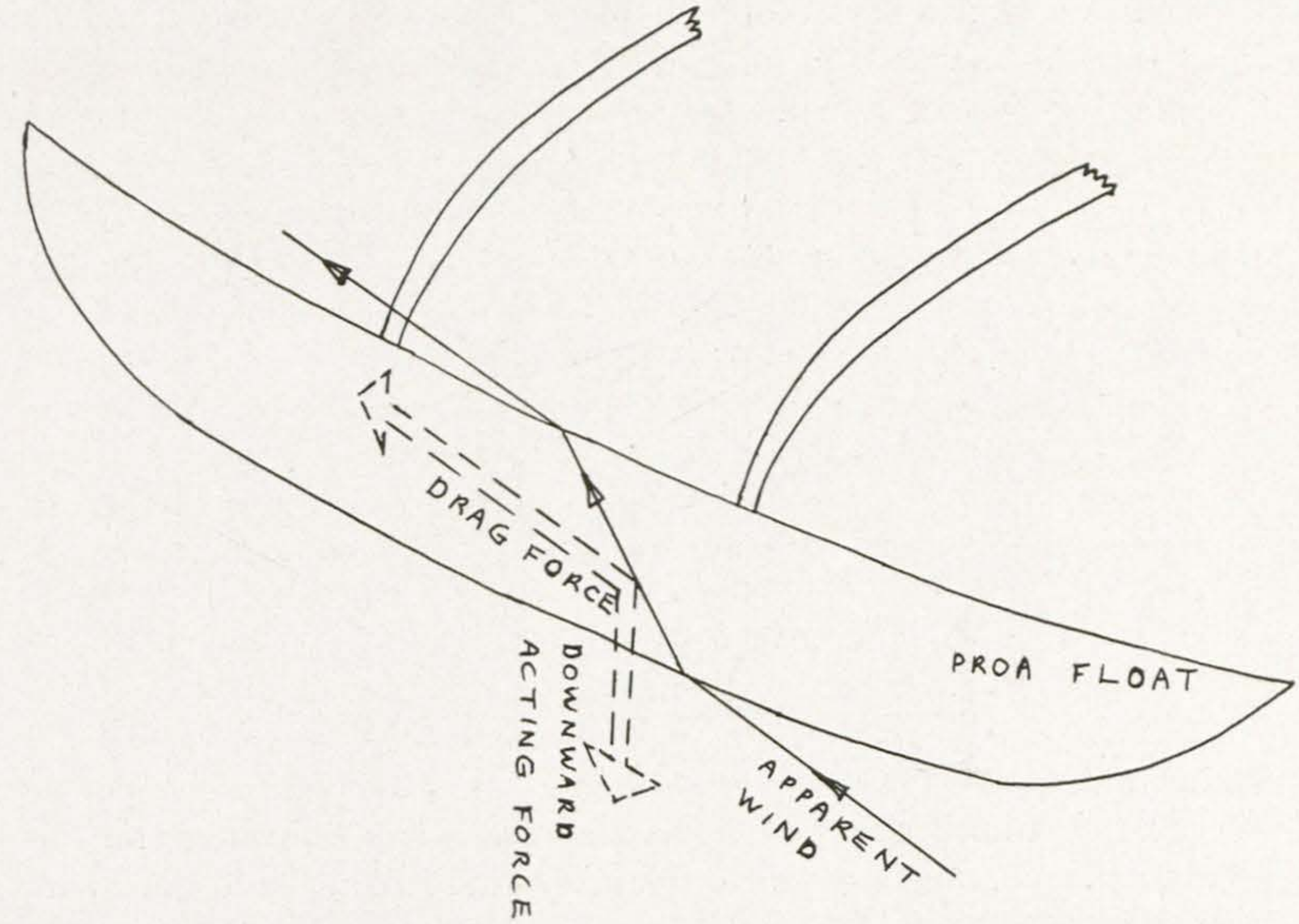
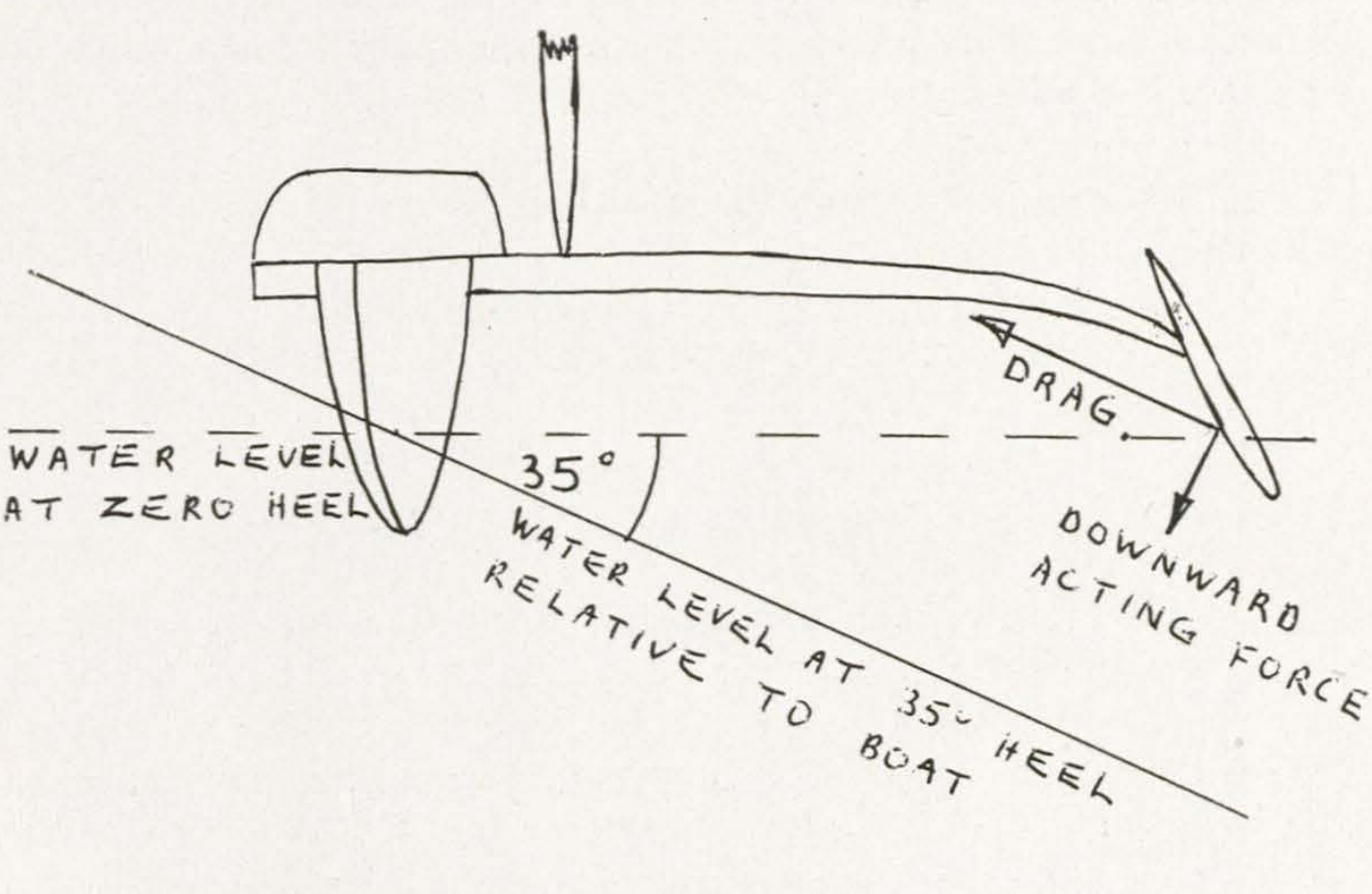


FIG. 5.



END VIEW OF BOTJE III

FIG. 4.

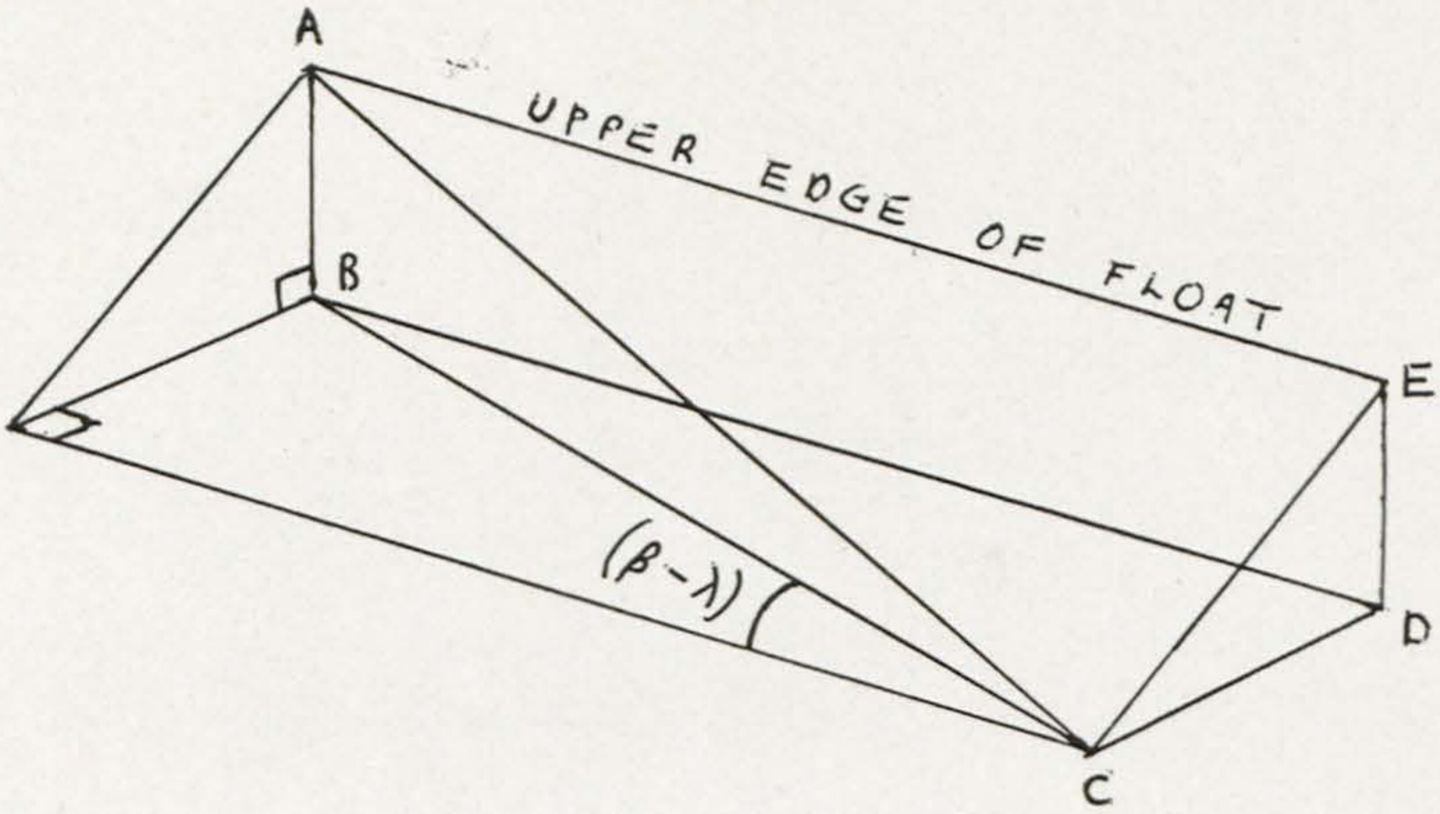


FIG. 1.

The proa heels about 5° before the float leaves the water and this gives the float an angle of 60° to the horizontal looking head on. But, with an apparent wind of, say, 30° to the fore and aft line, the angle of incidence of the float is 41°.

The maximum heel angle as shown in Taylor's fourth diagram would be about 35°. This gives the float an angle of 30° to the horizontal and a 16° angle of incidence. The derivation for the angle of incidence is shown in Fig. 1.

$$AB = ED$$

$$\text{Sine } (\beta - \lambda) = \frac{CD}{BC}$$

$$\text{Therefore } \quad BC = \frac{CD}{\text{Sine } (\beta - \lambda)}$$

$$\text{Tan } \quad \angle ECD = \frac{ED}{CD}$$

$$\text{Therefore } \quad ED = CD \tan \angle ECD$$

Where $(\beta - \lambda)$ = apparent wind angle to boat.
$\angle ECD$ = angle of float to horizontal.
$\angle ACB$ = angle of float to the apparent wind (angle of incidence).

$$\text{Tan } \angle ACB = \frac{AB}{BC} = \frac{ED}{BC} = \frac{CD \tan \angle ECD}{\dfrac{CD}{\text{Sine } (\beta - \lambda)}} = \tan \angle ECD \text{ Sine } (\beta - \lambda)$$

Therefore, when $(\beta - \lambda) = 30^\circ$.
At 5° of heel $\angle ECD = 60^\circ$, $\angle ACB = 41^\circ$.
At 35° of heel $\angle ECD = 30^\circ$, $\angle ACB = 16^\circ$.

The actual values of the coefficients would depend upon the shape of the airfoil used. However, comparing typical C_L and C_D curves, for varying angles of incidence as in Fig. 2, one can obtain some approximate proportions. C_D will be roughly four times the C_L at 5° of heel. At 35° of heel, C_D is only two thirds of C_L.

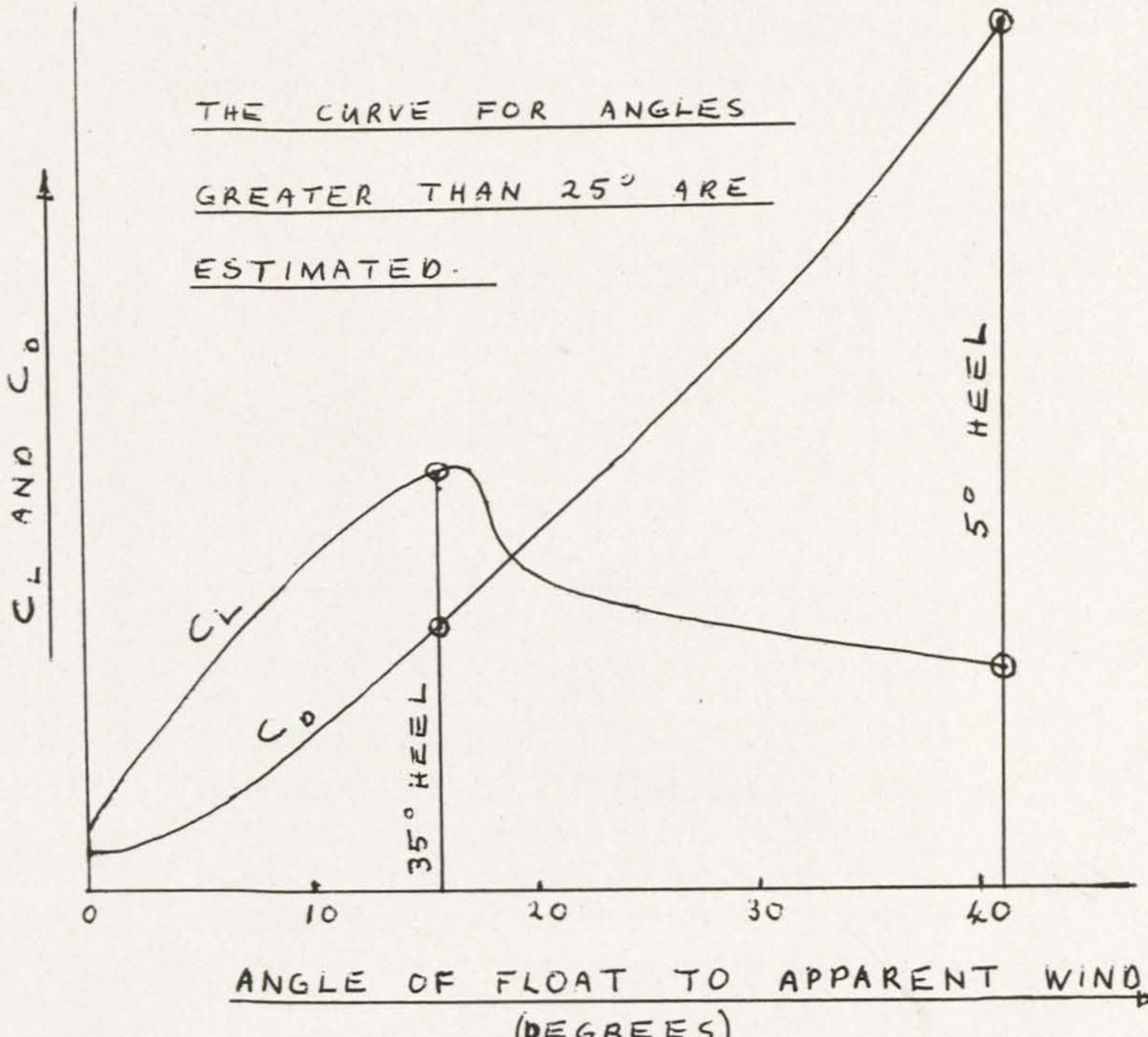


FIG. 2.

The capsizing component of the drag force for $(\beta - \lambda)$ equal to 30° will be half the drag force, since capsizing component = D Sine $30^\circ = \frac{D}{2}$ as in Fig. 3

There is a possibility that the aerodynmaic stabilising force would be increased when the craft speeds up under the action of a strong squall, since $\angle ACB$ would decrease due to the apparent wind moving forward and the apparent wind velocity increasing would increase the value of the lift since lift force $= C_L \frac{1}{2} \rho AV_A^2$, where V_A = apparent wind velocity, ρ = air density and A = surface area.

The moment arm of the drag force is approximately 2.9 units in length from the hull pivot point while the lift force moment arm is approximately 4.3 (at 35° of heel).

For $<ACB = 16°$, C_L is approx. $\frac{3}{2} C_D$. Where moment of the drag force capsizing component is M_D and moment of downward lift force (stabilising moment) is M_L.

$$M_D = \frac{C_D}{2} X\, 2.9 = 1.45\, C_D.$$

$$M_L = 4.3\, C_L = \frac{3}{2} C_D X\, 4.3 = 6.45\, C_D.$$

Therefore $M_L = 4.45\, M_D$.

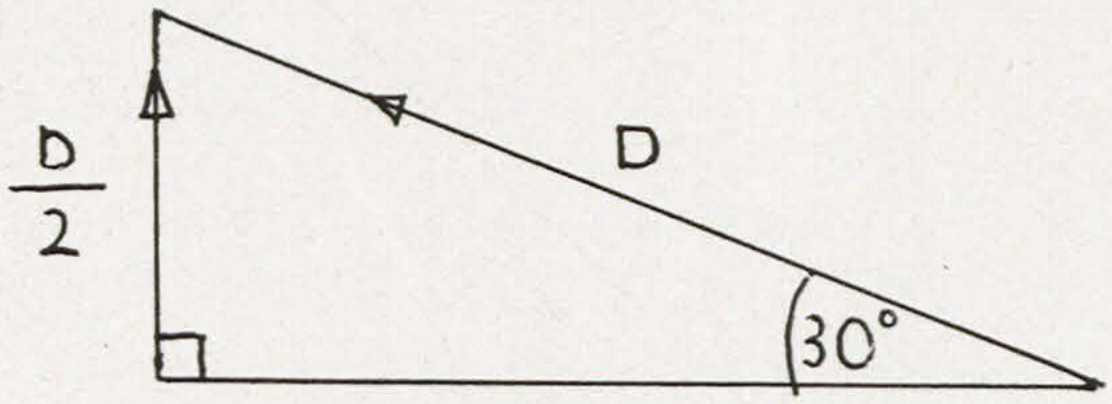


FIG. 3.

The proa would not capsize if $M_L + M_W$ are greater than $M_D + M_H$. where M_W = Moment of outrigger weight.
and M_H = heeling moment of the sail.

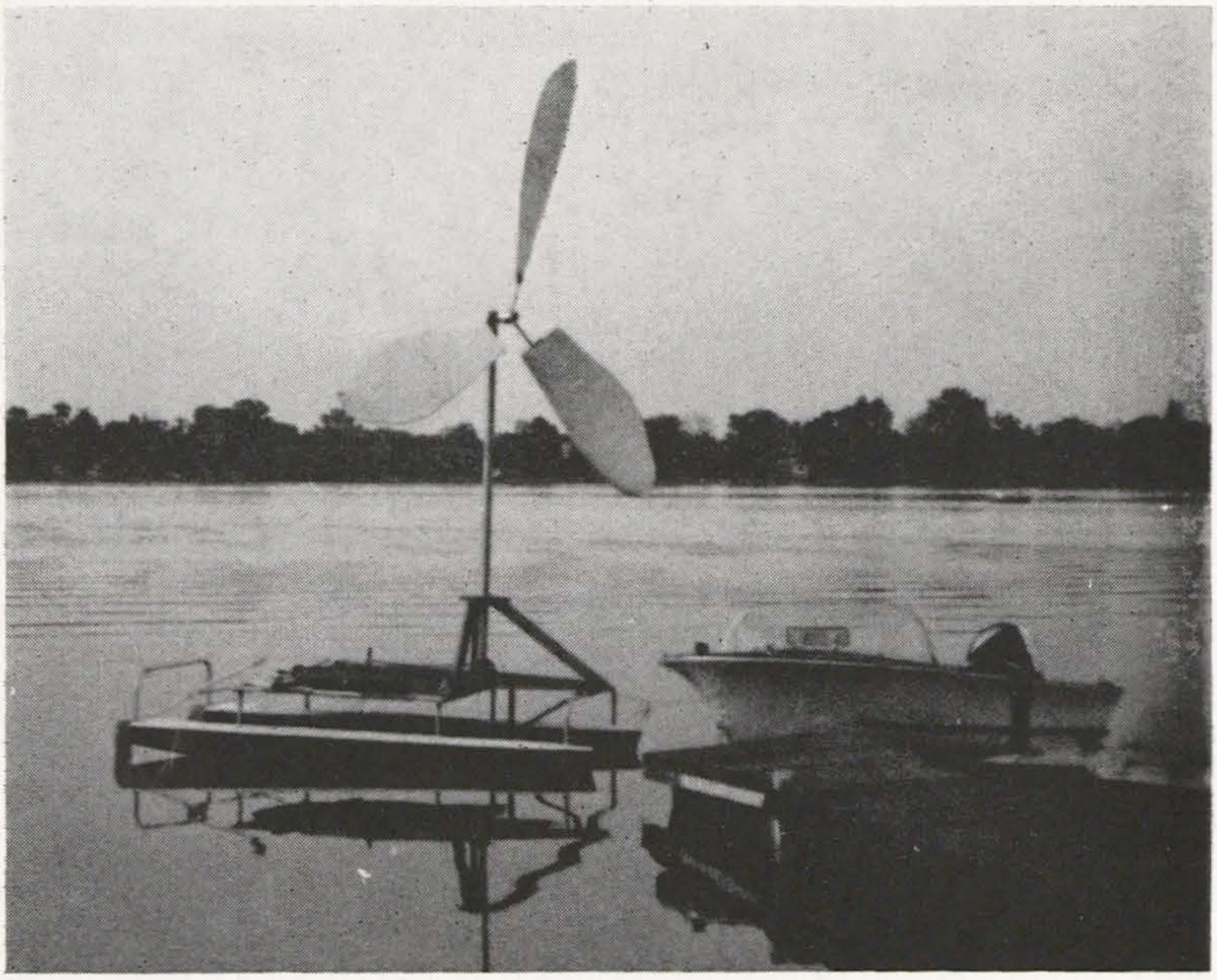
But, not knowing the value of the two latter moments, I cannot guess whether the proa will capsize under normal sailing conditions.

FULL-SIZE WINDWHEEL BOAT

BY

R. M. Pierson G. W. Eisenzimmer W. Zalewski
2025, Streetsboro Road, Hudson, O. 44236, U.S.A.

Hulls and deck of a 12 ft. lightweight catamaran have been adapted for a unique propellor-driven " sailboat " deriving its propulsive power from a 14 ft. 3-bladed windwheel. The concept was independently arrived at by two of us (W.Z. and R.M.P.) an ocean apart. On getting together, it developed that the Zalewski design was the earlier, and had been evolved into a small but practical working model subsequently described in A.Y.R.S. No. 41 (October, 1962). A hitherto unreported small working model had been made in 1941 by W. Hewitt Phillips of Hampton, Va., an engineer with the National Aeronautics and Space Administration. Certainly the most intriguing aspect of the concept was the hoped-for ability to sail directly into the wind, which had been abundantly demonstrated in both the Zalewski and Phillips models.



The Pierson, Eisezimmer and Zalewski Windwheel Boat

In scaling up to a man-carrying vessel, an Aqua-Cat belonging to G.W.E. was deemed an ideal platform for the drive rig, in view of its well-engineered fibreglass hulls supporting a tubular frame structure that greatly simplified mounting and demounting. *LUGU I* (short for *LUGUBRIOUS I*), shown in the accompanying photo, was launched in the latter part of 1965, almost too late to allow much mechanical de-bugging in what remained of the sailing season. Gear reduction between water propellor and windwheel was so arranged as to allow the mast-windwheel assembly to rotate freely through 360°; orientation with respect to the wind direction was maintained by a hand wheel axially mounted on the mast.

Five " runs " were made before cold weather set in—two short runs in very light air, two in very heavy airs that ended abruptly with mechanical problems, and one final run in a brisk wind where all went well. The latter, sailed in 12-18 knot breezes, included two periods of 5-10 minutes each of sailing directly into the wind. (Wind direction was gauged by tell-tail mounted well above the bow).

To our knowledge, this is the first recorded instance of man sailing directly into the wind.

Some observations made from experience to date are :

(1) Heeling moment under beam winds is very slight, suggesting that use of considerably higher ratios of " sail " (windwheel) area to displacement should be possible.

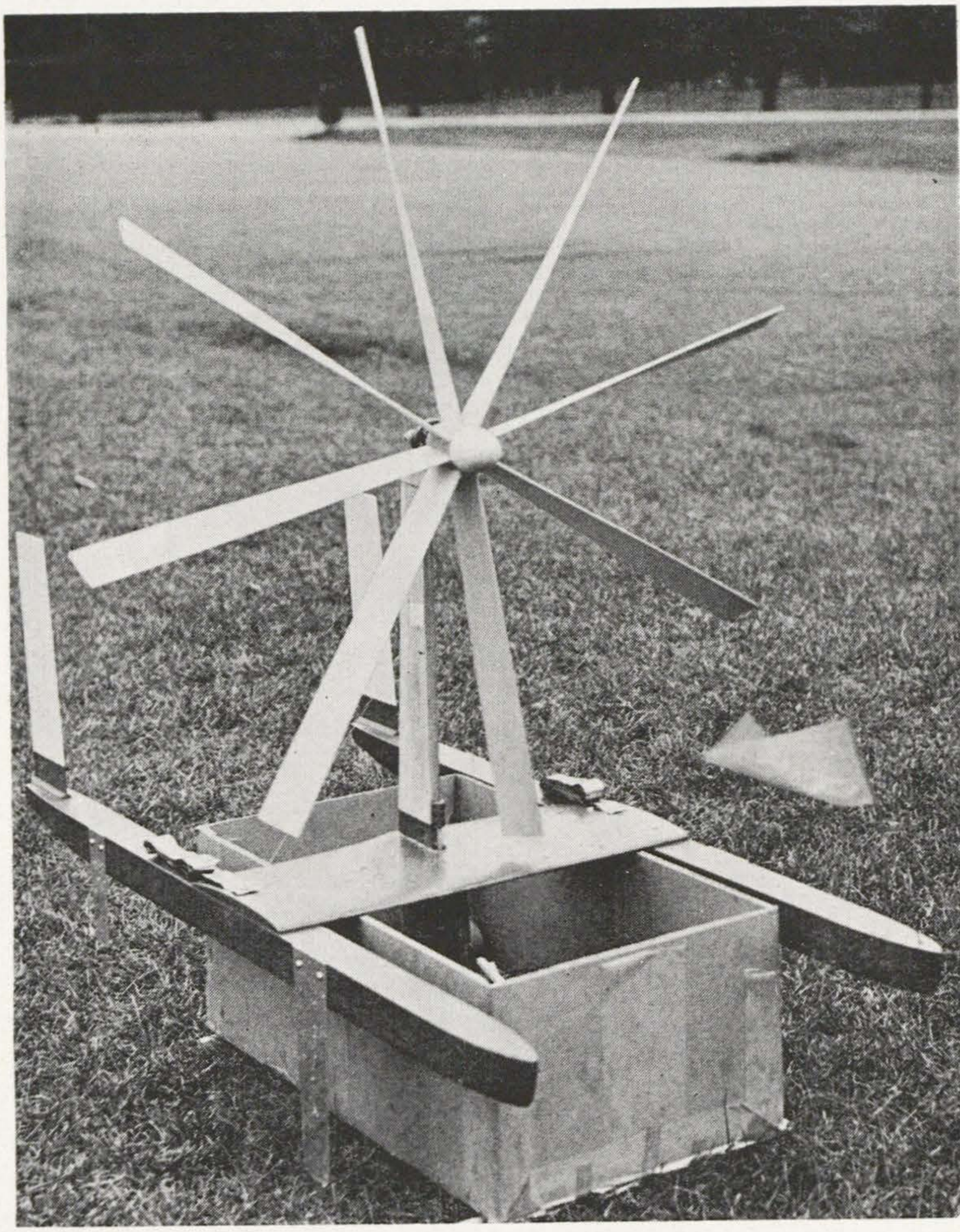
(2) As with lively centreboard sailboats, the fastest point of sailing appeared to be a beam reach. However, with greater optimization of gearing and of windwheel area-displacement ratio, the fastest point of sailing could well prove to be almost dead into the wind.

(3) Extraction of maximum power from the wind proved to be surprisingly dependent on attainment of a narrow optimum angle between plane of the windwheel and the apparent wind, which appeared to differ slightly from 90°. This sensitivity of " trim " seemed to be comparable to high performance centerboard sail boats.

(4) As expected, speed when dead downwind is comparatively slow, owing to the necessity of maintaining an appreciable difference between boat and wind speeds (to keep the windwheel turning).

Although these limited, qualitative observations are too few to justify prognostications on attainable performance, there seems little question that a new era of sailing should be opened up by the windwheel boat. Allowing for the anticipated disdain from the more traditionalist-minded sailors, there will be many sailors, and probably many non-sailors, who will be drawn to the sport by the new dimensions in speed and manipulative control offered. As with ice boating, speeds well in excess of the wind will be the norm rather than the excepiion, particularly when hydrofoils are used. Class racing should prove at least as exciting as in conventional sailboats, and will reward skill and experience even more, because of the greater number of manipulative parameters. The downwind course should prove particularly challenging, in view of the likelihood of its being sailed in a series of tacks with the apparent wind kept forward of the beam.

By the time this appears, a considerably improved version, *LUGU II*, should have been put through her trial runs. She will be well instrumented, and will be the basis of a more quantitative report in the future.



A Windmill-propellor boat

ANOTHER WINDMILL-PROPELLOR CATAMARAN

During the A.Y.R.S. Cruising yacht trials on the Round Pond in Kensington Gardens, London, this year, the boat shown in the photo graph was brought to the pond and buzzed its way directly to windward. Indeed, it can only sail on this course as far as we can see. The owner was not an A.Y.R.S. member and we could not confirm the origin of the design. It was alleged by one person to come from the American magazine *Popular Science*.

SEMI-ELLIPTICAL SAILS

BY

GEORGE DIBB and JOHN MORWOOD

The plan form of the single sail having the smallest " drag angle " is a semi-ellipse. The triangular form of the normal sloop loses a lot of drive (perhaps 10%) merely because of its shape, plus the other losses caused by twist, mast interference, losses below the boom, flattening at the foot, sail permeability and frequently lack of " flow " One fault not so often quoted is that the " soft " sail is not so predictable in shape and often stretches unfairly in use. Surely by now, we should be able to devise a sail which is free from all these faults except the boom losses and sail permeability.

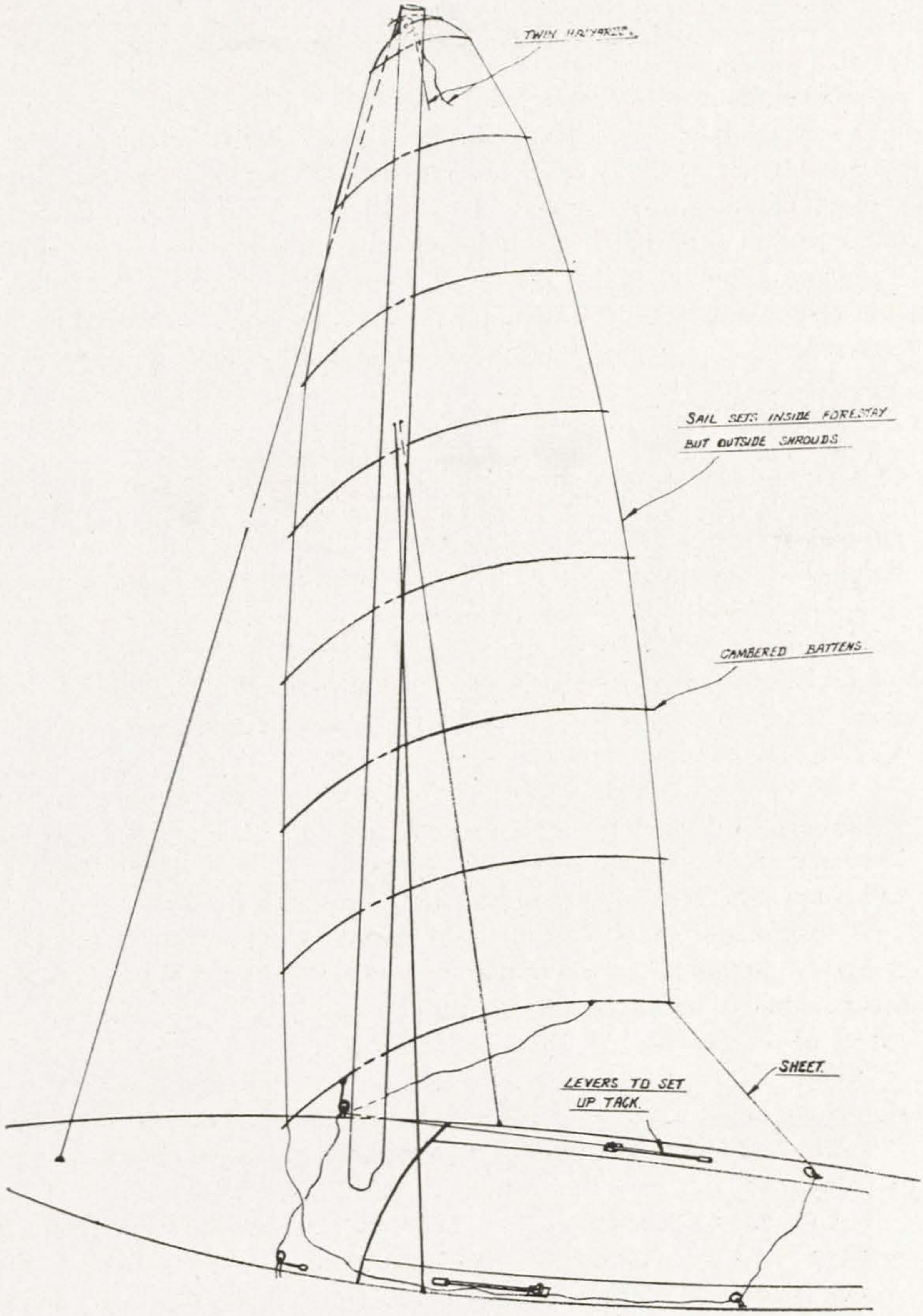
The Sail Shape. The " ideal " sail plan form has an aspect ratio of 6 : 1, using the formula $\frac{\text{Span}^2}{\text{Area}} \times \frac{3}{2}$, and for an area of 115 sq. ft., similar to, say, a *HORNET* or *MERLIN ROCKET*, we have a sail height of 21 ft. and a foot of 7 ft. This would be battened to a camber of approximately 1 in 7 and set with a mast to weather of it to give an unobstructed luff. For a start, we would make the battens arcs of circles but they might be part-elliptical for best effect. For an experiment, we would make such a sail and get a suitable boat to try it on, leaving the method of erection open.

Methods of Erection. For the present, we will ignore the constructional and staying problems and consider 5 ways of setting such a sail namely: (1) as a spinnaker, (2) a lugsail, (3) a squaresail, (4) squaresail convertible to a fore and after and 5 as a mast-aft rig.

From experiences with the Dibb trimaran, sailed by a number of A.Y.R.S. members and experiments by G. H. F. Singleton etc., we can assume that it will be necessary for the sail to be hoisted so that the centre of rotation is slightly forward of the centre of pressure, to retain stability. It has also been found necessary for the sail to be held by a rigid mast or yard, as it will flog violently under certain conditions if mounted on a jackstay. Other problems have been finding, and keeping the angle of incidence to the wind.

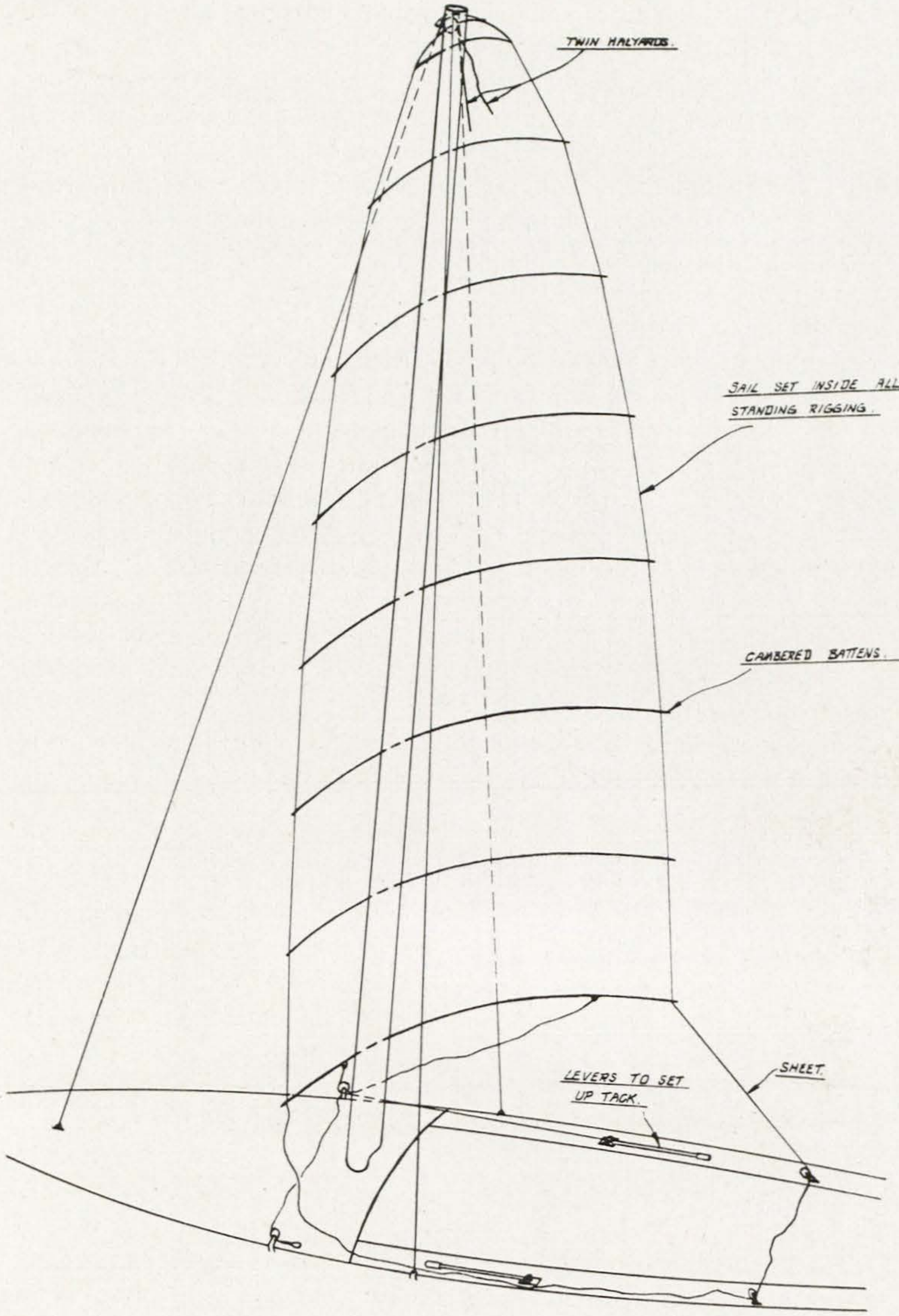
(1) *As a Spinnaker.* The head of the sail is hoisted by two halliards and for downwind courses, the foot is controlled by two sheets at 15% of the chord from either end of the boom. For close hauled work, the " weather " halliard is set up taut, the sheet being bowsed down to the lee rail, and the lee sheet is used to control the sail.

Tacking entails paying off the weather sheet and halliard and setting up the other pair, to pass the sail across the boat. During this time, the sail is virtually out of control, flogging violently in any weight of



SEMI-ELLIPTICAL SPINNAKER.

George R. Dibb.
31.7.1966.



SEMI-ELLIPTICAL LUGSAIL.

George R. Dibb
31·7·1966.

wind. Singleton found this sail to be almost twist-free and extremely close-winded, with much reduced capsizing moment, but extremely sensitive when close hauled and almost impossible to set or tack in strong winds. Other disadvantages are windage of the exposed mast and the very heavy mast-head loading, although modern mast design can cope with this latter problem. In strong winds, it might be necessary to lower and rehoist the sail on the new tack, or wear round, downwind.

(2) *As a Lugsail.* This is virtually the same as the previous method but the sail is carried inside mast-head shrouds. If the sail is tucked up close to a streamlined and rotating mast, the mast windage is almost negligible, but putting about would probably entail lowering and resetting the sail, as in the old dipping lugsails, to get round the shrouds. Even when lowered, clearing the forestay and shrouds could be difficult.

Wire spans would keep the battens against the mast and spread the loads fairly along it but would not necessarily eliminate twist. Some other means could be devised to keep all the battens in alignment on a streamlined mast, and if that mast could be without stays, as in some Chinese junks, this could be a satisfying compromise. However, *ILALA*, the Hasler junk-rigged schooner which Mike Ellison sailed in the last single-handed Trans-Atlantic Race, whipped her masts even when moored alongside in Millbay docks, Plymouth and Mike lost his foremast when nearing New York.

(3) *As a Squaresail.* This appears to be the ideal way of hoisting this sail but the Dibb outrigger showed a number of problems which have not yet been ironed out.

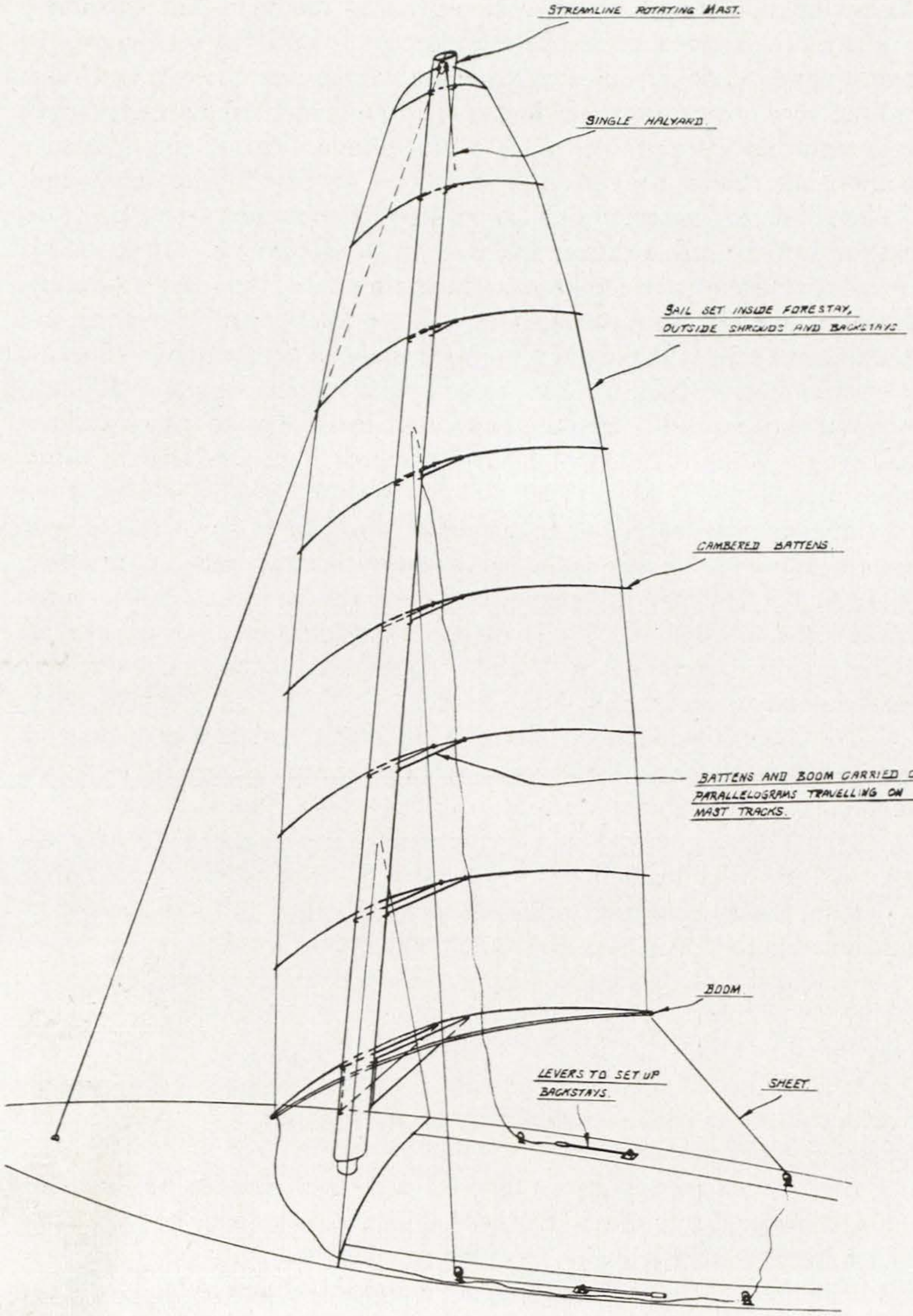
(a) The sail sweeps such a wide area when tacking that staying the mast is very difficult, hence the " lash-up " tripod mast.

(b) It was extremely sensitive to wind angle, and the angle from true heading to being taken aback was very small. This was aggravated by instability caused by the centre of rotation being well behind the the centre of effort. This made it necessary to check sail trim every yard of the way—and it didn't suffer fools gladly !

(c) The sail did not " fail-safe," it being necessary to haul the weather sheet to spill the wind; if sheets were let fly, the sail would swing broadside to the wind.

(d) When used with battens set at 1 in 9 camber, the sail was self-tacking probably due to the instability mentioned earlier, but when 1 in 7 battens were tried at Weir Wood, the tripod legs prevented the sail being hauled fore and aft, making it almost impossible to tack without making a stern board.

However, despite its problems, the sail proved to be very close-winded and efficient and well worth further effort to find ways of setting and controlling it, but the usual financial gremlins of all



SEMI-ELLIPTICAL SQUARESAIL

George R. Gibb
31·7·1966

development swung their leg over the gunwale while Dibb was watching his sail, and " bread and margarine " had to take precedence !

(4) *As a " Square " Fore and After.* This is an attempt to combine the handling of the square and lug sails. A streamlined rotating mast has the semi-elliptical sail hoisted on it and used as a squaresail. Below the sail, there is an oblique bearing whose axis of rotation is inclined forward of the centre of effort of the sail. The forestay is slack, and when this sail is caught aback, the hinge allows the mast to " fall " until caught by the forestay, this movement bringing the sail more into the wind . The backstays would be taken to winches, as only the weather one would be set up on each tack. The oblique hinge bearing would have to swivel with the mast to point upwards and forwards on each tack.

This system has many problems, not least being the tremendous loading in the hinge joint, and engineering wise, it is probably impractical.

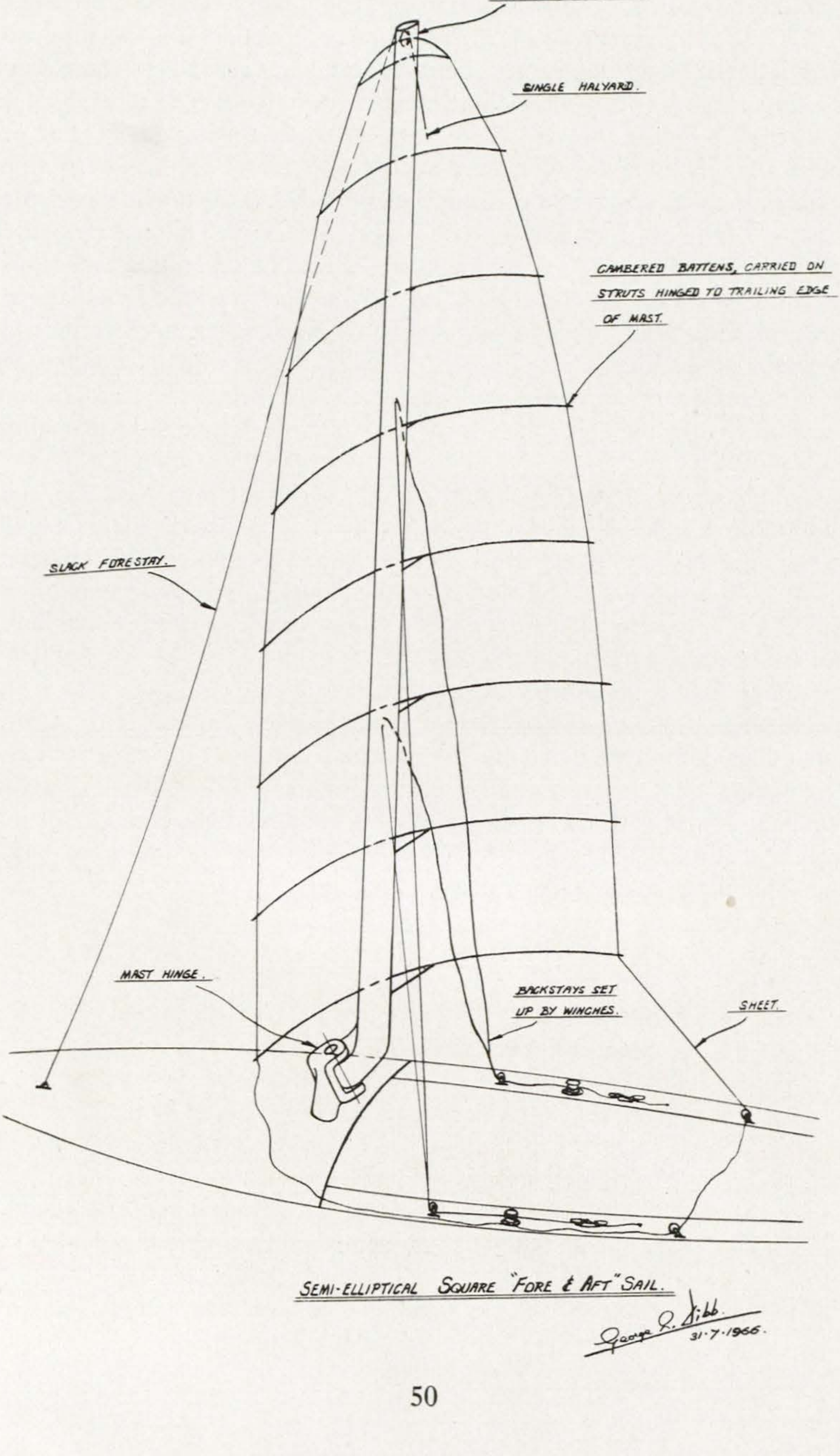
(5) *As a " Mast-Aft " Rig.* Here, the mast is behind the sail and cranked to reach forward to the halliard. The sail is tacked down to the deck and set flying or on a stay between this point and the mast head. This appears to be a satisfactory solution, but experiments by David Jeffrey suffered from violent flogging when putting about and put tremendous strains on the mast.

Paul Ashford also tried a somewhat similar experiment but with the mast in front of the sail and the sail carried between two wires, using Garnett battens to change the camber when tacking. Apparently, this worked well on a very small dinghy with an even smaller sail area, but it is doubtful if the wires could prevent flogging violently during tacking if it were to be scaled up to large size. Paul has now gone on to experimenting with flexible battens adjusted by wires.

A.Y.R.S. Publication References :

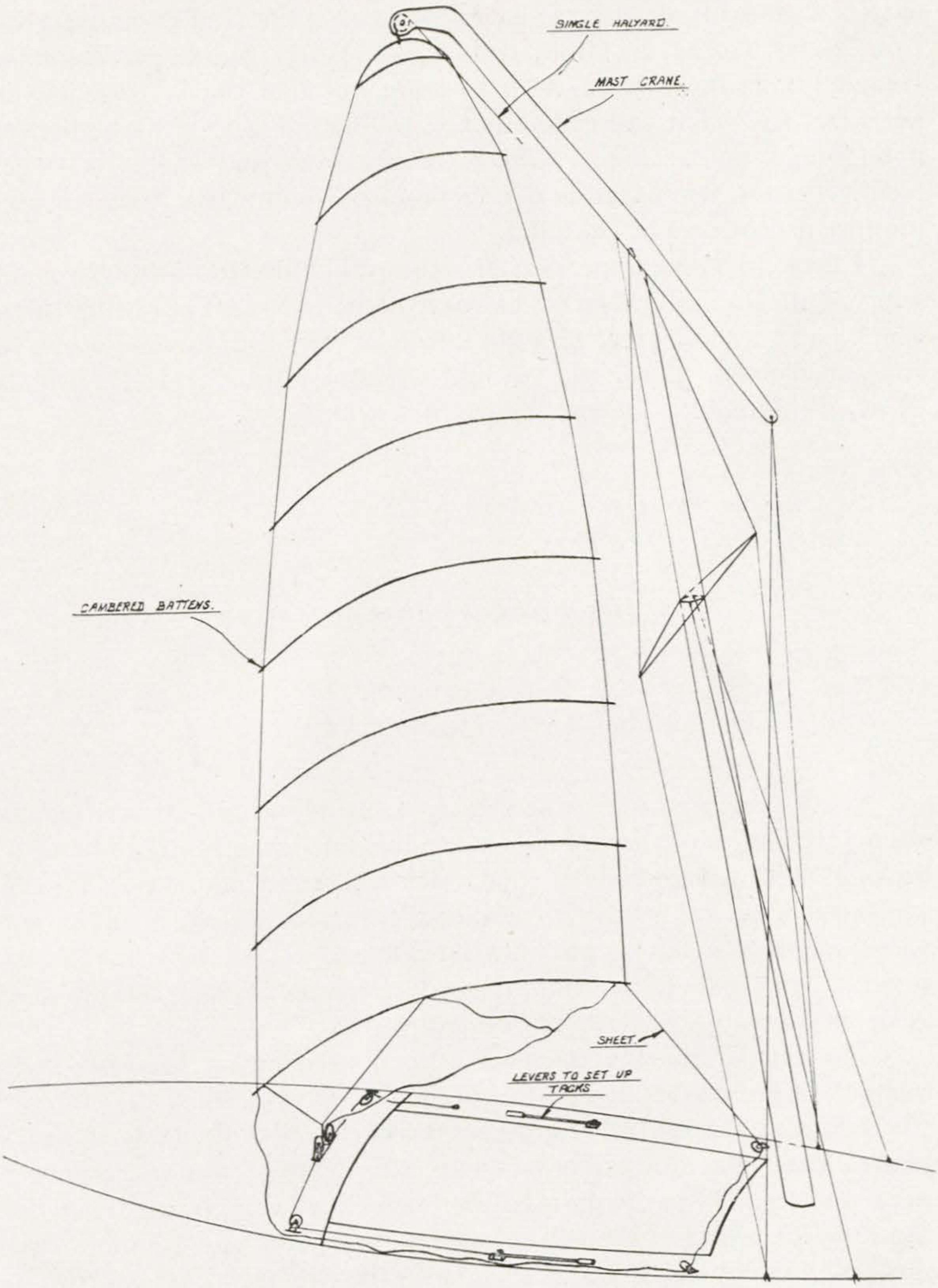
Pub. Nos.

4 & 9	The Squaresail.
26	A Semi-elliptical Sail—Mast-aft Rig.
43	Dibb Outrigger with Squaresail.
43	Dibb Outrigger-report on sailing trials at Weir Wood.
44	The A.Y.R.S. Sail—The Close-hauled spinnaker.
45	The A.Y.R.S. Sails—Square sail. Fore and aft Squaresail. A Semi-elliptical spinnaker—G. F. H. Singleton. Semi-elliptical fore and aft sails—Paul Ashford.



SEMI-ELLIPTICAL SQUARE "FORE & AFT" SAIL.

George R. Gibb.
31·7·1966.



SEMI-ELLIPTICAL MAST-AFT SAIL.

George R. Gibb. 30·7·1956.

Editor's Note: Blondie Hasler's Chinese junk rig has naturally caused a great deal of interest and I have often been asked where plans can be obtained, and for details of his self-steering gears. The address is: Col. Hasler, c/o M. S. Gibb, Ltd., Clock Tower Buildings, Warsash, Hants. It is, however, as well to point out that the Chinese lug is not a fast rig. The sail generally sets too flat, or with weak bamboos, it bags and the parasitic windage of the mast and sheets is large. Neither in the wind tunnel nor in practical sailing has it shown any promise except ease of handling.

I have, however, persuaded Stumpy Dibb to re-design these semi-elliptical sails, and so far he has evolved two ways of setting them which he says show great promise in model form. If anyone wants to buy construction plans, they should write to him at : 1, Heywoods Close, Teignmouth, Devon, England.

SERENDIP'S STERN BOARD

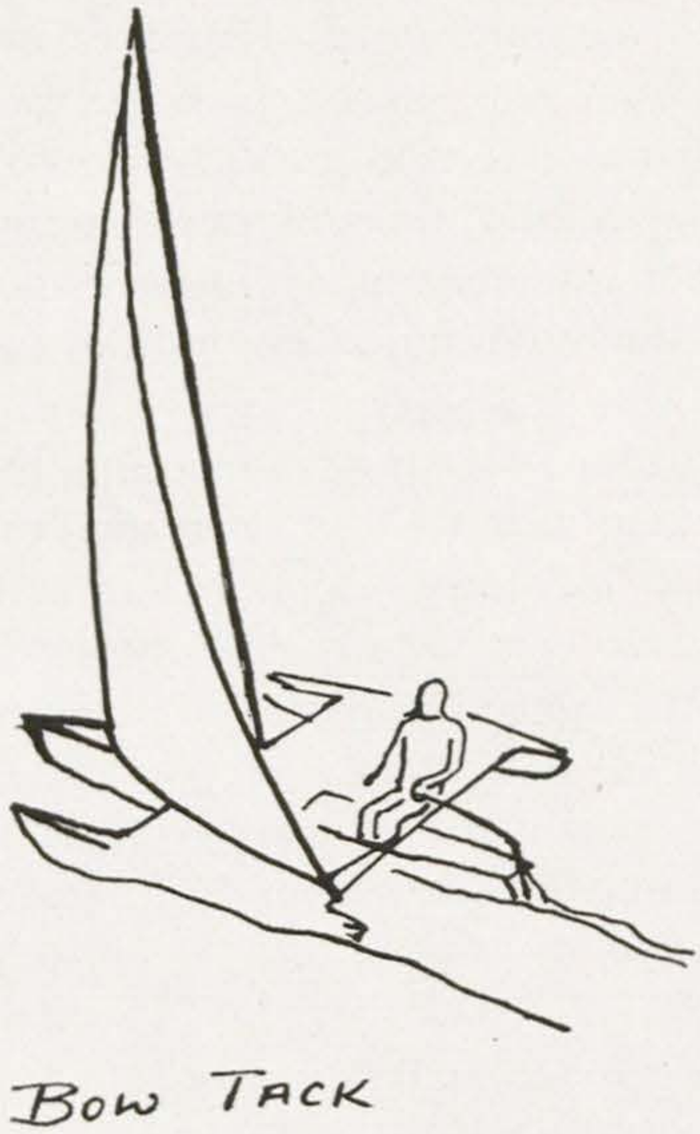
BY

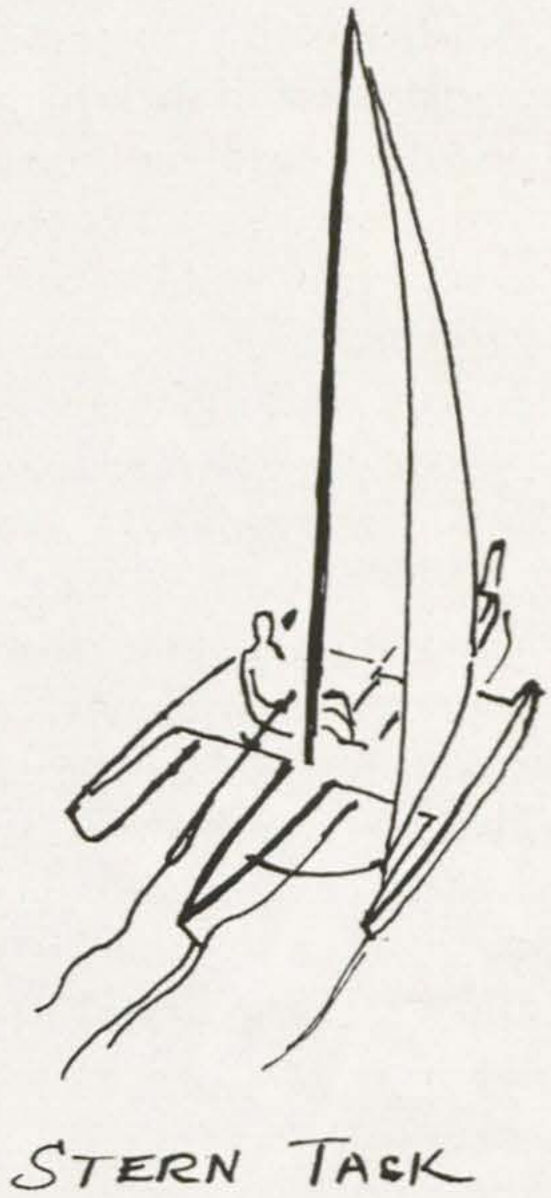
R. L. Andrews
25, Auduben Drive, Ossining, N.Y., U.S.A.

Many years ago the colliery brigs coasting around Britain would often save time and hazard when tacking into a harbour, by simply backing their square sails to make a stern board one way. I have wondered if an otherwise conventionally rigged multihull might not make use of the same option to advantage. Tests were made last summer with our 18 ft. sloop-rigged trimaran *SERENDIP*, a day sailer of generally conventional design.

The regular jib and mainsail were doused and a special sail of triangular form was set flying to lee of the side stays on the main halliard. The edges of the sail reversed roles as leech and luff, while the two control lines were alternately tack line and sheet. Drive and pointing were quite good, particularly if the tack line were brought to the weather side a bit. The drill in tacking was quick and simple, being (1) let fly the old tack line; (2) swig in on the new tack line; (3) trim in on the new sheet as the craft reverses itself and comes round to the new close-hauled heading. Do not trim too quickly, so that the craft can accelerate as it swings.

Balancing the boat around its centres was simple, being merely a matter of locating the tack-line—sheet line leads by trial. There is





one point worth mentioning in handling this sail: keep clearly in mind which is the sheet and keep that line free to run.

In summary, many single stick multihulls might be fitted for stern board tacking such as might prove useful in certain situations.

DISA's WING SAIL

BY

CDR. G. C. CHAPMAN, R.N.

At the first London Lecture meeting of the A.Y.R.S. in late 1964 Lloyd Lable made a reference to the " tiny Chinese minds " of the assembled members, and a few days later I saw a photo of a Chinese junk with two splendidly shaped sails, obviously a rig which anticipated the A.Y.R.S. by some centuries. These events, plus the stimulus of what we heard at the first few meetings, spurred me to set about making something " different " to sail with the next summer.

The Aim. As the winter went by the wish evolved into an aim to make, for my 14 ft. bermudian rigged dinghy *DISA*, a sail :

(a) with minimum drag and maximum drive

(b) with cruising capability: i.e. it could be lowered to allow hurricanes to pass safely—and possibly be reefed

(c) capable of being made with a minimum of resources and with readily available materials.

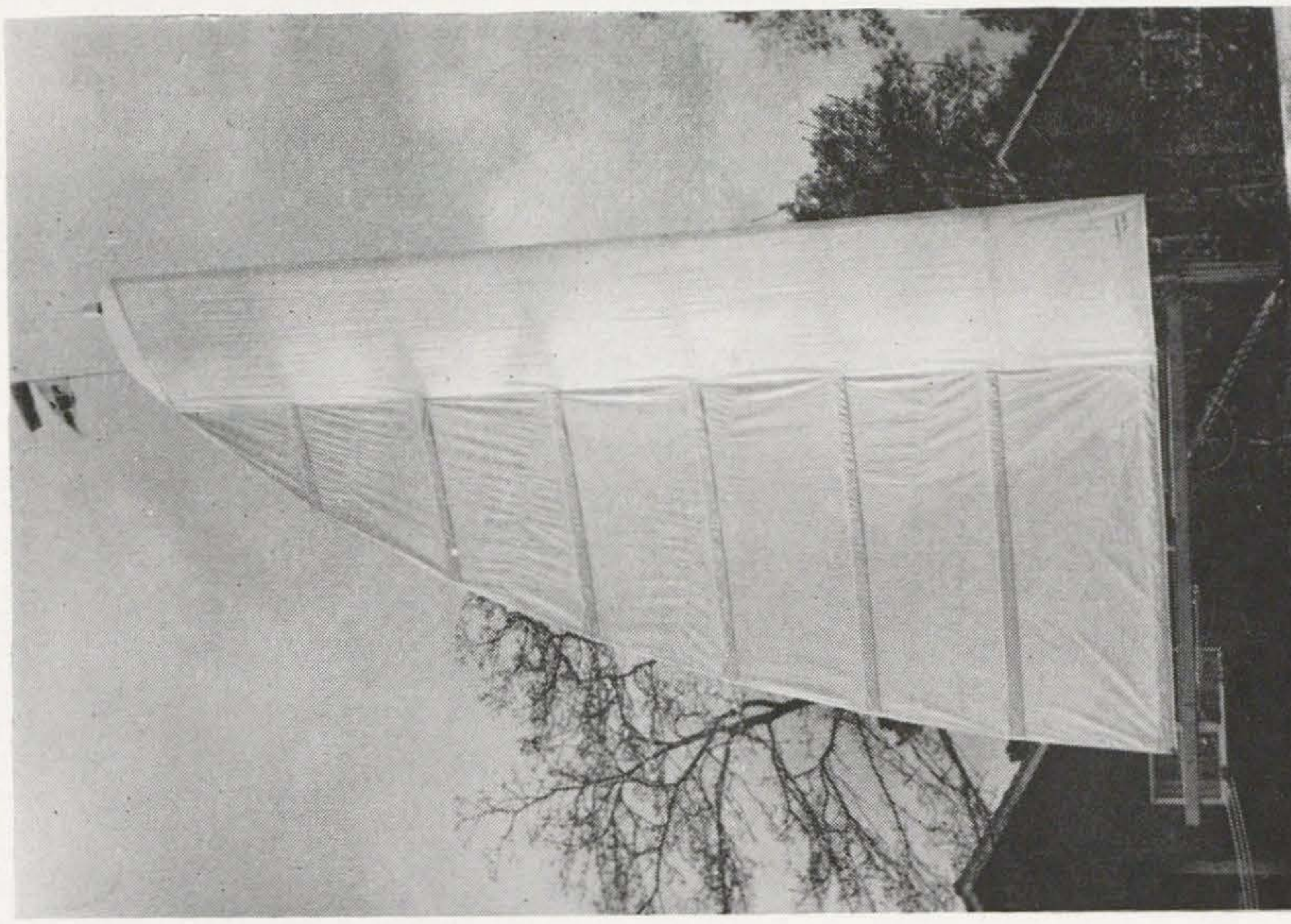
Research. This was limited by time. A first model, two foot in the hoist, was produced at a London meeting and raised a few comments and some useful information on mast making. John Morwood took one look and said " Of course a thick aerofoil is no good at our sort of air speeds."

The second model was only partly made by the next meeting, but when I showed John the proposed plan section (wing batten plus sail batten, see drawing) he said " Splendid." A few days later the model was finished and design of details started.

Design. The photographs show the general shape. As far as possible the final design simply scaled-up the model, but choices of scantlings were made with the timber merchant's catalogue in one hard, and by making full size or scale drawings to assess whether choices looked right. An idea of the proportions of other unstayed masts—Finn's & OK's— was a useful guide. Bowker and Budd's book *Make your own sails* (Macmillan) was also puchased, read and followed where applicable.

The size and general shape were chosen so that the mast and sail would fit *DISA* comfortably, with a centre of effort in about the same place as that of the bermudian rig, in order to preserve balance. I worked out sizes and areas for both an 18 ft. and a 16 ft. hoist and in the end, on grounds of cost and being chicken-hearted, opted for 16 ft. hoist—about 103 sq. ft., a shade larger than the bermudian alone. The position of the mast in the wing was chosen to give as much area as possible before the mast in order to preserve balance, without at the same time losing too much self-feathering power. See later for 'Port Tack Gust Effect'. In a redesign I would put the mast further forward in the wing and balance the boat by moving the centre plate aft. (The " wing " is the area of double thickness, stiffly supported by battens which embrace the mast; the " sail " is the conventional single thickness part abaft the wing).

One imponderable was the amount of bend to expect in the mast, and what allowance should be made in sail cutting. For this reason I first made the mast and then subjected it to a crude bending test. As a result of this I decided to drill the wing battens, and strengthen one of them half-way up the mast, so that an internal jumper stay could be rigged to prevent the mast from bending backwards. This was jury rigged (without any sail around it) and the mast stressed and the deflection measured. As a result I cut the luff of the " sail " with



DISA's Wingsail

$\frac{3}{4}$ in. of round about 1/3 of the way up, to allow the sail some shape when not heavily stressed, and to allow the sail to flatten when the sheets are right aft and the mast bends. As far as I have been able to assess during the summer the mast bends backwards relatively little. I have not got round to actually rigging the internal jumper stay and it does'nt seem necessary. Probably the stretched material of the wing contributes sufficiently to fore and aft stiffness. There is nothing which one can do about sideways bend, but this too has not been noticeably excessive.

In this first version I made the wing of uniform section all the way up, because there was no knowing how the leading edge, in particular, and the sides and trailing edge would shape themselves under tension and wind forces. In practice the wing has kept its shape very well, and particularly the leading edge has remained fair even in 20 knots of wind. There is none of the underfed look that doped-fabric aircraft wings develop. The cloths of the wing are wrapped from the trailing edge right round and back again, so that the leading edge is as smooth and fair and drag free as possible. Indeed the only seams in the wing are the horizontal ones, placed at the wing battens to provide reinforcement in way of the battens. In a new version I would probably taper the wing towards the top, probably with a definite kink in the leading edge two or three battens down from the peak, rather than by a gradual taper over the whole height. At any height the chord of the wing should be in the same proportion to the chord of the sail if the whole aerofoil section is to be in proportion and have the same angle of attack at all heights, i.e. no twist. With a wing that tapers at the top and a sail with a large round to the roach—as on the existing sail—this condition would be largely satisfied. Putting it another way, my present sail is carrying some useless area in the upper leading part of the wing. My sail indicates what is possible. Now the designers of aerofoil sails can design a more perfect aerofoil, elliptical shape and all, and it stands a good chance of being able to be made.

One point for thought here is the rake of the mast. Mine is slightly raked aft so that in the absence of wind the sail and mast will tend to rotate, under the action of gravity, so that the boom is amidships, aft of the mast. The mast could be raked aft more if it helped in achieving the besxt aerodydamic shape, but then on a run there would be the gravitational restoring force to be overcome which in a light air might be a nuisance.

Construction. This section deals only with points of interest that are not obvious from the Specification, which follows later.

The mast was built in the back garden, using an electric circular saw (drill attachment) and gouges to hollow out the two halves, and an old motor car inner tube and glue to stick the halves together. Cutting the tube helically gives a rubber strip about 1 in. wide and 65 ft. long. This was wound tightly round the glued mast to hold the halves together while they stick. A splendid method. Stupidly I failed to permute my two pieces of wood sufficiently and because their grains are not in opposition the mast has developed a twist of about 10° over its length. Remarkably few people notice it !

When my chandler sold me the sleeve for the lower mast bearing he thought it was a nylon fitting for connecting a hose to a water tank. It had a nicely finished $\frac{5}{8}$ in. hole in it, and after cutting off the hose spigot it screwed neatly into the bottom of the mast. A piece of $\frac{5}{8}$ in. brass rod makes a journal: it sits in a rectangular fitting of sheet brass and wood which in turn sits in the original step in the keel.

All the other parts are either of wood, conventionally fastened and glued, or are standard yacht fittings.

Fortunately for me, my wife's sewing machine started the sailmaking in good repair (and finished in good shape too !), in particular the little ratchet which transports the cloth is sharp. It was not therefore necessary to stick the cloth together with Copydex or to tack or pin it before machining, except occassionally. The technique of sail-making is most clearly described in *Make Your Own Sails* and I strongly recommend those people who want to know more about sails, and/or save money on their next suit, to read the book and make their own. A by-product is that I can now cast an almost professional eye on a sail and make valid comments. The ordinary stitching is perfectly adequate, particularly in heat-set terylene which has so little stretch in any direction. Some care was required in planning the sequence of operations in assembling the sail, but it was made (and later modified) without requiring the services of a six inch man or a machine with an eight foot reach !

Development. The sail was first hoisted towards the end of May and the boat put afloat a day or two later. A certain amount of experiment was required to establish the relative sizes of the forces required.

(a) for sheeting—i.e. pulling the boom to keep the whole sail at the desired angle to the wind

(b) for draft control—i.e. pulling (or pushing) the clew and wing boom/boom rod to get the sail into the desired shape. (Another name for this is variable geometry, which can be achieved by varying the rake of the mast, or sweeping the wings back).

I had the feeling from the start that it should be possible to devise an arrangement of sheeting and draft controls so that one rope in the hand would control both, by virtue of an automatic reaction between the two forces.

However, first it is necessary to explain that a correct geometrical relationship must be maintained at all times between wing/boom angle and clew position, so that the curve of the lee side of the wing, and the sail, is fair. This is done by means of the push rod and the endless cord. The latter which is attached to the clew and to the push rod slider, moves over sheaves let into the boom, and provides a convenient connection below the boom for the pull from the sheet.

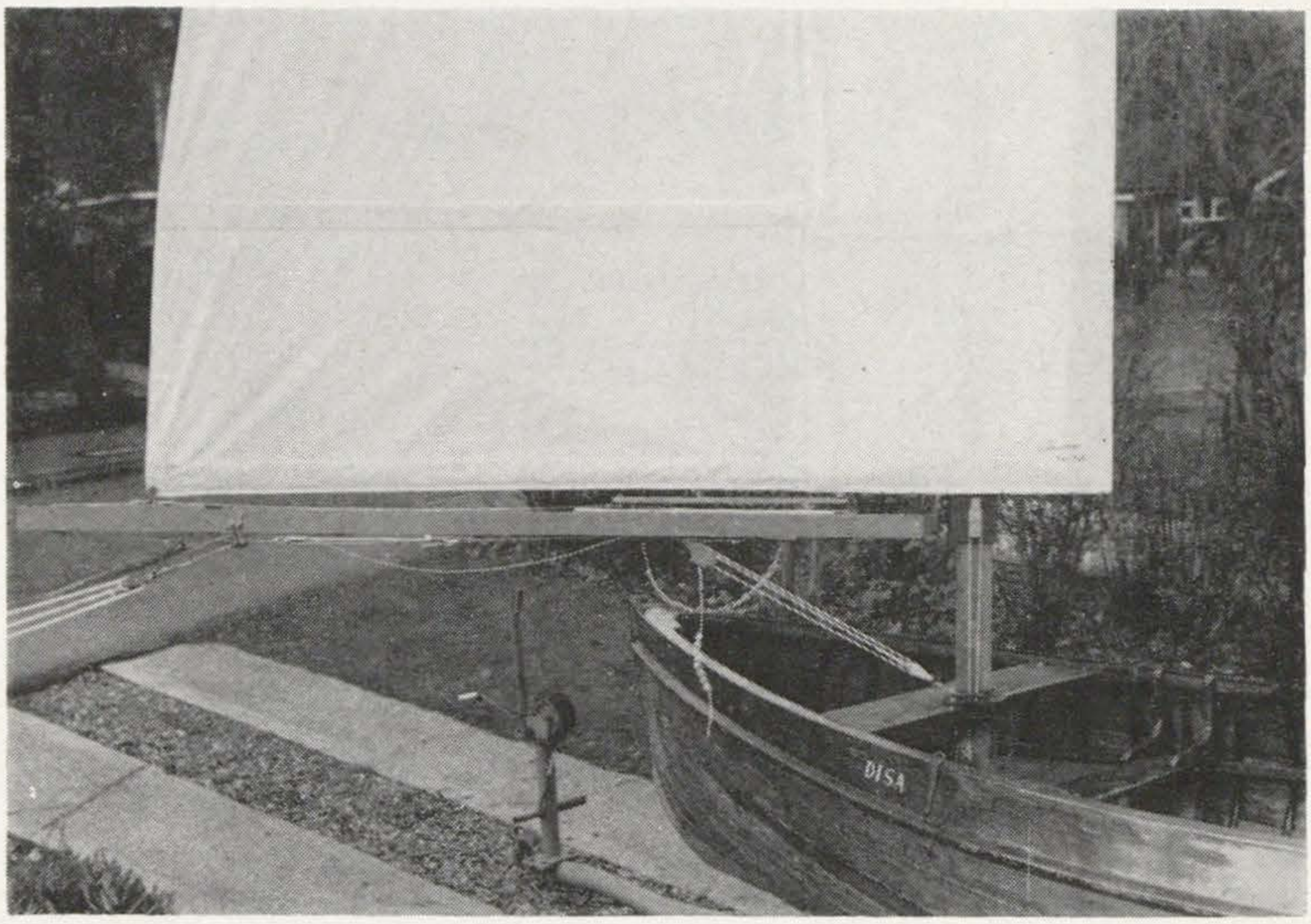
The philosophy is that stronger winds demand a flatter sail. Stronger winds increase sheet force, this is applied to the clew and push rod to flatten the sail. A necessary degree of bias is applied by a piece of elastic, whose tension is adjustable.

A further complication is that I do not have an athwartships track on the boat to carry the standing mainsheet block. So the latter is snap-shackled to a lifting eye (in the keel) in the stern-sheets, on the centre line. When close-hauled the sheet thus supplements the boom down haul, and its increased tension is available for sail flattening. There is merit in the snap-shackle: in light airs the sheet purchase is un-snapped and pulled up two-blocks, so one has a single part sheet. This makes for lightness of control. It also permits gybing the boom forward of the mast, a useful manouevre particularly in strong winds.

The boom downhaul (so-called kicking strap—what a stupid name!) is conventional except in its lower anchorage to the mast. This needs to be stood off from the mast at least the same amount as the pivot of the main boom. Before it was stood off the geometry was such that the sail tended to assume maximum draft when the sheet was slack. This militated against comfortable feathering when one wished to stop There is still a slight tendency to assume draft which I suspect is aggravated by the position of the mast inside the wing—for full comfort the mast should be further forward.

The October meeting at Weir Wood provided a splendid end to the season and an excellent strong wind test. All summer there has been relatively little wind, and it was fortunate that the stronger wind came at the end when I could afford to have things broken. Four of the seven battens broke—at the point of discontinuity where the sail joins the wing, and where there was (at the time) a discontinuity in the battens. In fact the breakages made little difference to sail shape when sailing, but they further reduced the flattening action when the sheet was free so that the sail did not sit very comfortably when the boat was pulled up the beach. I have now fitted a better batten pocket which takes a uniformly tapered batten. In addition the pocket is elasticated so that each batten is firmly pushed aft all the time. This should further improve sail shape.

The strong wind also showed that above about 10 knots wind, the force required to pull the clew aft (when close hauled) increases faster than the sheet force. I have since fitted a single whip purchase between the sheet and clew to give a mechanical advantage of two times, so that

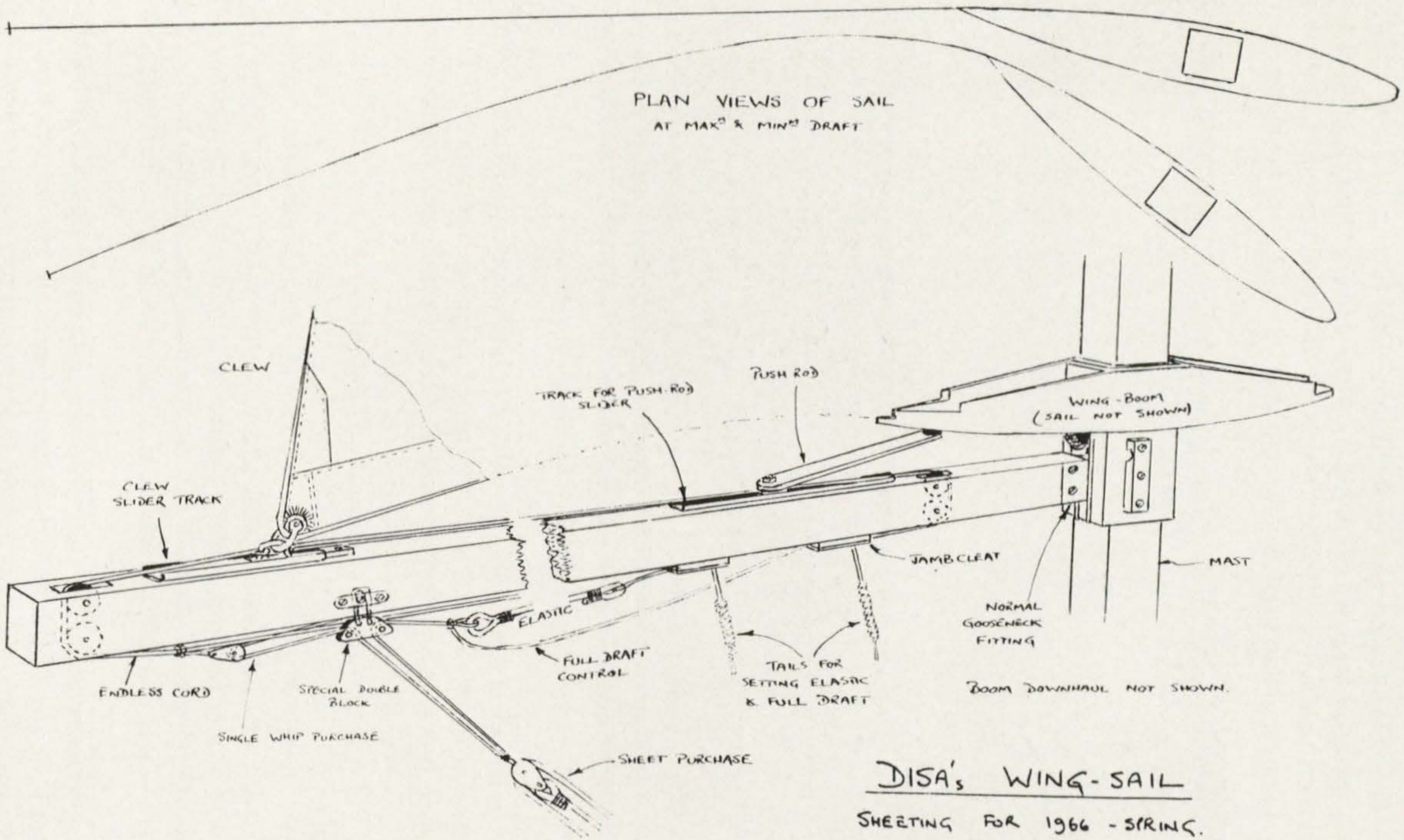


DISA—showing boom details

in higher wind speeds sheet force can still overcome clew force. Of course in light winds relatively greater force will be required from the elastic, but this is easily arranged. The sketch and photo show this rig, which will be tried in 1966.

The sketch shows the sail in plan at minimum and maximum draft. It also shows the sheet declutching line which is used to ensure maximum draft, when required. The tail, accessible from inboard, is hauled taut and cleated, and prevents the sheet from tensioning the clew. I am not yet sure whether it is better when running dead down-wind to set the sail flat, and expose the maximum area, or to set maximum draft. Perhaps this too should be a function of wind speed ?

Performance. To date I have not sailed against a bermudian rigged dinghy of the same hull design, and my performance measuring instruments are insufficiencly well developed to be able to say definitely that the sail is better than a nornal bermudian rig of the same area.



DISA's WING-SAIL

SHEETING FOR 1966 - SPRING.

I hope to discover the truth both by measurement and comparison in 1966. What I do know is that downwind (at Weir Wood) the sail drove *DISA* faster than she has ever sailed before—I saw 7 knots on the Smiths speedo and my crew reported 8—when the anemometer read 25 m.p.h. My impression is that close hauled *DISA* will sail as close as she did with bermudian rig and jib: and I am sure that the rigidity of the sail and its large draft (when needed) pays dividends in very light airs, because one does not have to heel the boat to keep any shape in the sail. The area is 103 sq. ft., a reduction of 23% on the old rig: my impression certainly is that she goes at least as well as she used to.

Handling. The rig is a joy to handle once you are used to it. Una rig is naturally easier to sail than sloop. But one has only the burgee and/or windsock as an indication of angle of attack, and there is virtually no indication of stalling—luff flap—because of the rigidity. Equally there is none of that nerve-wracking flapping of canvas when lying stopped or going about. It took quite a while at Weir Wood to get used once again to the sound of flogging sails and the flap of halyards against masts !

For 1966 the sail has been fitted with 4 in. tufts of black wool—like reef points—at about three foot intervals all over. These are to indicate the direction of air flow on the surface of the sail. In a good light they are visible through the sail, when lying close to it, but they will not be visible through the wing. Perhaps driving mirrors will be needed for the helmsman to sight the lee side of the sail when hard on the wind, and sitting out ?

Control of draft presents little difficulty, and if one sheets hard in when going about the sail will usually change the sense of its draft automatically. Occasionally if the clew or push rod slider is sticky the wing-boom likes a push from the crew as you go through the wind.

Gybing with the boom passing over the bow is a useful and morale raising trick: besides as you pull the sail aft again you get a useful little push. Remember to tell the lookouts to duck.

One thing to watch is " Port Tack Gust Effect." Close hauled the sail drives best with the apparent wind at such an angle that it is *just* striking the " lee " side of the wing. Now the wind in (northern hemisphere) gusts *veers.* A powerful gust accompanied by several degrees of veering changes the angle of attack of a port tack sail from positive to negative. With a soft sail, the sail simply goes aback and flaps. The wing sail develops almost as much lift inverted as it does right-side-up, so one experiences a sudden capsizing moment to what one thought was " windward." (Question: which tack are you then on ?) This can be bottom-wetting. In the southern hemisphere for port read starboard, for veer read back, and its still your backside that gets wet.

Hoisting and lowering are little different from normal. The sail *can* be lowered with the sail battens in, but I do not propose to make a habit of it. The sail stowed very happily on the mast all summer, with a canvas cover over all. (Photo in A.Y.R.S. Journal No. 53.)

References. Recent writings on wing sails include :—

" Yachts and Yachting "—8th Jan. 1965—" Sprinter "
14th May 1965—Col. Bowdens sails
6th Aug. 1965—*THUNDER II* (p. 289)
1st Oct .1965—*QUEST*

" Yachting World "—Oct. 1965—*QUEST*.

A.Y.R.S. Journal No. 53 has some more photos of *DISA's* sail.

Specification

Sail. Best Heat Set Terylene, $4\frac{1}{2}$ oz. per sq. yard.

Wing. 7 in No sections, each 5 ft. 6 in. long x 28 in. high. Seams 1 in. wide, $\frac{3}{4}$ in. tabling top and bottom for $\frac{3}{8}$ in. x 3/32 in. brass strip for screwing to headboard and wingboom. Wing battens supported on a $\frac{1}{2}$ in. wide loop sewn into wing 6 in. from forward, and on similar poppered loop $7\frac{1}{2}$ in. from aft. Longitudinally, wing battens are a push fit in wing.

Sail. Nominal 36 in. clothes laid diagonally, i.e. at right angles to main leach. $\frac{1}{2}$ in. seams. No false seams. No. broad seaming. Luff cut with $\frac{3}{4}$ in. round at 6 ft. up.

Batten pockets. On sail—$3\frac{1}{4}$ in. wide, 7 in number. In wing—(Modified after Weir Wood) A tube of sailcloth forming a continuation of the sail-batten-pocket runs into the wing. At its end a sock of sail-cloth, pulled aft by elastics buttoned to tube, restrains batten. Pocket is restrained sideways by cords tied to wing batten—to prevent forward end of batten deforming side of wing.

All cloths heat sealed with soldering iron.

Area 103 sq. ft. Height 16 ft. 3 in. Centre of Pressure at height 6 ft. 8 in., and 3 ft. 8 in. from leading edge.

Mast. Spruce. Total height 19 ft. 6 in. Two pieces glued together. Uniform section 4 in. x 3 in. from truck to thwart, then tapered to $2\frac{1}{2}$ in. at foot. Hollowed progressively: $\frac{3}{4}$ in. wall thickness at top to $\frac{3}{4}$ in. hole at wingboom level, and down to halyard exit. Cap —$\frac{3}{8}$ in. ply. Two headboard locks: $\frac{3}{8}$ in. ply rectangles recessed into mast, spring loaded outwards, retained by two screws, released by internal cord. Upper journal: fabricated plywood, bound with 1/32 in. brass. Lower bearing: adapted nylon hose fitting. $\frac{5}{8}$ in. brass pin in wood plug fits in step in keel. Cleats to taste.

Mast Thwart. 8 in. x 1 in. hardwood. Incorporates clamp-cum-upper bearing, fabricated from hardwood and plywood.

Headboard. Sides of $\frac{1}{4}$ in. ply, $5\frac{1}{2}$ in. x 31 in. Base $\frac{3}{8}$ in. ply. Bulkheads $\frac{3}{8}$ in. ply. Box in centre to embrace mast further reinforced with 1/16 in. ply. Top faired with balsa. Incorporates eye for halyard, hole for burgee stick, socket for anemometer, recesses in underside to take locks.

Wingboom. Box to embrace mast of $\frac{3}{8}$ in ply, $8\frac{1}{2}$ in. high, doubled at aft end to carry gooseneck fitting. Slides of boom $\frac{1}{4}$ in. ply, base $\frac{3}{8}$ in. ply.

Wingbattens. 6 in number. $\frac{1}{4}$ in. ply, 2 ft. 8 in. x $3\frac{1}{2}$ in. Sides reinforced by strips $\frac{1}{4}$ in. x $\frac{3}{4}$ in. x 16 in. long glued in before cutting hole for mast. Drilled as required for batten restraining cords and anemometer cable.

Sail Battens. Ash, $\frac{1}{8}$ in. x $2\frac{1}{2}$ in.: tapered as required.

Main Boom. Spruce, 8 ft. long. $2\frac{1}{2}$ in deep x $1\frac{1}{2}$ in. wide.

Push Rod. Ash, 2 ft. 2 in. x 2 in. x $\frac{1}{2}$ in.

Costs.

	£	s.	d.
Timber	13	0	0
Cloth	13	16	6
Cordage	3	0	0
Fittings	4	0	0
Fastenings		15	0
	£34	11	6

Weights. In lbs.

ITEM	WINGSAIL	BERMUDIAN
Mast	38	$25\frac{1}{2}$ incl. shrouds
Rigging	—	7 incl. sheet
Mainsail	5 terylene	7 cotton 98 sq. ft.
Jib	—	$2\frac{1}{2}$ cotton, 35 sq. ft., incl. sheets.
Boom	10 incl. sheet pushrod etc.	$13\frac{1}{2}$ bare
battens	2	$\frac{1}{4}$
headboard, wingboom, wing battens	9	—
jib stick	—	1
	64	$56\frac{3}{4}$

NOTE: The wingsail mast was intentionally made on the strong side so that it would not break too soon: I feel its weight could be reduced somewhat, and a metal mast would be even lighter.

DISA's WINGSAIL—POSTSCRIPT ON PERFORMANCE

BY

CDR. G. C. CHAPMAN, R.N.

DISA's wingsail performance has now been assessed over a range of wind speeds.

Firstly, John Hogg made static measurements of the boats' performance at Weir Wood. I say " Static " because he sat on a (Fred Benyon-Tinker's) moored catamaran and measured the various quantities whilst I sailed the boat away from him, close hauled for a distance of 30 yards. Some nine runs were made with each of two rigs: first the Bermudian rig, set with small jib and two rolls in the main in order to equate the sail area with the wing-sail, which performed second. The winds were light, only up to 8 knots and the only conclusion which could fairly be drawn was that the wing-sail drove the boat to windward about as well as the reefed Bermudian rig, whose Portsmouth Harbour Rating is 114, unreefed.

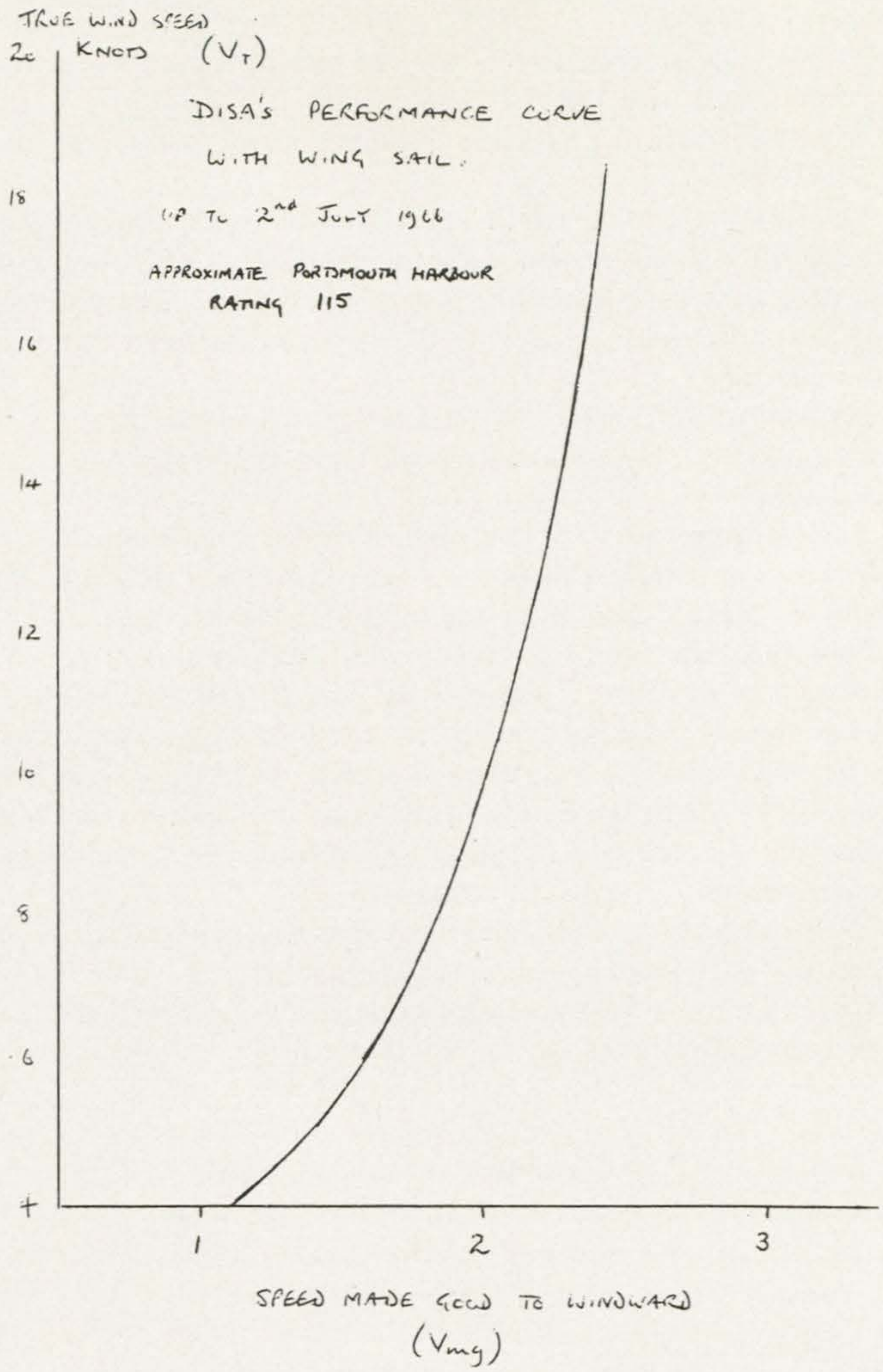
Secondly, *DISA* has been sailed on Portsmouth Harbour against various unsuspecting R.N.S.A. dinghies rigged with the standard gaff-rigged cotton sails, about 130 square feet total and a Portsmouth Harbour Rating of 115. At the same time, dynamic measurements have been made, using instruments carried aboard *DISA*.

In a 15-20 knot wind, *DISA* managed to outpace two R.N.S.A.'s over about a mile, starting 50 yards down. With an apparent wind of 20 knots, it has been very noticeable that the R.N.S.A.'s were, if anything, over-canvassed and they were sailed with gunwales close to the water. *DISA* pointed higher and sailed with about 10° of heel.

On another day, in a wind of 8 to 12 knots, *DISA* passed over the starting line about half a minute after the main fleet of R.N.S.A.'s. One of these was passed after the first half mile of the beat to windward. The remainder of the fleet were well bunched and remained so, except for a second straggler who was overtaken at the windward mark. After the race of about 2½ miles, *DISA* finished about a minute after the leading R.N.S.A., having overtaken two out of a field of seven.

These tests are very subjective because I do not know how well the skill of the other helmsmen compare with my own. Nor do I know whether the other hulls are really identical with *DISA's*. What I think is true, though, is that the wing-sail comes into its own at higher wind speeds. It should therefore show up better when rigged on a fast hull and sailed against comparative hulls, Bermudian rigged.

My conclusion to date is that I prefer the wing-sail in *DISA* because :—



(a) In winds over 8 knots, it drives her as fast as the Bermudian of greater area.

(b) It is easier to handle.

(c) She sails more comfortably in higher wind speeds (i.e., over 15 knots).

The graph compiled from static and dynamic readings, shows the best performance to date, in good conditions, i.e., a steady wind and sea no more than 'slight'.

Dear Sir,

Thank you for your letter, and interest in my experiments with the spritsail, and with the lateen sail.

Enclosed you will find some drawings which will show you how I rigged the sails.

To judge the efficiency of those little known rigs I had the experience of sailing during one season with the bermudian sail, first a unarig (75 sq. ft.), afterwards a masttop sloop (80 sq. ft.). The unarig had a luff of 19 ft., the sloop 15 ft., with 50 sq. ft., in the main and 30 sq. ft. in the roller jib.

Unfortunately I made only a few speed measurements with the bermuda rig. So, the comparative efficiency of the rigs had largely to be estimated.

All measurements were made by sailing on a canal on whose banks the distances are marked by concrete markers every 100 meters, and clocking the elapsed time from one marker to the next one.

Four measurements were made with the bermudian rig, all with wind abeam, about 30 with the spritsail, and 40 with the lateen.

High speeds were not reached for the following reasons: the boat is too heavy: a trimaran of nearly 300 pounds on 15 ft. of waterline; the sail area is too small; the winds on the canal are unsteady as the banks are relatively high (about 7 ft.) and partly screened by trees, brushwood and a few houses.

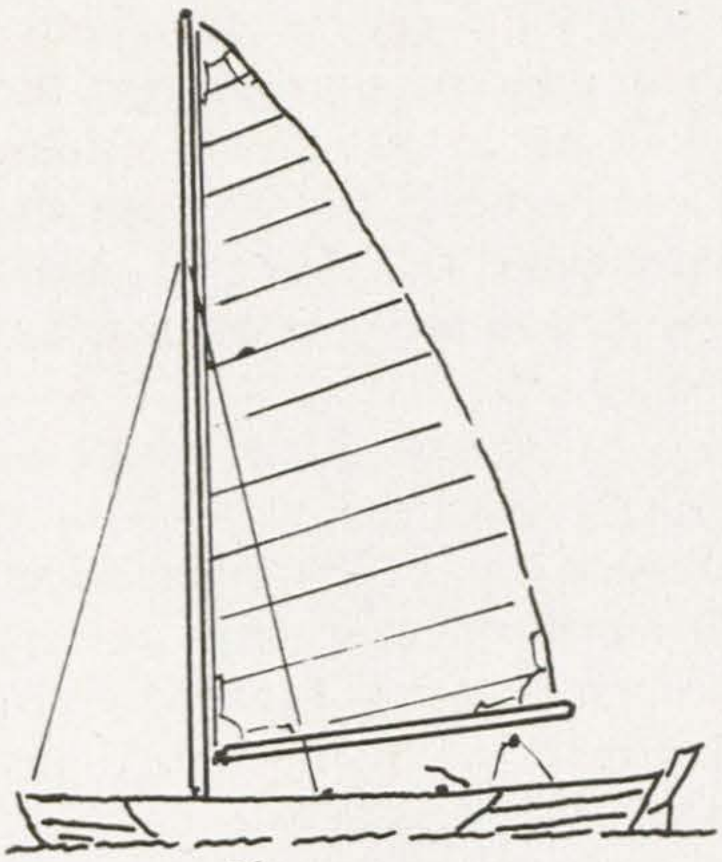
Even on short stretches of no more than 100 meters there would be three or four patches of alternatively light and strong wind.

I give you now a comparative table of the best recorded speeds, for what they are worth.

Best recorded speeds in knots

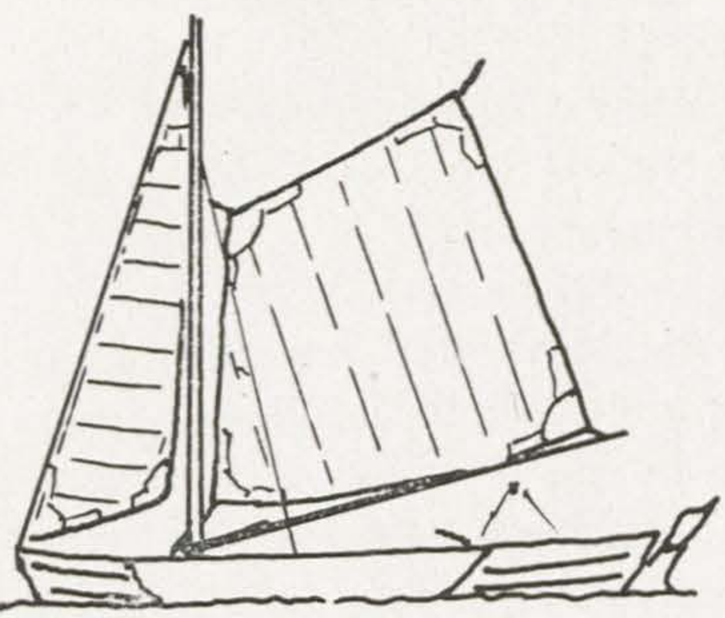
Course	Bermudian	Spritsail	Lateen
Close h.	n.m.m.	n.m.m.	5
Reaching	5	$6\frac{3}{4}$	$6\frac{1}{4}$
Running	n.m.m.	5	7

n.m.m. = no good measurements made

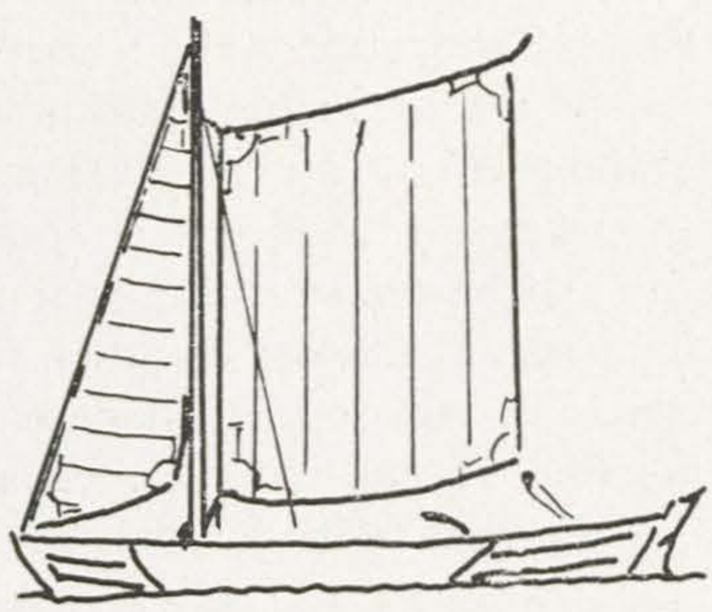


I A

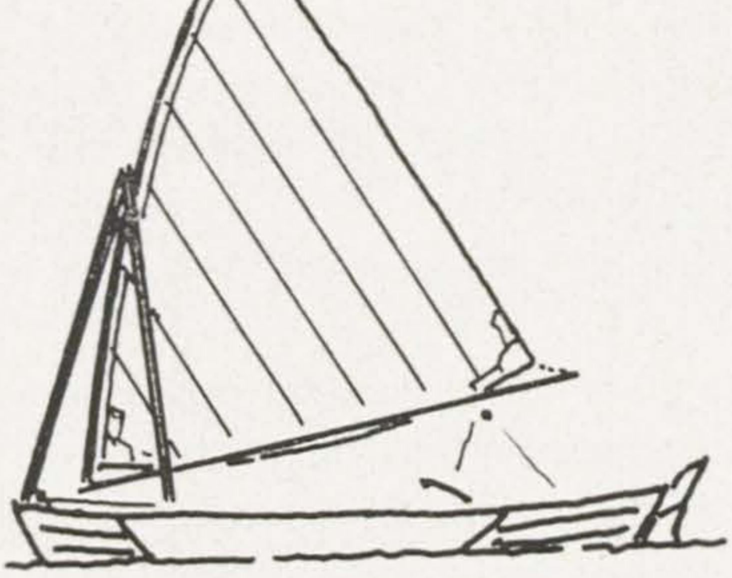
I B



II A



II B



III

The day I reached $6\frac{3}{4}$ knots with the spritsail I was absolutely certain that a much higher speed would be recorded as the wind was steadily growing stronger and more steady, and every run gave better times than the former one. As the wind grew stronger one got the impression that the boat started to enjoy it, and to get into her strides. Unfortunately at that moment I accidentally holed the jib with the boathook, and on the next run it was blown loose of its clew. With the mainsail alone (55 sq. ft.) the boat was still reasonably manoeuverable and she logged still something more than 4 knots.

To show you how the unsteadiness of the wind on the canal can influence reliability of the measurements I may cite the following example. During one of the runs that same day, before the accident with the jib, I covered the first ± 80 meters of a hundred meters stretch in 20 seconds. Then I came through a patch of near windstillness and the last ± 20 meters took 11 seconds to be covered. This gave a total time of 31 seconds for the stretch of 100 meters, and brought down the average speed to 6.26 knots. If the patch of light wind had been lying some fifty yards farther down one could have hoped to come very near to the 8 knots mark.

For this reason, and also because the measurements for the bermudian rig are nearly non-existent, I think it is better to base provisional conclusions on estimations and feeling.

My impressions are that in light weather the bermuda rig, and especially the sloop bermuda rig is notably better than the two other rigs. In these circumstances it certainly is unbeatable to windward. Spritsail A was absolutely nowhere in the light going, probably not only because of its lowness, but also because of the flatness of the main. This was the reason why spritsail B was made which not only was higher but also much fuller. Light wind performances were then better but still not as good as those of the lateen, which in turn were not as good as those of the bermuda rig.

In light to moderate weather both the bermuda and the lateen rig were good, the former one being better to windward, the latter better with the wind aft of the beam. Spritsail B was perhaps slightly better than the lateen to windward but still less good on all courses than the bermuda and than the lateen rig on running and reaching courses.

When the breeze freshened somewhat the bermuda rig seemed no longer to follow suit. Capsizing force seemed to be rather large in comparison with drive, especially downward thrust seemed to play a appreciable part, which made the lee float nosedive. The result was that I have never been sailing really fast with this rig, as I did it often with lateen and spritsail. In these circumstances both spritsail and lateen rig were good, the spritsail being perhaps slightly faster close reaching and to windward, the lateen certainly faster on broad reaching and running courses.

But when the wind started to pipe up, the spritsail undoubtedly was the better rig, especially spritsail A. I think I reached the highest speeds in about force 5 winds with this rig. The lateen sail became then unstable and even unmanageable, probably due to bowing of the yard (antenna) and subsequent deformation of the air foil.

A noteworthy characteristic of the lateen is its tremendous initial thrust, which gives sharper acceleration to the boat than both other rigs do.

So, my conclusion would be that the spritsail really holds the highest speed potential, but that on an Olympic course the bermuda rig seems to be hard to beat, except perhaps in strong winds. Anyway alltogether the difference between the three rigs seems rather small, as the lateen is a very good allround sail, and also holds good high speed potentials.

But there is not only speed, there is also ease of handling.

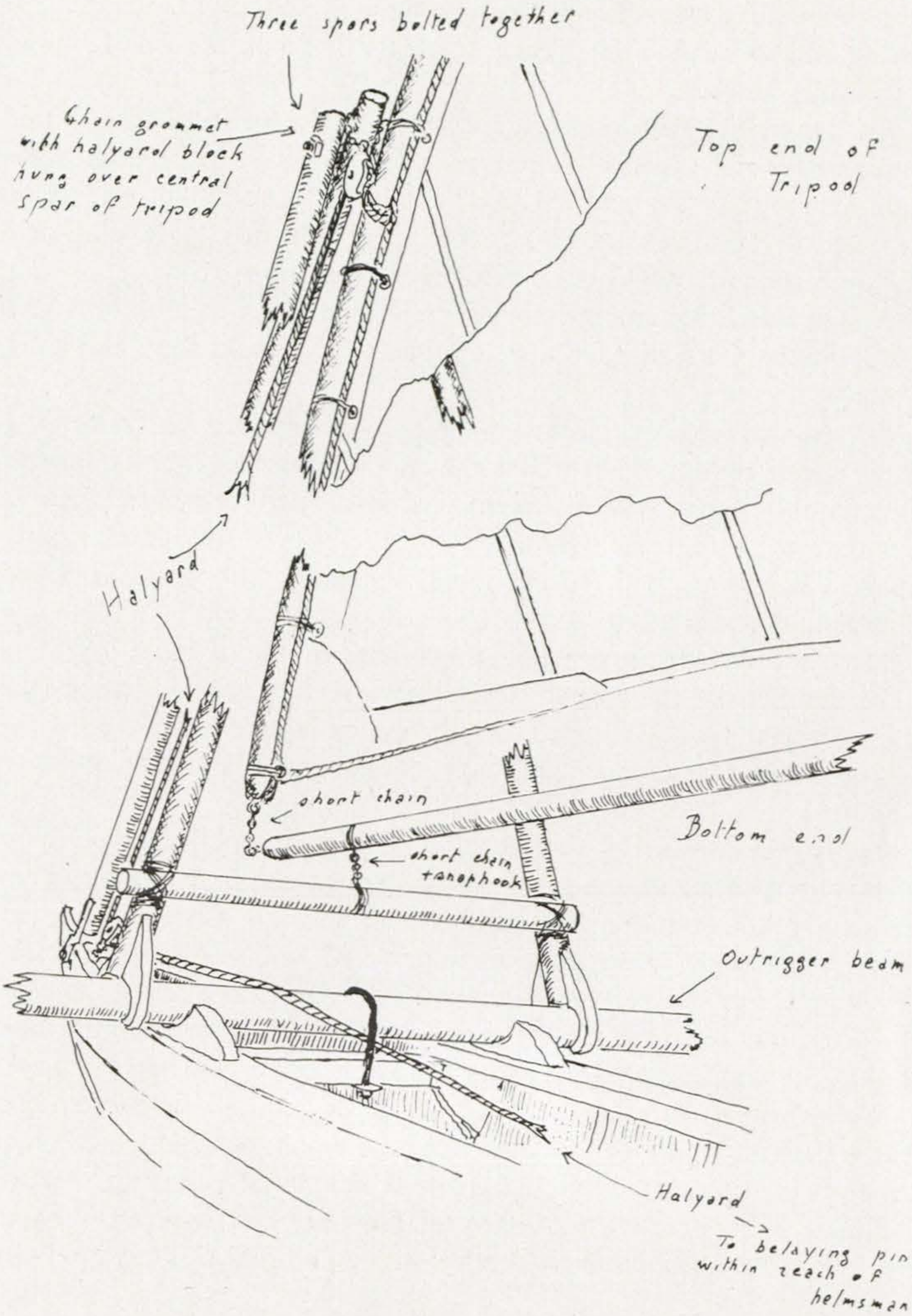
In this respect the spritsail certainly is unbeatable. The bermuda rig, even the most sophisticated, is prone to jam when it has to come down in a hurry in a smart following breeze and with no room to turn the boat.

Setting and lowering the antenna of a lateen is all right in a small boat but on a larger one it is a problem, and it can be a dangerous one. Even in a small boat the fluttering top of the sail allways manages to drop into the water when the sail is lowered, and the long antenna to catch something which is not its business. Its main advantage compared with the bermuda is that it never refuses to come down quickly, and also, for the single hander that it only needs one sheet.

The spritsail on the contrary is set or handed in the time one needs to light a cigarette. These operations can be performed by one man from his place at the tiller, without danger of jamming, whatever the direction or strength of the wind may be, and without danger of being clubbed on the head by the boom, or being buried under a cloud of canvas.

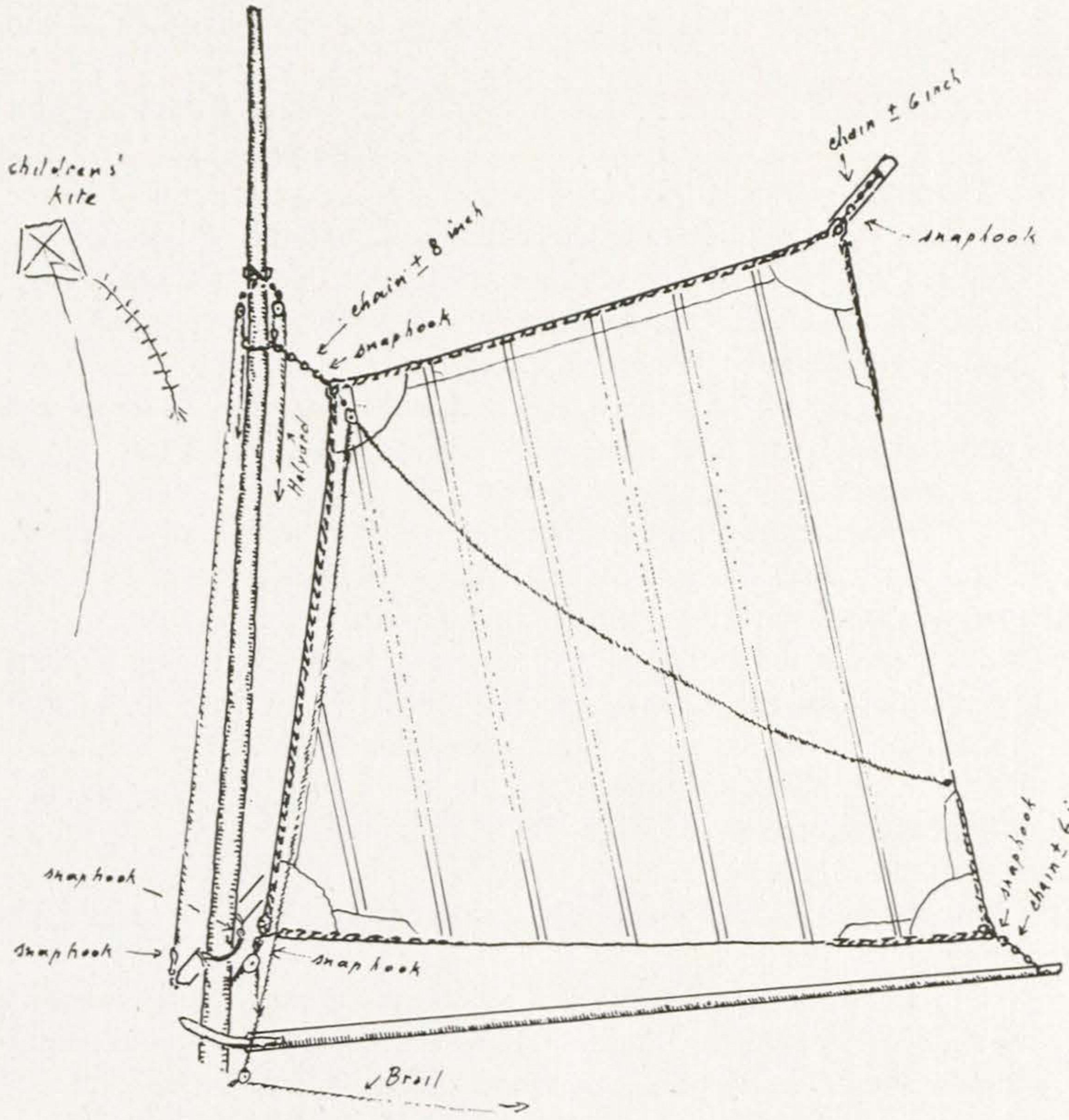
When the sail is handed, all is out of the way in the boat with the sail furled overhead, so that one can walk around in his boat or row or scull it as if it were a simple rowing boat.

There is of course the problem of the furled sail hanging high in a gale of wind (on a mooring, or when the boat has to be rowed). This again is no problem in a small boat as sail and sprit can be lowered in a matter of seconds, and stowed inside the boat. Rerigging or changing sail, again is a matter of seconds (if rigged as my boat was).



The story that a spritsail is better on the tack with the sprit to windward than on the other tack is a myth. I never found any difference. I even tried an arrangement on sail B (boomless) with two sheets on the clew, of which the one not in use was lying idle over the sprit until the boat was tacked, It worked all right but was discarded as having no sense.

The sail is always free of the sprit. Only with rig B the sprit tends



to divide the sail in two parts when it is on the leeside on running courses. But on running courses this does not matter. When close hauled or reaching the sprit does not, or barely touches the sail.

My spritsail was largely inspired by the rigging of the flatbottomed fishing boats that used to work between the isles of the river Scheldt estuary. Those boats were called " hoogaars " and were considered as the swiftest of those waters. I enclose hereby a copy of a drawing of such a boat by Mr. J. Van Beylen, Director of the Antwerp Maritime Muzeum. It was published in Tome XIII of the *Mededelingen van de Marine Academie van Belgie* Uitgeverij De Sikkel N.V. Lamoriniére-straat, 116, Antwerpen, page 134.

May I attract your attention on the great beauty of this boat, and its rigging ?

You will also observe that the shape of the spritsail roughly reminds one of a children's kite, with the apex attached halfway to the mast.

Old hands told me that the sail stood about 3 to 4 ft. from the mast.

In my first spritsailrig I really made a kite shaped sail. For this reason I needed a boom. When I decided to make a slightly larger and fuller sail, I also modified the shape to be able to sail it without boom.

I believe that spritsail A holds the highest speed potential of the two, but for lighter winds sail B was better as it was higher and more fully cut.

Now spritsails come in a lot of other shapes.

There is first another Dutch and Flemish kind which is relatively high and narrow, and often narrower at the peak end than at the bottom, and this one is rigged to the mast.

There is the Thamesbarge spritsail which is more steeply peaked.

There is the Pacific variety which probably is the spritsail as it was at the very beginning in Europe: a simple square piece of cloth.

Björn Handström in *The Ship* gives other shapes, e.g. page 226 on the Hawaiian catamaran, or on page 211, the Greek or Turkish variety which seems to furl to the mast, along a wire, like a curtain.

Last but not least there is of course the shape you suggest and which is interesting as it combines the mainsail and the top sail in one single sail, and further as it allows reefing in the classic way.

So, some more experiences along those lines should certainly be interesting.

You noticed, I suppose, my jib, which is narrow, nearly vertical and notably higher than the main. When I designed it, I was inspired by some drawings of 17th and 18th century Flemish and Dutch boats.

It proved to be excessively efficient, and I feel that the jib being notably higher than the main is an important factor.

So; I hope I've told you at least a couple of things which can really interest you and other members of the Association.

This year, I plan to have a try with the " Pacific lateen " with its isoceles shape. I certainly will tell you what I think of it.

Very sincerely yours,

K. Michielsen.

SAILBOARDING : EXCITING NEW WATER SPORT

BY

S. Newman Darby

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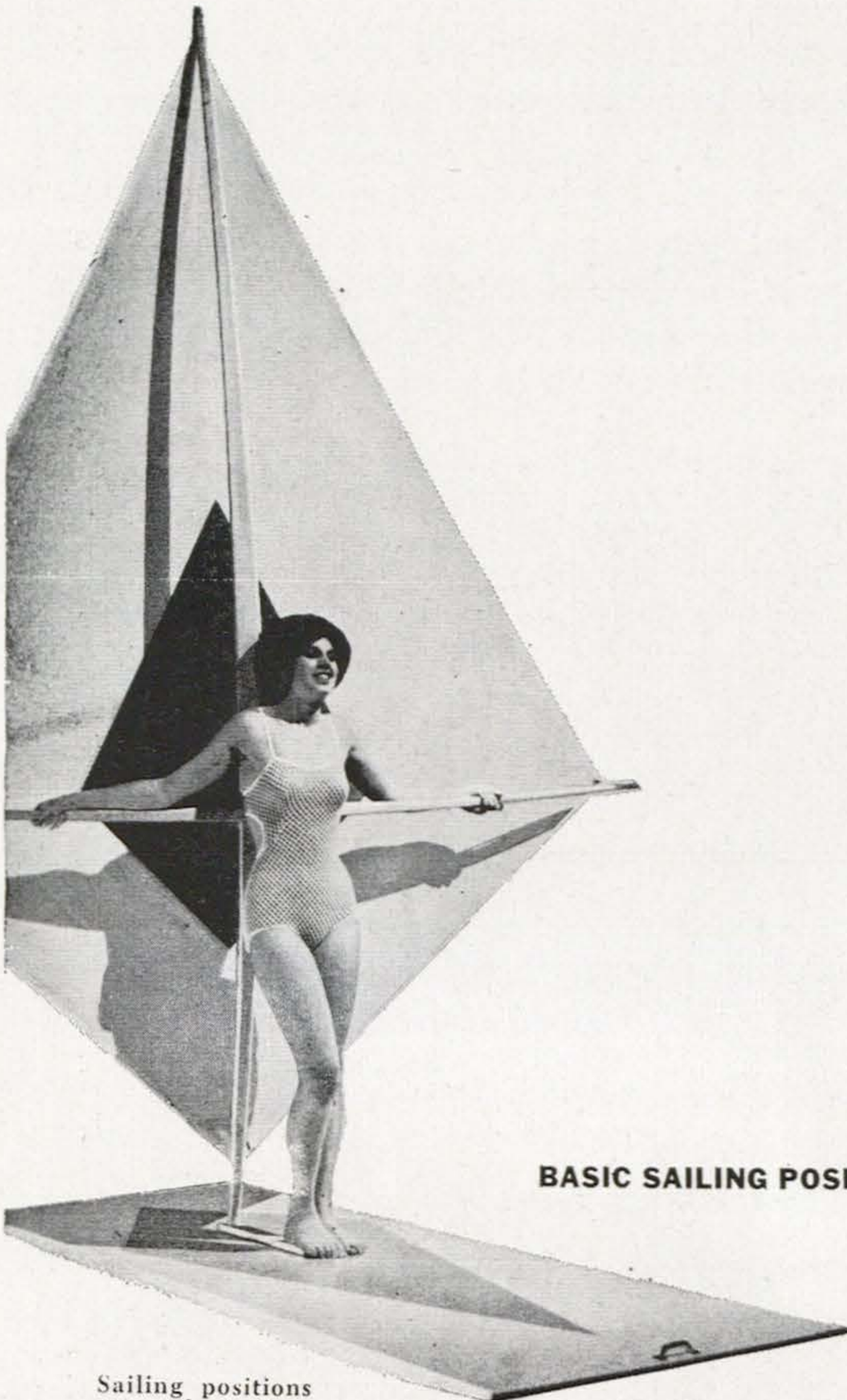
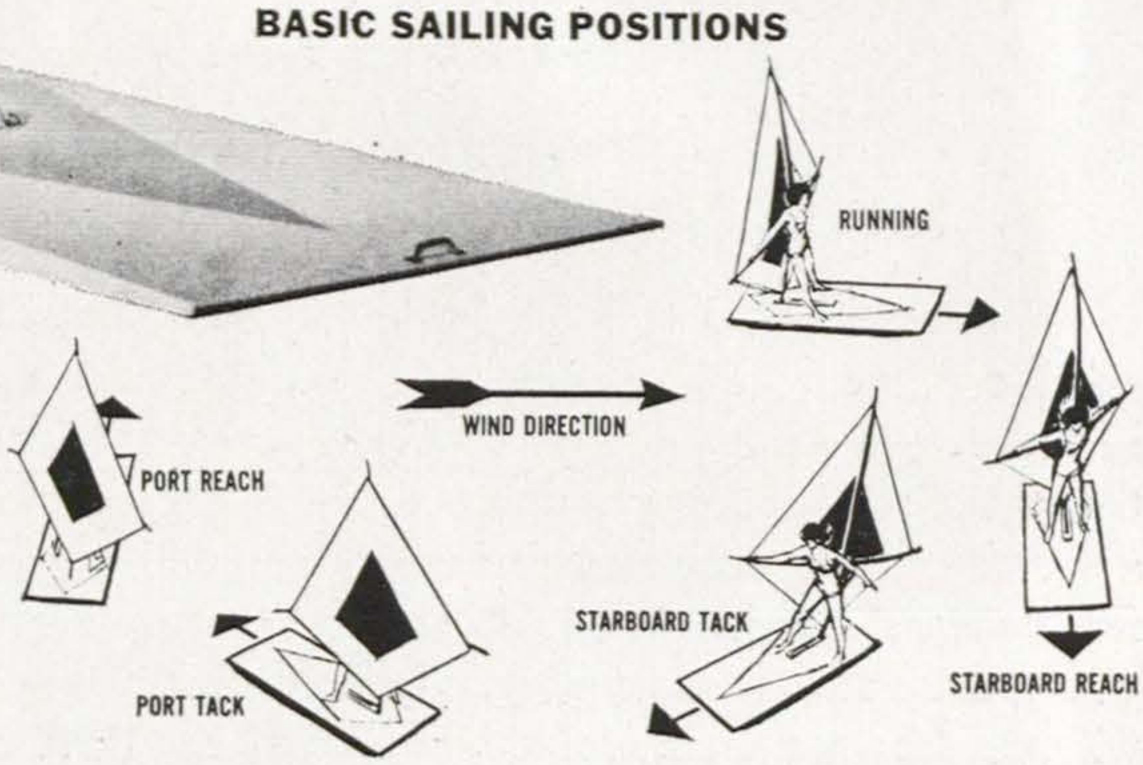
A sport so new that fewer than 10 people have yet mastered it promises to become inexpensive sailing fun for many who love to sail, but don't want to have to live with the expense of keeping a full-size boat. Sailboarding is sailing with a difference. You get all the fun of handling a fast, responsive boat. You can have the fun of spills without the work of righting and baling out. And you can learn to master a type of maneuvering that's been dead since the age of the picturesque square riggers.

You'll find the sailboard versatile: You can use it as an aquaplane behind an outboard as well as sail it. You can even take a nap on it while sunbathing.

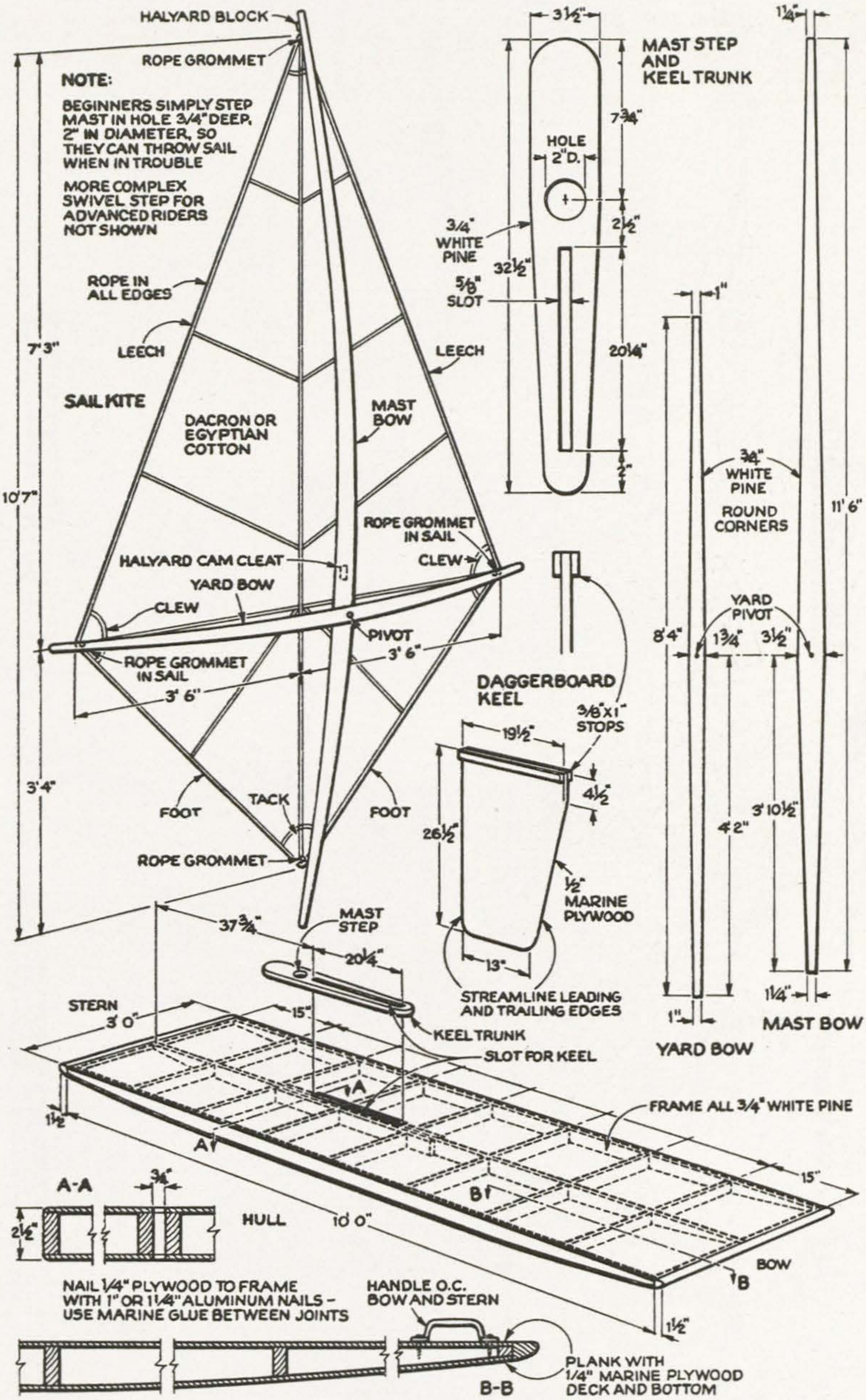
Learning to handle a sailboard is quite a change, even for an experienced paddle-board sailor, because you have no rudder and must steer with the sail. You also have to learn to handle what is really a square-rigged ship rather than a fore-and-aft Marconi rig like that on small sailboats you have known.

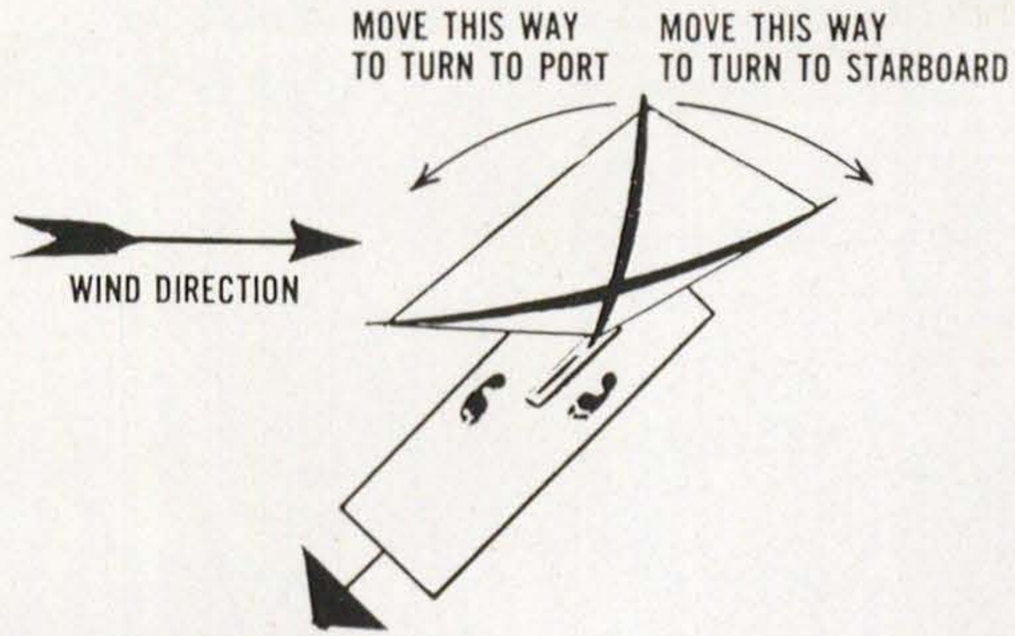
What about safety ? A basic requirement is that you be a really good swimmer. You are sure to spend quite a bit of your learning time in the water. Second, if you feel the wind is too strong for you, simply throw the sail kite overboard (make sure it's secured to the sailboard by a lanyard so you can retrieve it once the gust has passed). Third, if you feel yourself tipping, let go of the sail and dive overboard. That way, you wont' fall and hurt yourself on the board. The sail in the water will act like a sea anchor, so the board will not drift out of reach. Then you simply climb back aboard, pick up the sail, and start over. When picking up the sail, get the wind on the underside and it will help you bring the mast into position. The wet sail will work even better than a dry one.





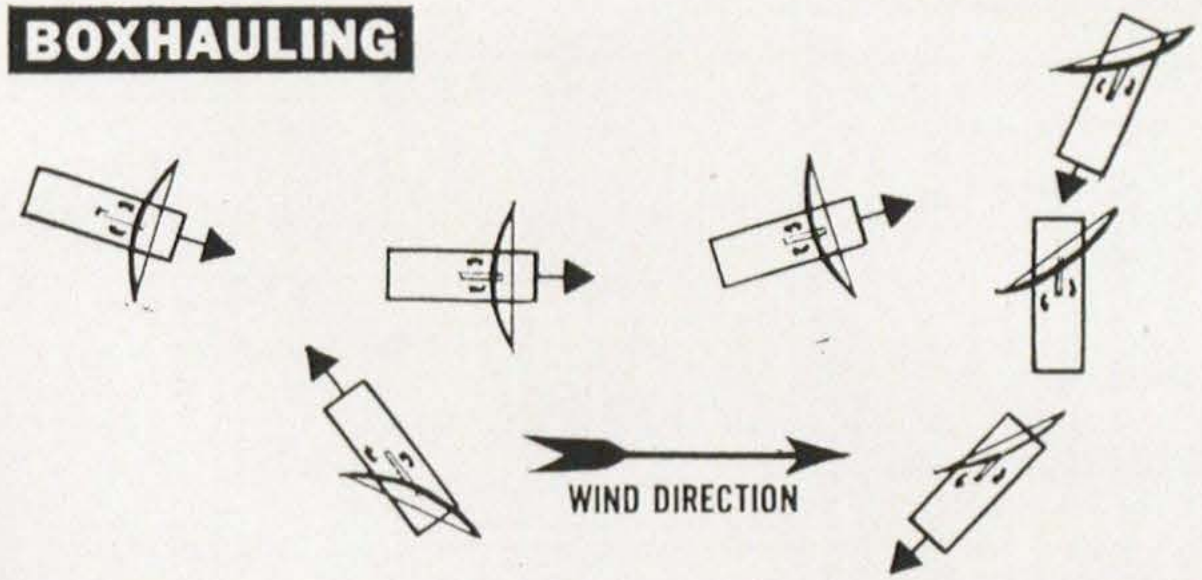
Sailing positions are similar to those for any sailboat, but this one is a square rigger, so the wind pushes it. You steer by pivoting the mast in its socket, tilting sail.

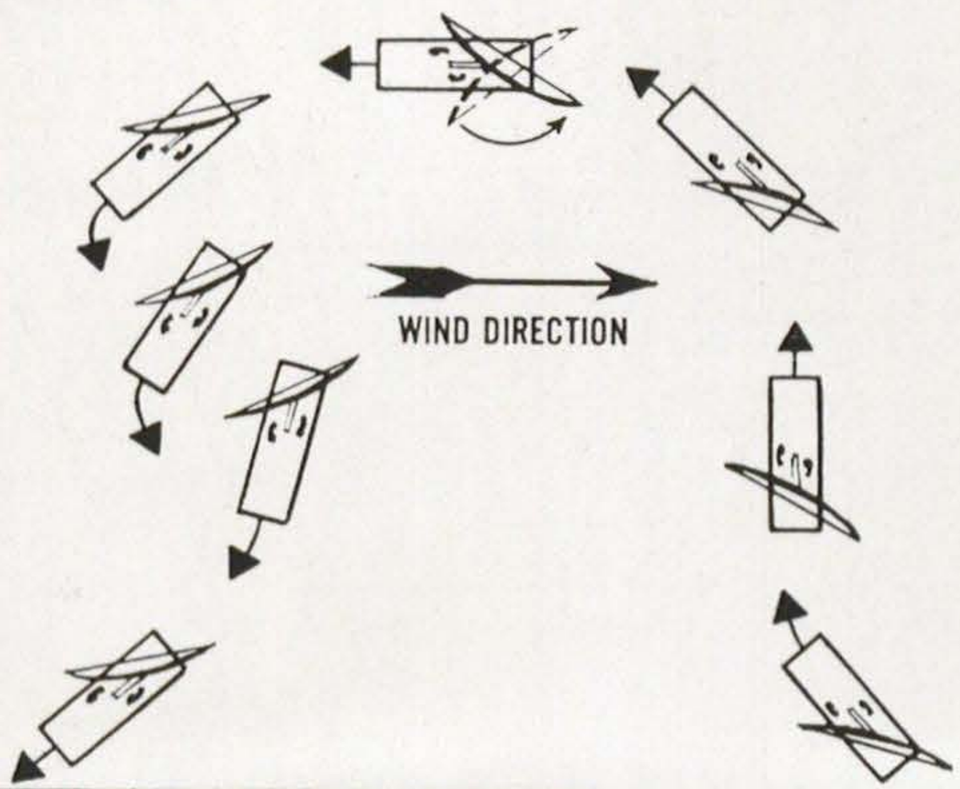

HALYARD BLOCK
ROPE GROMMET
NOTE:
BEGINNERS SIMPLY STEP MAST IN HOLE 3/4" DEEP, 2" IN DIAMETER, SO THEY CAN THROW SAIL WHEN IN TROUBLE
MORE COMPLEX SWIVEL STEP FOR ADVANCED RIDERS NOT SHOWN
ROPE IN ALL EDGES
LEECH
LEECH
7'3"
SAIL KITE
DACRON OR EGYPTIAN COTTON
MAST BOW
10'7"
ROPE GROMMET IN SAIL
HALYARD CAM CLEAT
CLEW
YARD BOW
CLEW
PIVOT
3' 6"
ROPE GROMMET IN SAIL
3' 6"
3'4"
FOOT
TACK
FOOT
ROPE GROMMET
37 3/4"
MAST STEP
20 1/4"
STERN
3' 0"
15"
KEEL TRUNK
SLOT FOR KEEL
A
1 1/2"
A
FRAME ALL 3/4" WHITE PINE
15"
A-A
3/4"
2 1/2"
HULL
10' 0"
B
BOW
B
1 1/2"
NAIL 1/4" PLYWOOD TO FRAME WITH 1" OR 1 1/4" ALUMINUM NAILS - USE MARINE GLUE BETWEEN JOINTS
HANDLE O.C. BOW AND STERN
B-B
PLANK WITH 1/4" MARINE PLYWOOD DECK AND BOTTOM
3 1/2"
MAST STEP AND KEEL TRUNK
7 3/4"
HOLE 2" D.
2 1/2"
3/4" WHITE PINE
32 1/2"
5/8" SLOT
20 1/4"
2"
DAGGERBOARD KEEL
3/8" X 1" STOPS
19 1/2"
4 1/2"
26 1/2"
1/2" MARINE PLYWOOD
13"
STREAMLINE LEADING AND TRAILING EDGES
1 1/4"
1"
3/4" WHITE PINE
ROUND CORNERS
11' 6"
YARD PIVOT
8'4"
1 3/4"
3 1/2"
3' 10 1/2"
4' 2"
1 1/4"
1"
MAST BOW
YARD BOW



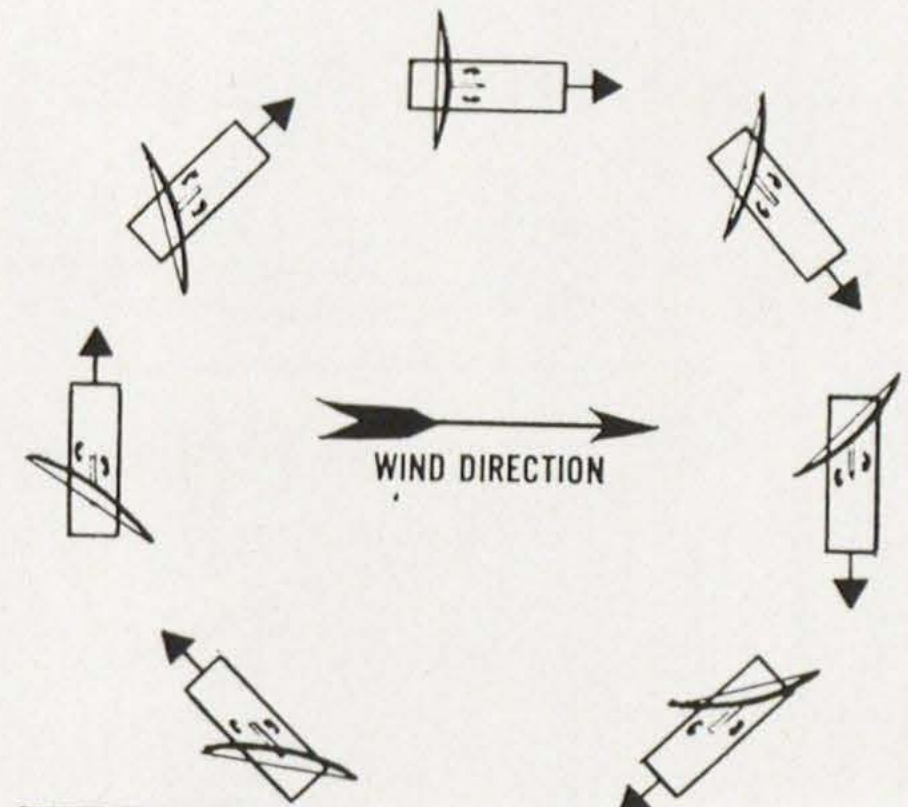
HOW TO STEER

BOXHAULING





HOW TO COME ABOUT



HOW TO JIBE

Although part of the fun of learning to handle a sailboard is falling off, a basic rule is to have someone with you in another boat in case of emergencies. If you tire from strenuous manoeuvring, just throw the sail overboard and lie down on the board for a restful sunbath.

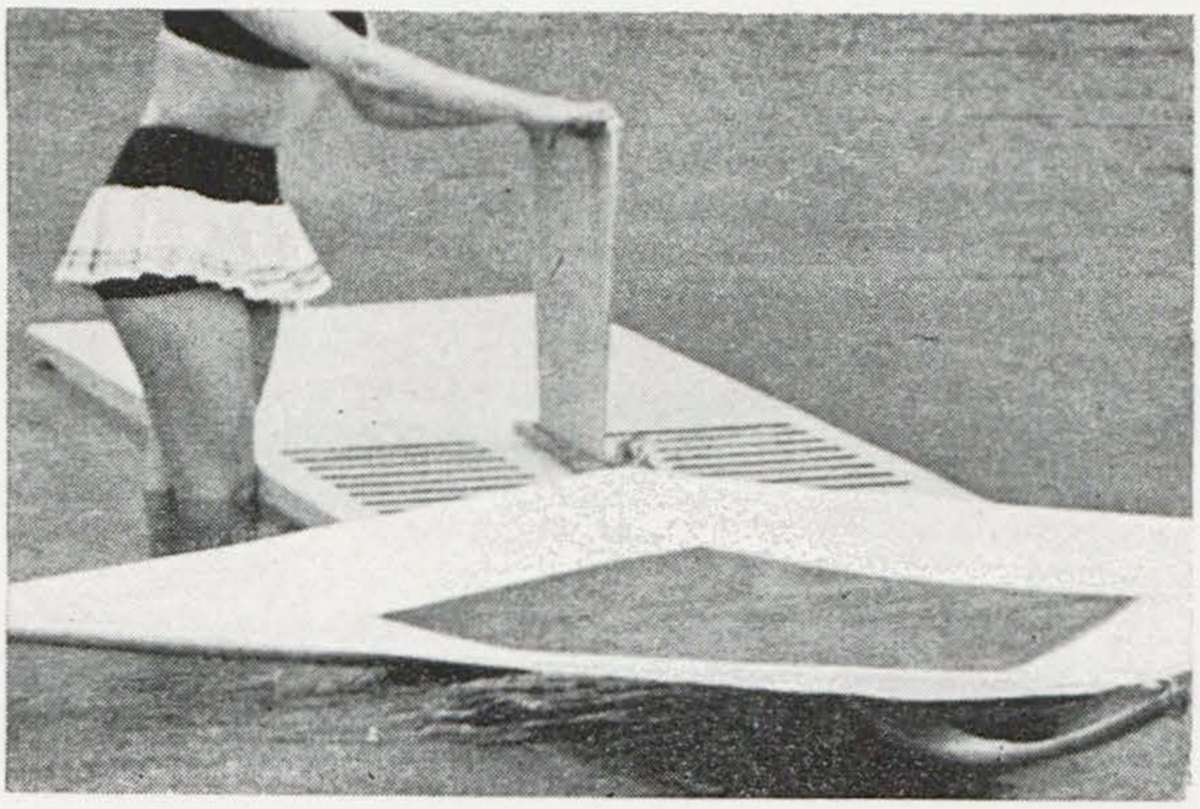
Building the sailboard. Frame the 3 ft. x 10 ft. flat deck with $\frac{3}{4}$ in. x 2 in. white pine. First cut three 10 ft. longitudinal pieces and fair each of these equally at both bow and stern ends. Begin the fairing about 25 in. from the ends and carry it on an even curve to a thickness of about $\frac{3}{4}$ in. at the ends. A bandsaw will be a big help in cutting these curves but you might use a saber saw.

Space seven crosspieces on 15 in. centres and shape nosings from $\frac{3}{4}$ in x $1\frac{1}{2}$ in. whitepine strips for bow and stern.

Cut $20\frac{1}{4}$ in. from the centre longitudinal at the point shown for the daggerboard. Form a slot by gluing and nailing $\frac{3}{4}$ in. x 2 in. x 36 in. strips on either side of the remaining end pieces. Assemble all parts with waterproof glue and aluminium nails.

Plank the frame with $\frac{1}{4}$ in. marine plywood top and bottom. Make the daggerboard from $\frac{1}{2}$ in. marine plywood with $\frac{3}{8}$ in. x 1 in. white-pine stops nailed and glued along the upper edge. The mast step and dagger-board trunk are made in one piece from $\frac{3}{4}$ in. x $3\frac{1}{2}$ in. x $32\frac{1}{2}$ in. white-pine.

The mast is $\frac{3}{4}$ in. x $3\frac{1}{2}$ in. white pine or spruce 11 ft. 6 in. long. Taper it to $1\frac{1}{4}$ in. at the tips so it will bow to hold the sail. The yard is $\frac{3}{4}$ in. x $1\frac{3}{4}$ in. white pine 8 ft. 4 in. long tapered to 1 in. at the tips.



Round and smooth the edges of the mast and yard so they will be comfortable to handle.

Sew the sail from Dacron or Egyptian cotton with rope in the outer edges for reinforcement. The drawing gives dimensions. If you'd rather not attempt to make it yourself, you can buy one ready-made.

(The author is producing a limited number of complete fibreglass sailboards to sell for about $270, knocked-down plywood kits (with sail and fittings) for $162, sails for $40, and finished spars for $32.50. For further information, write S. Newman Darby, 333 Park Street, West Pittston, Pa.)

CATAMARAN AND TRIMARAN INTERNATIONAL NEWS

In the last issue we gave brief particulars of some articles that have appeared in C.A.T.I.N. in 1966.

Many readers have asked for a complete index and this is now available FREE.

Please send a stamped addressed envelope if you would like one.

The JULY issue had

1 Photos on the wonderful new *Glass Slipper II* catamaran made by Glas-Craft using new construction techniques.

2 Photos of the Round Britain *Toria*, *Mirrorcat* and *Sumner*.

3 Particulars of the Crystal Trophy Multi-Hull race sponsored by Shell-Mex and B.P. Limited with photos.

4 Twelve large photos of the " Tall Ships," etc.

For your future enjoyment we have :

In the SEPTEMBER issue

1 Construction story and photos of *Toria*.

2 A " Round Britain Race " story from Derek Kelsall the winner in *Toria* and the story from Mike Ellison in *Iroquois*—winner on handicap.

3 New 'A' class cats—a new wingsail 14 ft. 6 in. cat *Solitiare*.

4 Photos and story of the Round the Island race, Multi-Hull winners.

5 The new *Prout* 45 ft. cruiser.

6 The new 'C' Class boats—*Lady Helmsman*—challengers for the Little America's Cup, etc.

7 North American Multi-Hull S.A. race results and pictures.

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