CATAMARANS 1969

AYRS PUBLICATION No 67

THE AMATEUR YACHT RESEARCH SOCIETY

(Founded June, 1955 to encourage Amateur and Individual Yacht Research)

Editor and publisher:

John Morwood, Woodacres, Hythe, Kent, England.

EXTRAORDINARY SOCIAL MEETING

We are happy to announce that His Royal Highness, Prince Philip, who contributed so much to our enjoyment at the previous special meeting of the AYRS, will again honour us with his presence in the Chair, at a further special meeting on April 1st. The subject will be:—

THE 1968 SINGLE-HANDED TRANS-ATLANTIC RACE

The speakers will be people who sailed in the race, and, we will show Colin Forbes' film, which he took while actually participating.

The meeting will take place at the Caxton Hall, Westminster, London, on April 1st. Everyone should be in their seats at 7.15 pm. Tickets will cost £1 each and members can apply for up to three tickets.

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FRONT COVER

GOLDEN COCKEREL sailed by Bill Howell, photographed after crossing the finishing line of the 1968 Single-Handed Trans-Atlantic Race, at Newport, Rhode Island. Bill was Australia's only entrant. Although *GOLDEN COCKEREL* was not designed as an Ocean Racer, (it was built to a C/S/K stock cruising catamaran design—now 6 years old), with good seamanship and skill Bill took 5th place. (See page 23).

British headquarters

The response to the questionnaire on siting a British headquarters, whilst small in relation to the total membership, was nevertheless, gratifying in volume and in the degree of interest expressed.

To those who took the trouble to reply, I should like to express thanks and to those who offered concrete ideas (some in considerable detail), I should like to add the committees' gratitude to my own, whilst from those who did not respond, we accept the vote of confidence expressed by silence.

The committee is confident that the membership believes the time to be ripe for a central headquarters to be established (about 92 per cent in favour) whilst in assessing the pros and cons of a marina or inland lake, geographical siting etc., account was taken of both 'for' and 'against' votes.

The result was overwhelmingly in favour of a marina and very much against an inland waterway, with the southern counties as the most desirable site. Consideration will also be given to the possibility of establishing a number of small sites throughout the British Isles (why not the World?), *provided* that enough offers of local management warrant such a step. The response would have to be much greater than was evident when we endeavoured to set up regional groups some time ago.

We are now examining the suggestions in detail and visits to several sites will be undertaken in the near future, whilst the all important financial 'ways and means' will be thrashed out by our business management sub-committee.

The committee is confident that the finances can be arranged either, by some form of membership debenture scheme or by co-operation with a development company.

The successful conclusion of this project will undoubtedly add greatly to the stature of the AYRS, not the least aspect of which will be in the inflow of funds with which to extend our activities in the research field and the establishment of an AYRS 'College of Yachting'.

Lloyd Lamble, Committee Chairman.

The AYRS

The Society plods on under some difficulties. The publications are now being edited and assembled by various kind people. But, they are often doing this kind of thing for the first time and schedules are hard to meet. However, with our usual good luck and the good wishes of members, I feel sure that we will able to carry the load in the future.

The main complaint against the AYRS

Many members would like to have more articles on conventional single hulled yachts and resent the 'continuous procession of similar multihull designs'. What I feel here is that the ordinary yachting magazines produce plans for single hulled yachts in adequate numbers for anyone and our place is to study the performance of such yachts and the design where appropriate. Multihulls, however, still need much improvement not only in design but in construction, which we can force by giving accounts of them.

The membership
The figures for membership for 1967 was 1,551. That for 1968 is 2,034 which shows that the Society is very much alive. Each year, many people drop out, either because their interest in yachting stops or because they cease to be interested in our subjects. But their place is taken by many new members, many of whom write the most enthusiastic letters about our work.

The '*Ayrsfoil* Class'
We are still as keen as ever to have people build flying hydrofoil craft, either from their own designs or from those of Don Nigg. Don's plans cost £10 or $20.00 US). We still need 'Class Secretaries' in all sailing areas. The *Ayrsfoil* is a development class with every feature variable, even the sail area, except for the overall dimensions of the hull.

The AYRS burgee
Members are urged to sail under the AYRS Burgee (prices 5½ in $2 or 14/-, 16 in $4.00 or 28/-) and put AYRS on the transoms of their boats.

Binders for AYRS publications
These can be got from ESIBIND Ltd., Hartley House, 4 Uxbridge Street, London, W8. at a cost of £1-1-0, each post paid. Each binder takes about 20 publications.

The index
This was distributed with publication No. 66a. If any member has not got his copy, will he please write to Woodacres. This index could be most useful to members who want to look up things. We think it is excellent but, if any member has any ideas for its improvement, will he please write in.

Changes of address
Our members seem to move around a lot, judging from the number of changes of address we get each year. When we are not notified, publications are lost. Members may find that their changes of address are not on our latest list of AYRS members. This is because we were not told in time to get it in the list, though this is as up to date as we could make it.

Overseas AYRS groups
On the whole, I don't think that we have ever shown much national bias in our editorial policy, other than the fact that we cannot get to see regattas in far off parts of the world and, when we ask local folk for accounts, they don't always appear. We are concerned with the general administration which adds a local bias to some things, but we bring in articles from anywhere in the world without fear or favour. The American members are strong in numbers but, except for Los Angeles, they are not organized. New Zealand, too, has many members but they do not meet at the moment. The Australians are keen folk but, like most, they are too scattered for meetings. Ray Dooris, though no longer dealing with the distribution of publications, is still ready to help members with their questions.

WILLS VENTURER II

This 'C' Class catamaran with sloop rig is second to none in her hull form, though her rig puts her out of contention as a competitive 'C' Class boat. She is ours by 'permanent loan' from Messrs. W. D. & H. O. Wills, the Tobacco Company, who built her, and has been sailed by Tom Herbert, 23 Oakwood Gardens, Seven Kings, Essex this year. However, she is often too much for Tom and he would welcome people to sail with him, and preferably people who can contribute something to the upkeep of the yacht.

AYRS books

After 14 years of our publications, there is a wealth of information in our publications on many subjects. We would like to reprint all back issues now out of print but this might not be economic in all cases. It would be better if interested folk could assemble the material from past publications into book form. Titles might be: 'Ocean Cruising', 'Catamarans', 'Trimarans', 'Sail Design', 'Hull Design', 'Hydrofoils' etc. If anyone would like to do such a job for us, we would be happy to pay him royalties when the book is published.

Boat-building in Ferro-cement

How to build a Ferro-cement boat by John Samson/Geoff Wellens. This book, price $9.75 or £4-4-0 is a complete and comprehensive study of boatbuilding in Ferro-cement. It covers every aspect of the matter from the types of cement one can use to various ways of assembling the wires before casting on the mortar. Though fairly costly, this book would be needed by anyone thinking of building a boat in this material. Copies are available from Woodacres, Hythe, Kent.

Members' Letters

We always answer any letter which contains a request for information—even if we don't know the answer. Sometimes of course, there is a delay but we always reply. It is this two-way communication which gets us material for the publications. We like to have descriptions of boats of all kinds, particularly if they have some unusual features.

Boat Show 1969

Due to messing about of the AYRS by the Boat Show organisers, we were left, at the last minute, without a stand. Due to tenacity and hard work by Eric Thorne Symmons, a small, but useful, stand was obtained and fitted up. Rodney Garrett very kindly allowed us to exhibit his hydrofoil stabilized trimaran *SULU* (see pages 9, 10 and 11) but owing to lack of space this interesting craft had to be placed at the back of the stand. However, it was noticed by many visitors to the show and so helped considerably to attract them to our stand.

The usual planned display of boats or models could not be made, so concentration was made on the publications and this proved a highly successful operation—the sales of Self-Steering (Hardback) going particularly well, whilst the number of membership renewals was considerable, as in previous years, and new members totalled 55 at the show, despite a further let down by the organisers, whereby, they had agreed to issue to all overseas visitors a personal invitation from Sir Peregrine Henniker Heaton to visit our stand. These invitations were never issued, which was a great shame.

Lloyd Lamble, Committee Chairman.

John Morwood

The January issue of the magazine, usually issued at the Boat Show, was not available, owing to our founder editor—John Morwood—having worked himself into the ground, both in his large medical practice and in the AYRS and, indeed, the point has been reached where John can no longer shoulder the volume of work entailed in running the AYRS and the executive has been exploring ways and means of alleviating the situation.

The membership is now showing signs of exploding, and the Society must now either go on or go back. We have a committee of men, whose qualifications would enhance any board-room and, in John Morwood, we have a man, whose qualities of both knowledge and enthusiasm—the exact measure of which, would be difficult to duplicate, to say the least.

Nevertheless, it has been recognised for some time that provision must be made for the future of the Society and, after discussion of many ideas, it has been decided to try and find someone to relieve John Morwood of the more onerous aspects of the magazine—which, after all, is the life blood of the AYRS. Assistance on the editorial side is also required and reference to this has been made in publication No. 64. We feel that a reasonably substantial salary could be paid to the right man, to manage the Society in a way which will take advantage of the upsurge, now evident, whilst the editorial help will have to be voluntary, at least for the moment.

The foregoing is the most important issue to face the AYRS at any stage so far, and we appeal to all members to give the most serious though and help in these two matters—either by practical offers of help, or by suggestions as to actual personnel. We believe that John Morwood's dream of an AYRS College of Yachting, with a permanent HQ is a practical proposition, which is capable of realisation—provided that, from this crossroads in the AYRS history, we take the right turning, having plotted the course carefully and made sure that we are ship-shape and in all respects, ready.

Lloyd Lamble, Committee Chairman.

Catamarans 1969

This publication has been edited by David Gaffyne and Joyce and Ron Doughty. We owe the new printing layout and many of the photographs to the Doughtys.

I am not much of a believer in change for change's sake, believing that, when one has a good formula of work which has proved successful, one must think carefully before making a change at all. However, the new printing style is far more readable in my opinion and I hope that it will be liked. The Doughtys have really put a lot of thought and work into this issue and are to be congratulated on a very nice job.

We are lucky to have Bob Harris' article on the design of catamarans both for cruising and racing and the new catamarans we show prove that the major snags in that field are nearly all conquered. □

WEIR WOOD MEETING, 1968

by Dennis Banham Highlands, Blackstones, Redhill, Surrey

As last year, we started our annual week-end meeting in heavy rain and gale force winds. John Morwood and myself stood looking over the gloomy rainswept water and he remarked 'another AYRS wet weekend!'—and so it seemed. However, about 11 a.m. the sky brightened and the rain eased off, though the wind stayed very strong and even seemed to increase.

Members started to arrive and quickly took their boats through the decontaminating routine before starting to assemble them at the water's edge.

By lunch time, the sun had come out and for the remainder of the afternoon and all day Sunday, we had sunny weather and strong winds—ideal conditions for trying out the gear and construction strength of the members' boats.

It was a little difficult sorting out some of the more conventional AYRS boats from those of the Weir Wood Sailing Club, which were present in large numbers, but if anyone's name isn't mentioned, I hope to be forgiven for the omission.

We were able to ward off the local Club's new objection concerning the 'third party' insuring of AYRS boats by obtaining insurance through the Royal Insurance Company in a 'block' cover. Rather a last minute effort, I'm afraid, as several of the 'so-called' Marine insurance firms flatly refused to insure multihulls, and as for 'experimental' and 'research' craft . . . ! Two firms did not bother to reply and time was running out. Rodney Garrett rang me up and put me in touch with the above Company whom I found most helpful and co-operative, both in taking out a block third party for the weekend and a season's cover for my own new trimaran *WIND CHEETAH*.

The following craft were present at this year's meeting:

TRIMARANS

1 Rodney Garrett's new 18 ft *Mosquito Mk.II SULU* (with foils).
2 Kenneth May's 16 ft 6 in *KELEK* with inflatable outriggers.
3 John Partington's 16 ft *CHEROKEE* with new centre hull.
4 Russell Madden's 18 ft *LULU* una rig.
5 Dennis Banham's 18 ft *WIND CHEETAH*.

HYDROFOILS (as distinct from trimarans with foils)

1 Chris. Rowe's 20 ft *SUNBIRD* with two foils.
2 Paul Dearling's PBK canoe *LONGFELLOW* with Clark foils.

CATAMARANS

1 Kenneth Ward's new 16 ft *Lightning STREAK*.
2 Charlie Burr's *Swift*.
3 Harry Ralph's 13 ft own design *BUZZ OFF*.
4 Peter Gibby's 14 ft 6 in *Cheetah PURR*.

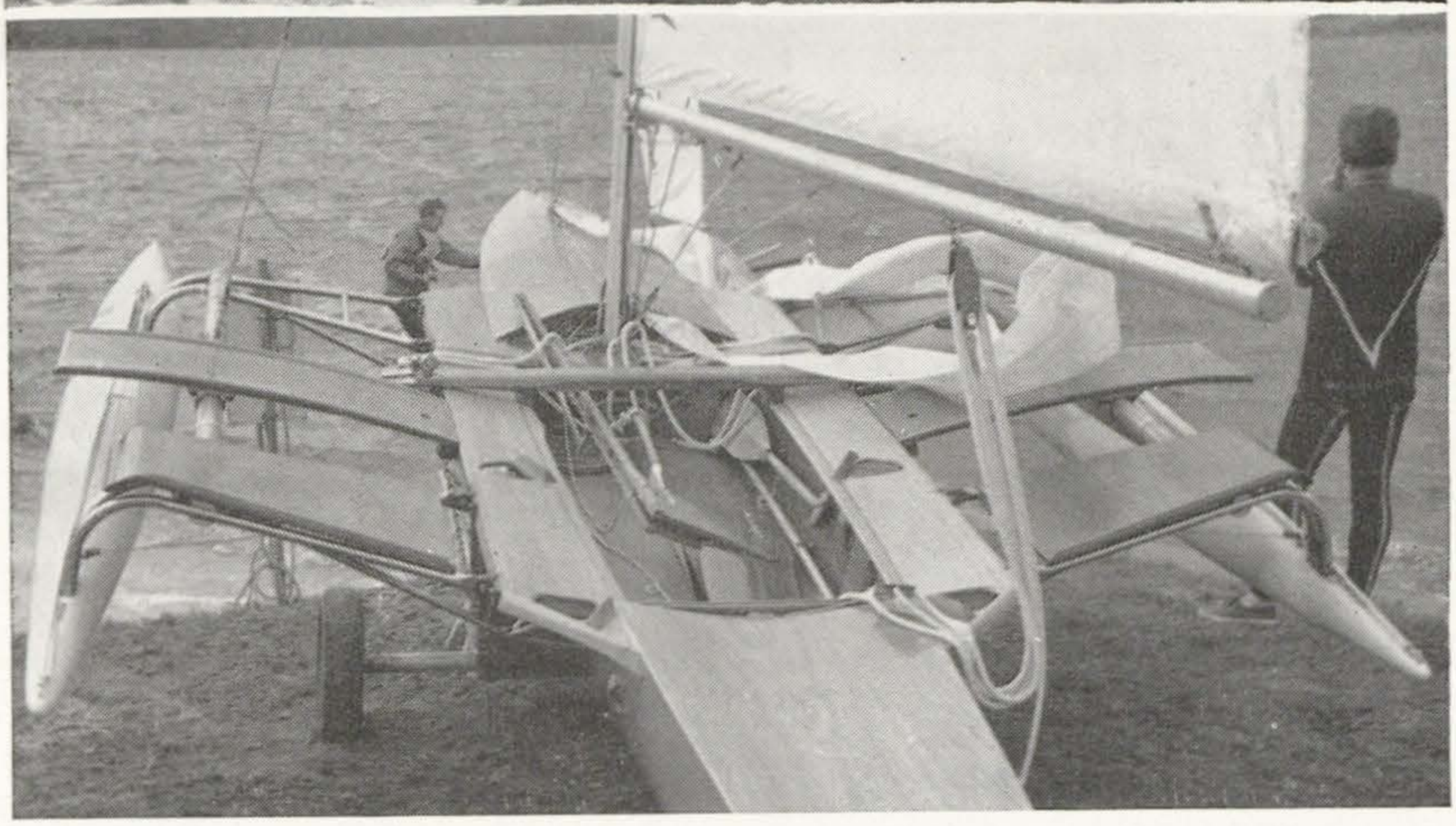
MICRONESIAN

1 Chris. Hughes' Proa *KIA KIA* with new sail plan.
2 Charles Sutherland's outrigger canoe *CINNAMON*

SULU sailing upright in a strong breeze with the windward foil fully retracted. The submerged leeward foil is stabilizing the craft and holding the leeward float clear of the water
Photo: Joyce Doughty

Trimarans

Once again the boat that really stirred the imagination was a *Mosquito* class trimaran, the new Mk. II, *SULU*, designed and built by Rodney Garrett and Derek Norfolk. The floats on *SULU* are developed from those used on the



Photos: Top, Rodney Garrett. Bottom, Kenneth May

Two views of *SULU* showing the general shape and layout

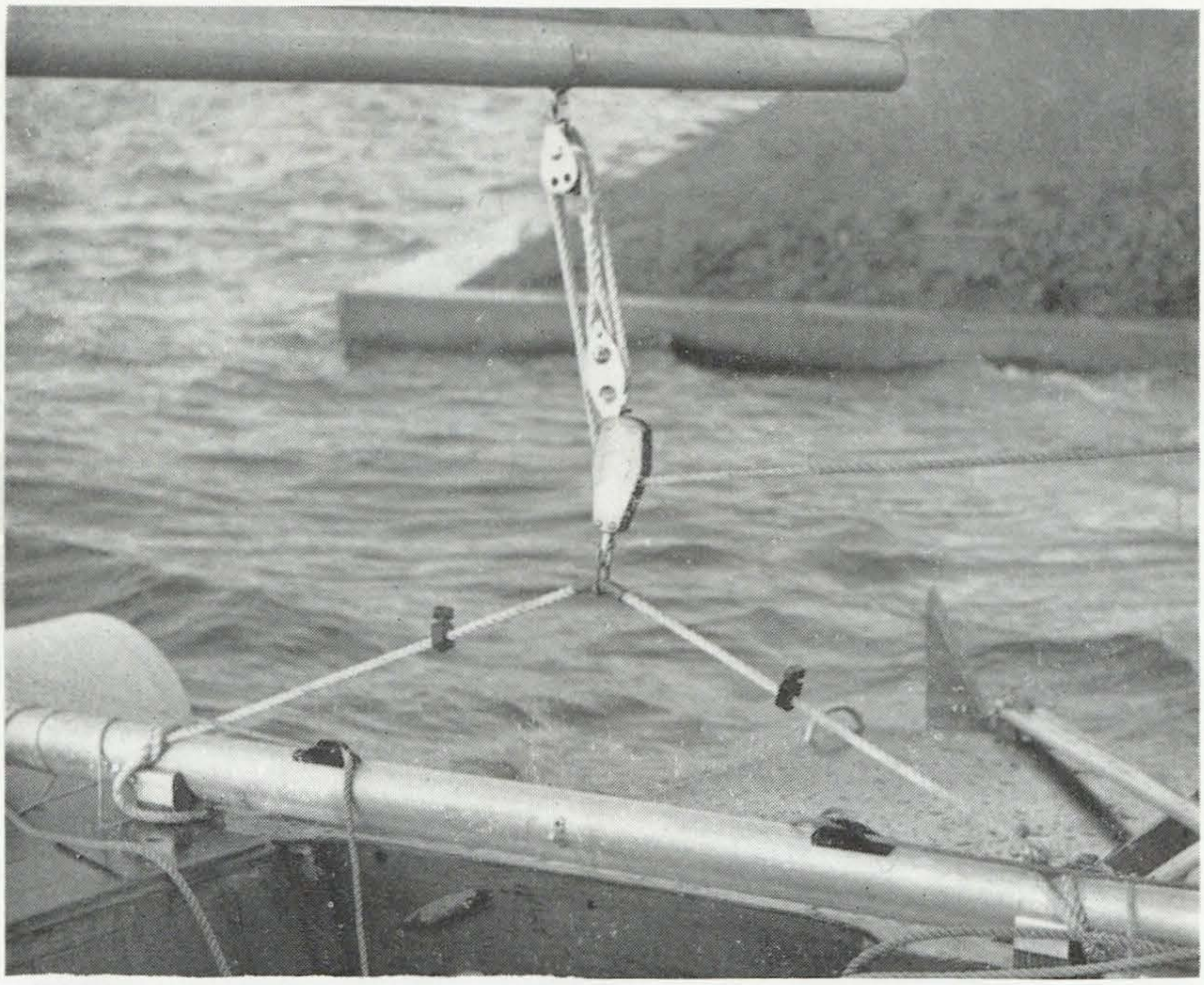
Mosquito Mk I, *AU LAIT*, and they now have canoe shaped bows. *SULU* also has a new main hull which is formed in plywood by the cold moulding process. Well-cut 'Anderson Aerofoil' sails of only 166 sq ft ensure a first class performance. To supplement this modest sail area Rodney now has a new jib giving an extra 12 sq ft.

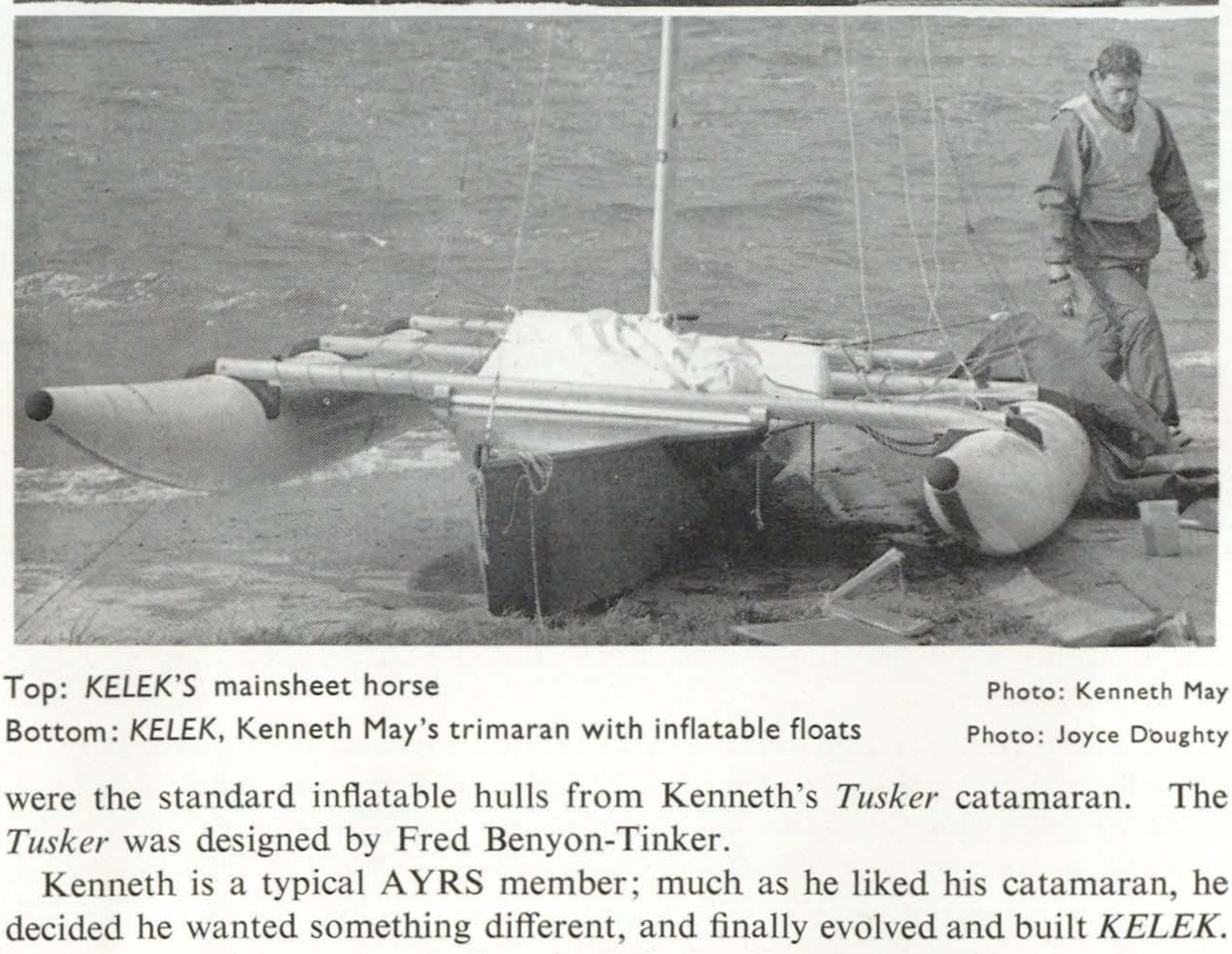
Rodney kindly took me out in *SULU* and I was able to try the fully retractable foil system which did indeed work, and I had an exceedingly fast yet effortless sail.

This boat really is a breakthrough in sailing. At the moment Rodney and Derek are busy writing up the details which will be published in a future AYRS Publication.

Kenneth May turned up with his new trimaran *KELEK*. The main hull was an 'opened-out' and rebuilt *Shearwater* hull, while the two outriggers

Opposite: Three views of *SULU*'s foil system. Top: Fully extended in the working position. Centre: As the float doors open the foils are folded and retract into the floats. Bottom: The foils are now fully retracted within the floats and the doors are closed giving a clean surface finish Photos: Rodney Garrett





Top: *KELEK'S* mainsheet horse — Photo: Kenneth May

Bottom: *KELEK*, Kenneth May's trimaran with inflatable floats — Photo: Joyce Doughty

were the standard inflatable hulls from Kenneth's *Tusker* catamaran. The *Tusker* was designed by Fred Benyon-Tinker.

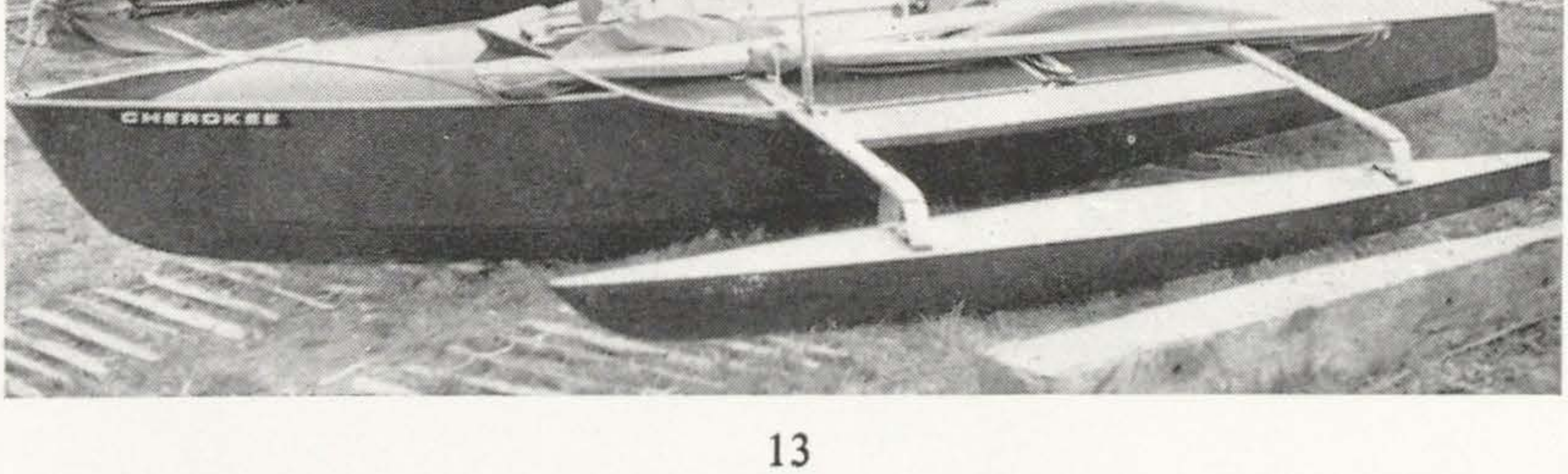
Kenneth is a typical AYRS member; much as he liked his catamaran, he decided he wanted something different, and finally evolved and built *KELEK*. Like all AYRS boats, much thought and attention to detail has gone into its construction and the result is a trimaran of wonderfully stable performance—a quiet soft movement even in strong winds and rough water. Kenneth and his wife Betty, who came from Salisbury, Wiltshire, can be justly proud of their boat. I was fortunate in having a sail on *KELEK* with Kenneth and found her easy to handle and a delight to sail. One special feature of Kenneth's design was the mainsheet horse, which though simple (consisting of rope and a piece of curved copper tubing) was extremely effective (see photograph).

John Partington, brought his new *CHEROKEE* all the way from Manchester, and very nice his new main hull looked. Of John's own design, the hull (a double chine) does not have 'stringers' but relies entirely on the strength of the marine ply, being joined at the chines by fibreglass. The decks are flared out to allow ease of sittng out, and to cut down some of the spray from the bows when the craft is travelling fast.

Using the same floats as last year, John told me he intended to increase their bouyancy during the winter months and re-design them. However, even in their present configuration, they proved very effective and *CHEROKEE* was out sailing when several other craft had been brought ashore due to the rough conditions.

Russell Madden's new boat *LULU* turned up to give us an idea of what

CHEROKEE Photos: Kenneth May



Launching the 18 ft trimaran *LULU* Photo: Kenneth May

Russell has been doing for the past 18 months or more up in Essex. A long slim hull connected by welded alloy tubing to two 8 ft outriggers, and sporting a Una rig of approx. 100 sq ft. What a pity the strong winds and rough conditions proved too much for Russell's craft and he found it impossible to hold her upright for more than a few minutes when the wind forced *LULU* over too far for Russell to hold and she capsized. However, Russell managed to right her for a few minutes, but had to give up when the mast was once more forced down on to the water. What always amazes me is the tenacity of the AYRS members! After long winter evenings, often in cold garages and usually alone, they construct their boats and put all they know into the workmanship. Then, travelling many miles, they launch their craft, only to have the weather beat them. Yet, like Russell, they haul their craft out of the water and even before the stern is clear, are already turning new ideas over in their minds, and looking forward to the next time.

Keep up the good work, Russell, for you have a lovely looking boat, and one that, when you bring it along next year (and I hope you will) should prove your ideas and be another step towards filling the gap between the true trimaran and the hydrofoil craft.

Finally in this group, my own boat *WIND CHEETAH.* Having decided that a cabin 'off-shore' cruising trimaran moored at Poole in Dorset, did not give me the hours of sailing I had hoped for, I decided to sell my *SEA WRAITH* and build a day-sailing trimaran which I could handle (unload and launch etc.) myself. *WIND CHEETAH* has turned out bigger than I had anticipated! However, I find her a nice craft to handle even in the rough conditions of last weekend. I have written an article for the next AYRS trimaran publication giving details of her construction, so I will simply say that all who sailed her, and there were many, enjoyed themselves and said kind words to me. Of simple construction, the three hulls being connected by alloy poles, she is easy to assemble and dismantle for sailing, the poles being fixed to the hulls by clamps.

Many hands making light work of launching *WINDCHEETAH* Photo: Joyce Doughty

WINDCHEETAH, well reefed and showing her paces. Two tubes clamped together form the forward cross-member. This arrangement was used to prevent it from whipping and proved very successful

Photo: Joyce Doughty

HYDROFOILS

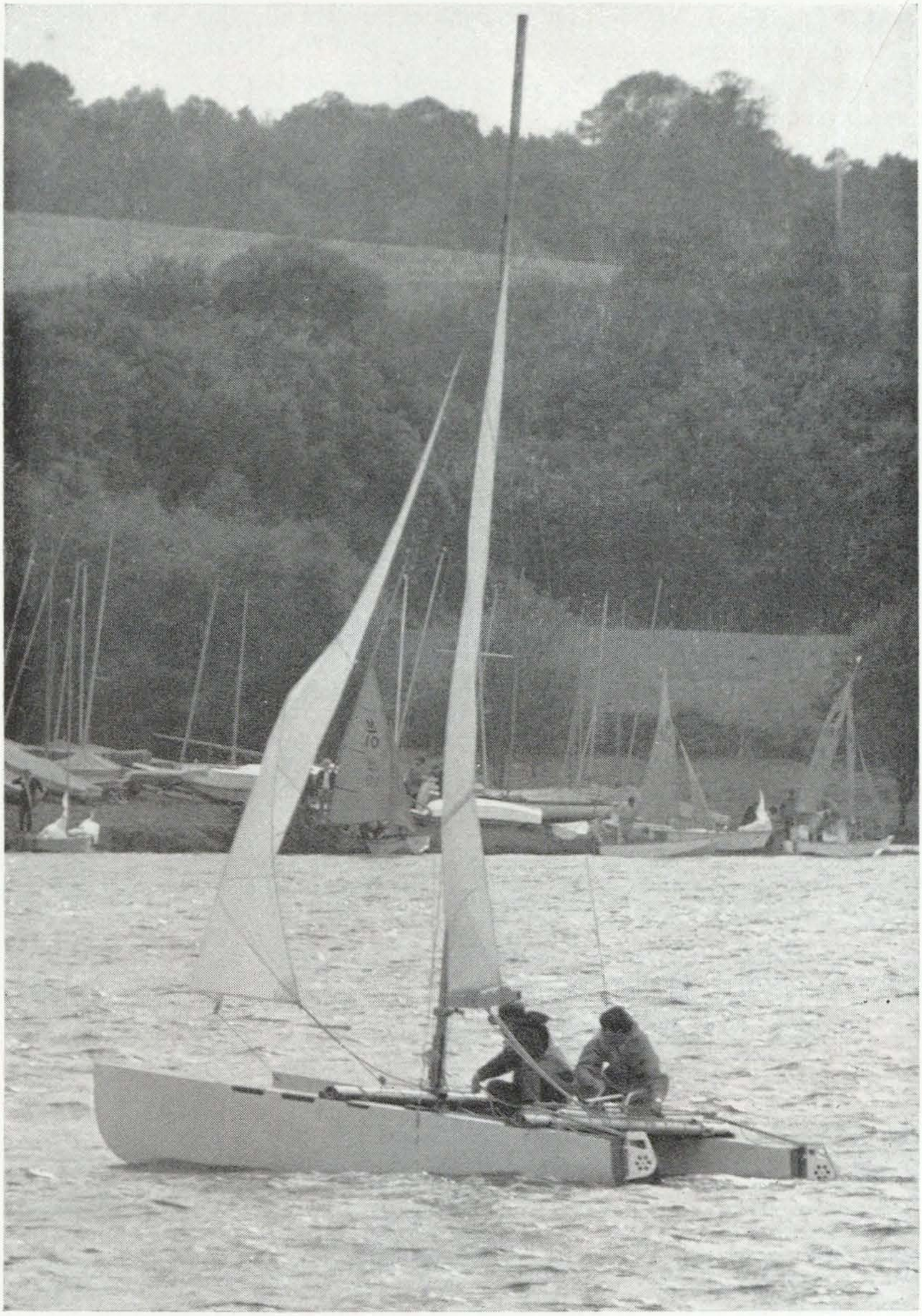
Chris Rowe turned up around Saturday lunchtime, having come from Colchester, Essex, for the afternoon, and having to return home the same evening.

He brought his *SUNBIRD* and promptly started drilling holes in the alloy connections in order to bolt on the foils. The original idea had been to use a *Fireball* for the main hull, but Chris had finally decided upon a 20 ft hull.

Here again considerable ingenuity had been used to connect the cross members to the main hull. On close inspection I discovered that the movement of the cross member enabling the crew to alter the incidence of the foils was made through two 'con rods' complete with 'big ends' taken from a car engine! Unfortunately, when Douglas Clarke, the crewman (test pilot?) took *SUNBIRD* out, he was only able to go about 50 yards, and then, due to lack of side bouyancy, the craft turned over and had to be hauled in. Douglas tried once more but to no avail, and sadly he and Chris dismantled the boat and went home. A very good effort and only beaten by the rough conditions and lack of bouyancy. Chris has promised to return next year having made the necessary modification. We look forward to seeing *SUNBIRD* successfully skim over the waters of Weir Wood Reservoir.

Paul Dearling's PBK canoe *LONGFELLOW* with Clark hydrofoils turned up again this year and Paul took full advantage of the strong winds to demonstrate the efficiency of the type of foils on his craft, as compared, say, with

Foil stabilizers enable Paul Dearling's PBK canoe to carry a larger sail area than is usually possible with this type of boat Photo: Kenneth May



Ken Ward's catamaran *STREAK* Photo: Joyce Doughty

Rodney's on *SULU*. I must say, *LONGFELLOW* certainly went extremely well and proved quite stable in spite of the large sail area Paul was using. This was, I believe, approx. 90 sq ft instead of the makers recommended 15 sq ft!

As proof of the tremendous pressure generated, and pressing on the foils, one of them broke off with a loud 'bang' late on Sunday afternoon, just at the time when people were hauling in their boats ready to take home. I examined the broken foil and found it difficult to believe that such a well made, and sturdy structure, should fail simply by pressure and not through contact with a submerged object. There aren't any floating logs drifting below the surface of the reservoir so one is forced to believe that pressure caused the foil to break. However, a very successful weekend's sailing had been had so Paul wasn't too despondent and promised to return again next year with *LONGFELLOW* suitably modified.

CATAMARANS

Kenneth Ward turned up with a lovely new *Lightning* class catamaran named *STREAK.* I watched Kenneth arrive, and was intrigued to see what looked like a van with the roof cut out, to allow the catamaran to lie on its side, and thus save any dismantling problem. One spectator was heard to remark that 'it was the first time he had seen someone construct a boat and then build a van around it!'

Be that as it may, it wasn't long before Kenneth, with the aid of several willing helpers had his catamaran out of the vehicle, and safely on the grass ready for rigging.

Photos: Kenneth May

Charles Sutherland's outrigger canoe *CINNAMON*. The bottom section of the main hull is made of fibreglass and the remainder is completed in laminated plywood

KIA KIA

Photo: Kenneth May

The boat had very deep hulls which gave the impression of strong construction, and a craft that could stand up to anything the weather or its owner cared to throw at it.

Once in the water *STREAK* certainly lived up to its name, and gave a terrific performance. Kenneth has a craft that I am sure will make many so-called design experts sit up and take notice. Congratulations, Kenneth, on making a boat that I am certain will make a name for itself in the catamaran field. I look forward to hearing and seeing more of the *Lightening* class cats and *STREAK* in particular.

Charlie Bull and Harry Ralph turned up late on Sunday afternoon, having been delayed at Eastbourne by their own club's fixtures. It was nice to see Charlie with his *Swift*, and Harry with his 13 ft prototype *BUZZ OFF*. As they will be keeping their catamarans at Weir Wood, I look forward to seeing both in action in the near future.

Peter Gibby's new smart-looking *Cheetah* catamaran *PURR* looked efficient,


Chris Hughes sailing his proa *KIA KIA* Photo: Joyce Doughty

and ready to take on all comers. Peter handles her well but much prefers to let someone else helm, while he spends all his time swinging at the end of a trapeeze. Very expert he is at it too. It was a delight to watch him swing and balance his craft keeping her in as nearly a perfect sailing position as possible. 'Out on the wire' is not an easy thing to do perfectly and when the conditions are as bad as they were last weekend, Peter really showed us how it should be done.

MICRONESIAN

Chris Hughes brought his delightful *KIA KIA* proa along again this year and amazed everyone with his expert handling of this unconventional craft. Chris has altered the rig and now sports a new sail complete with battens. The result is a craft that looks right and because it is right, puts up a remarkable performance. Strong winds and rough conditions?—Chris just sailed out, up and down the reservoir as steady as a rock and perched on his outrigger wore a contented grin on his face as he watched several of the local club's modern designed craft capsize, one after the other.

With his own method of altering the boom from one end of the craft to the other (by means of pulleys and ropes) when he wants to change tack and his unique steering system (by moving the whole end of *KIA KIA*) Chris has really got his sailing down to a fine art. I found her easy to handle and exciting to sail.

Charles Sutherland's *CINNAMON*, a canoe with outrigger, showed us just how beautifully a hull can be made. Charles has spent considerable time on the design and construction of his craft, and he must be very pleased with the result. Although mainly of ply, the bottom section is solid fibreglass and the two materials are bonded together forming a slender smoothly finished hull that promises to slip through the water very easily indeed.

Charles paddled his craft around and proved its stability for all to see. I happened to turn up just as he launched *CINNAMON* and was promptly given a glass of champagne to celebrate the event. And very nice too!

Unfortunately, later in the day the heavy and rough conditions broke off the outrigger and Charles had to swim his boat back to the bank holding the broken pieces in one hand and towing the canoe with the other. However, about an hour later, when passing his boat, I saw him tying and screwing the outrigger back on to the cross-members and getting ready for another go. Well done, Charles! We look forward to seeing you and your lovely boat next year.

This year we had all the wind that we wanted (frequently more), and in consequence, were able to put our craft through their paces with no holds barred. Certainly the rough conditions found out one or two weak spots, but better to have this happen on a reservoir, than off the coast with no rescue boat in the offing.

My thanks to all who came and made our weekend such a success. A big thanks also to the ladies who came, and so patiently waited and watched their menfolk enjoy themselves. It was nice to see old friends turn up again and much of my time was spent talking to them. Two very keen members, Mr. and Mrs. Sully, came again this year all the way from Wadebridge, Cornwall. How pleasant it was, to notice members who had craft take these two out for a sail, for if anyone deserved to have a go, surely these two did.

I look forward to next year's meeting, and trust that many members will turn up with many new and exciting craft, for all of us to admire and enjoy watching and to see that little extra idea which might be just the thing to improve the performance of our own boats. □

'GOLDEN COCKEREL'

by Bill Howell 91a The Broadway, London, S.W.19

I have been asked to summarise my multihull conclusions after finishing fifth in the 1968 Single Handed Trans Atlantic Race, and sailing my 43 ft catamaran *GOLDEN COCKEREL* back from Newport, Rhode Island, to Plymouth, England with a crew of six.

But first, a word of warning! I am strictly an amateur yachtsman, and have no pretensions to design knowledge. I have been sailing monohulls since 1950, mainly single handed, but was a multihull mug when I had the *COCKEREL* built and launched in January, 1967.

Now, after 8,000 miles of hard sailing which included a capsize in the first Crystal Trophy race, I still reckon myself a learner. I want you to keep this in mind when reading the rest of the article.

Heavy weather

The feature of the Single Handed Race was the Force 10 storm of 11th June which trapped the *COCKEREL*, together with several of the leading yachts. It was the worst storm that I have hit in 35,000 miles of ocean racing and cruising. At the centre of the disturbance my Brookes & Gatehouse Hengist/Horsa recorded a steady 55 knot wind, and at one time the indicator needle was stuck hard against the 60 knot mark (the maximum reading).

I hove-to under double-reefed mizzen (about 30 sq ft) with the helm lashed hard down to leeward. All stores, sails, water, everything moveable was lugged into the windward hull. The dagger plates were raised to give as little lateral resistance as possible.

The mizzen boom on *GOLDEN COCKEREL* is sheeted to both hulls so that it can be bowsed down hard. The reefed mizzen was thus taut as a sheet of metal and could not flog. If it had, I should certainly have lost sail or mast. A continuous mizzensheet running through blocks on both hulls is a great advantage for heaving-to in a catamaran so that the mizzen cannot flog.

The seas were about 30 ft high and each crest was breaking. I found that 49 out of 50 times *COCKEREL* came up into the wind under the influence of mizzen and rudders so that each breaker was taken obliquely on the bows. However, every 50th wave seemed out of sequence, so that she could not round up in time. This wave struck the high topsides broadside-on, burst clean over the cabin top, and threw the big catamaran bodily to leeward like a ping-pong ball.

At first I was worried by this. But at no time did the *COCKEREL* seem in danger of capsize. There was no tendency to trip over the leeward hull as she was thrown down wind. I should have been worried if I had had a skeg on the keel that might have gripped the water and so tripped her. I was glad that my water was in five gallon plastic jerry cans which I could take out of the leeward hull to lighten it and stow low down in the windward hull.

I did not try to lie a-hull under bare poles, as I found the effect of the mizzen in bringing the head up to the wind made life easier. But I should not now

GOLDEN COCKEREL being overhauled berfore the race Photo: Multihull International

be afraid of lying a-hull, provided I was in a catamaran that did not draw too much water and did not have a fixed skeg. Lightness and shallow draught, so that the yacht offers no resistance to waves and water, mean safety in survival conditions like the 11th June storm.

At the beginning of the storm I did try running under bare poles. The Brookes & Gatehouse speedometer recorded 14 knots as I surfed down the fronts of the breakers. I did not find this exciting, as I felt the yacht was barely under control. The pressure of water racing past the hull was too much for the servo blade of the Hasler self-steering gear, and its shear release device threw the blade out of the water. I then steered by hand, in pitch blackness and driving rain, until finally I lost control as the catamaran surfed at 15 knots down the front of a comber. She broached very smoothly and did not appear in any danger of capsize—much to my surprise. I would say from this experience, that a broach at high speed under bare poles in a multihull with dagger plates up is not as dangerous as a broach in a monohull.

I would also tentatively say that the correct tactic in a multihull when running under bare poles is to trail warps to slow her down, rather than run the risk of losing control when surf-boarding down the fronts of large waves.

Self steering

This was my biggest problem in the race. Most of the race was run in unsettled meteorological conditions, with line squalls striking unpredictably.

Unlike a monohull, which heels when hit by a sudden squall, the multihull accelerates. This brings the apparent wind forward. However, the wind vane keeps the yacht at a contsant angle to the wind, so that, as she accelerates, she begins to bear away.

These sudden accelerations and decelerations meant that *GOLDEN COCKEREL*'s progress across the North Atlantic Ocean was a series of large S curves. When she reached the 12-14 knot range, the Hasler self-steering gear was simply overcome and the servo blade released itself, otherwise it would have broken.

The result was that I spent a great deal of my time attending to the self-steering gear and had to rein the *COCKEREL* in, trying to keep her speed down to about 10 knots.

Tom Follett did not have this problem in *CHEERS* as, by use of a forward dagger plate, he could balance his proa without the use of a wind vane self-steer.

I am going to experiment with small forward dagger plates, and have asked Blondie Hasler to apply himself to the problem. I think that the answer will be found by balancing the hull with forward plates, as with *CHEERS*, together with a Hasler type gear modified so that the angle of attack of the servo blade in the water can be altered, and an automatic mechanical bias attached to the wind vane so that it can allow for changes in the apparent wind direction.

The only other answer is a conventional electrically powered automatic helmsman, which is excluded by the rules from the Single Handed Trans Atlantic Race.

Damage and repairs

The only gear that I lost on the two crossings of the Atlantic was one shackle and one sail tie. The only damage was a butt joint foward where a frame joined the keelson. I repaired this by bracing a length of plywood between the inner and outer hull frames, and the repair was so good that I sailed back across the Atlantic with it.

This is the more remarkable as I am so kack-handed that I can harldy repair a kitchen chair, let alone a yacht's hull.

To my mind one of the really great advantages of a plywood/fibreglassed catamaran like *GOLDEN COCKEREL* is the ease of repair. If frames or stringers crack or break, the narrow hulls can easily be braced across with a length of ply. If a hull is holed, the hole can be covered with a square of ply which can be similarly braced to hold it in place.

I am confident that even a hopeless workman like myself can successfully undertake repairs at sea in a catamaran's hulls that I would find beyond me in a monohull. This is a big factor in single or short handed ocean cruising and racing.

Hepplewhite sheet release gear

I had three of these gears on board, one for each headsail and one for the main.

The headsail sheet gears were modified with springs so that the jam cleats sprang apart to release the sheets. This was found necessary as the friction of the sheets around the winch heads did not give enough tension at the Hepplewhite jam cleats to release them.

This modification was not found necessary for the mainsheet.

I can only say that the Hepplewhite release gears were a great success and are a must for any multihull.

What trouble-free sleep I did manage to have on the single handed race was in the knowledge that the gear was switched on and that I was safe from capsize.

I must admit that occasionally the sheets did release through wave instead of wind action, but I soon learnt the right degree of adjustment—the inconvenience of clambering out of a warm sleeping bag into a cold cockpit to winch in the sheets was a small sacrifice for peace of mind.

Sail handling

I had the large wardrobe of 14 sails on board and had 281 major sail changes during the race (an average of 9 sail changes per day—this compares with an average of less than one sail change per day by Brian Cook in the monohull *OPUS*).

I found that, in the squally conditions, a multihull was much more sensitive to the right amount of canvas than any monohull on which I had sailed. The right balance of sails was certainly more crucial for the self-steering gear, which behaved more erratically the less balanced the sail plan.

On the credit side, I found the actual effort of sail changing much easier on the stable platform of the catamaran.

I had long sail ties lashed to the forward safety net, and as a headsail was dropped it was quickly lashed down to the net with these. I also had fish net lashed between the stanchions forward to prevent the clew of the headsails slipping over the side.

With these precautions, I never had trouble with a single headsail change, and was never in danger of losing or damaging a sail.

My main difficulty was with the topping lift, which kept wrapping itself around the aerial insulators on the backstays. On the return trip, a member of the crew began to use the mizzen staysail halyard as a topping lift for the main boom, and this solved the only problem that I had had with sail changing.

I might add that I had a racing mainsail cut with a full roach and fully battened for its top third. It was a wonderful sail that gave me a full knot to windward more than the cruising mainsail cut with a straight roach and unbattened.

Fatigue and noise

I averaged only about 5 hours sleep per day on the race, but I cannot say that I became over-tired. Whether this was due to the easier motion of the multihull is hard to say.

However, I slept in the cabin and not in the hulls. Of one thing I am certain. If I had been forced to sleep in the hulls in the conditions of this race, bashing hard to windward day after day, then I should have arrived at Newport, Rhode Island, a physical wreck.

The hulls of a catamaran are like bongo drums under high speed conditions, and it is just impossible to sleep there at speeds exceeding 8 knots.

On the return trip it was interesting to see the crew emerging like termites from the comfortable double bunks in the hulls to sleep on the hard cabin floor as soon as the *COCKEREL* swung into her racing stride.

From my experience, a central living cabin where the crew can escape from the noise and fatigue of the hulls is a necessity in an ocean racing or fast cruising catamaran.

Safety precautions

Nobody knows better than I that the main danger of a catamaran is the capsize. My main safety precaution against this was the Hepplewhite sheet release gear. Without the Hepplewhite gear, you can only depend upon the skill and watchfulness of the crew.

The mechanics of catamaran capsize need a separate article, but I must say that the dangerous points of sailing are close reaching under big headsails and reaching under a shy spinnaker. There must be no horn cleats on board so that, if you begin to capsize, the sheets can be released instantly through jam cleats.

If I had capsized, then I could have unstrapped my safety raft from underneath the safety net. The engine compartment had been crammed full of emergency gear, from food and tools to a walkie-talkie emergency radio, and this could be opened from underneath the bridge deck.

Having inflated the life raft, I should have hauled it onto the bridge deck between the hulls, lashed it there and lived in it until the storm subsided. I should have opened my emergency cache of supplies and waited for help, and would not have wasted any effort on attempting to right the capsized catamaran, as I consider this an impossibility, single handed or otherwise. When the emergency food had run out, I should have donned my underwater suit and snorkel and dived into the catamaran for more food.

Monos versus multis

I believe that a lot more development work needs to be done on self-steering before they become suitable for single handed racing or cruising. I also think that designers place too much emphasis upon the top attainment speed of multihulls. Fourteen knots in a 43 ft catamaran is quite fast enough, thank you. Frankly, when you start spurting at 18 to 20 knots, I find it terrifying and unsafe, as the smallest mistake in helmsmanship could be a disaster. I always feel then like reaching for the hand brake to slow her down.

I think that designers should concentrate on getting multihulls up to the 12 to 14 knot speed bracket and keeping them there.

This would help the self-steering problem and the single hander's nerves.

As to the question of the structural safety of multihulls, I can only say from experience that my *GOLDEN COCKEREL* is a miracle of design strength. In the Single Handed Race, I beat to windward at 7 knots across the tail of the Grand Banks of Newfoundland in conditions of such appalling severity that I thought I must damage the yacht. She survived unscathed through seas that would have opened up my old teak-built monohull *STARDRIFT*.

I cannot speak for sandwich construction or fibreglass mouldings. But a plywood hull, professionally designed and fibreglassed like *GOLDEN COCKEREL*, would survive anything less than an atomic bomb. She is as strong, or stronger, than any monohull.

She has her disadvantages. She is less manouvreable, under sail or power, than a monohull, and this can be embarrasing in the little creeks that the English use as yachting centres. She dances and sheers about at moorings, refusing to lay docile like her orthodox sisters. Her 17 ft beam makes her difficult to squeeze into marinas.

But she's roomier, more comfortable under sail, and foot for foot under all conditions of sailing she's faster. My main complaint would be that she's still an adolescent, who needs time before she can mature into a full woman. But mature she will. The problems of her sudden acceleration, self-steering gear, inclination to invert, manoeuvrability and strangeness will all be solved.

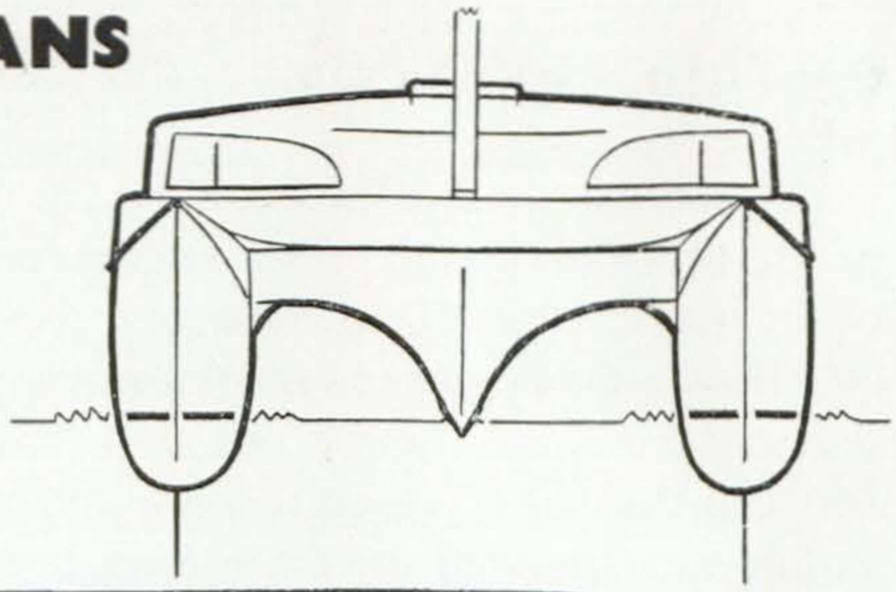
Then she will be respectable, and they'll all want to be seen with her. □

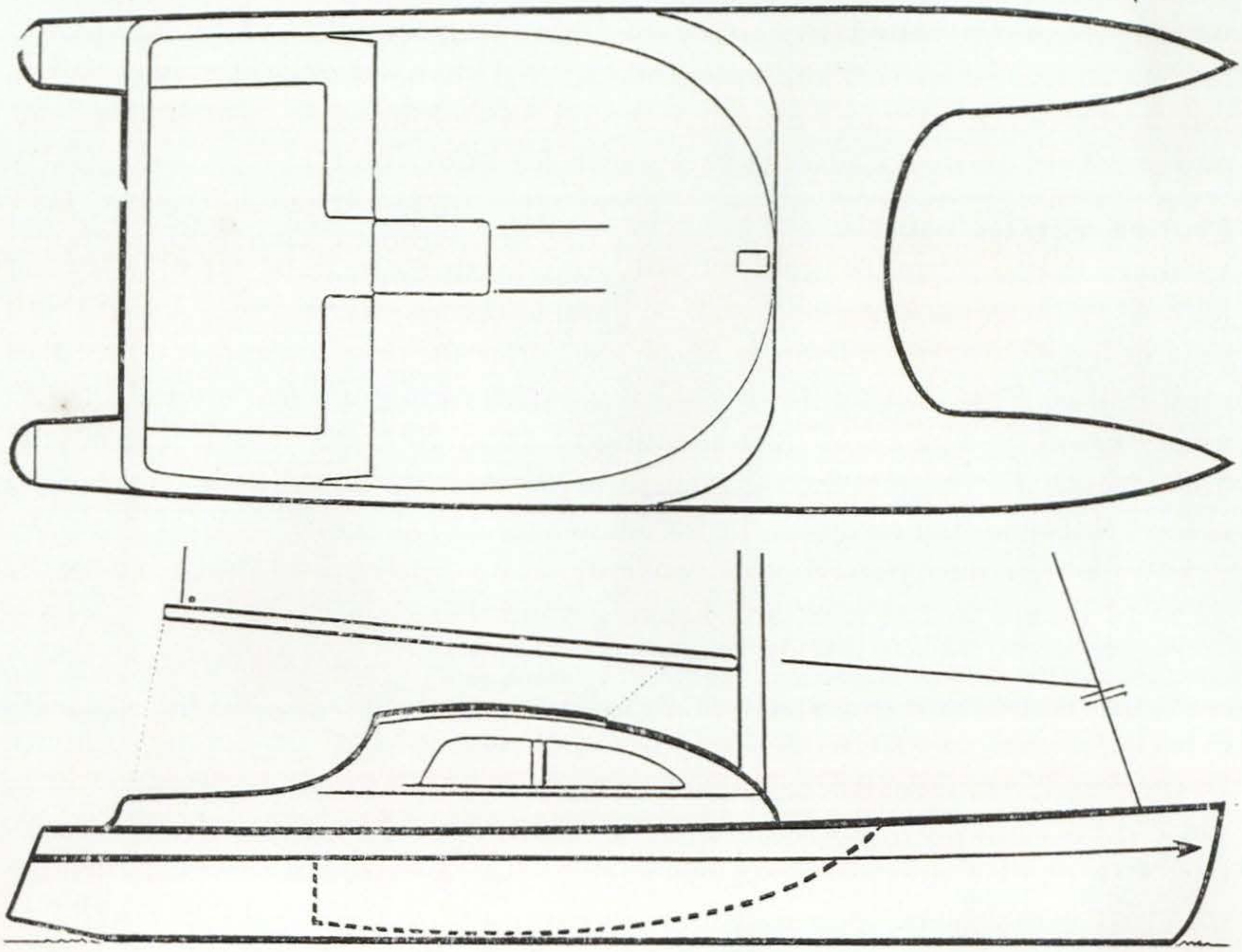
THE TRI-CAT CONCEPT FOR CRUISING CATAMARANS

Designer: Ralph Flood

3883 Sunbeam Drive, Los Angeles,
California, USA

LOA	34 ft 5 in
Beam	14 ft 3 in
Weight	4,900 lb
Sail area	525 sq ft





The catamaran (double hull) configuration has certainly proven to be the most efficient sailboat shape yet devised. In the daysailer type boat this fact has become so obvious in recent years that the cat is slowly but surely gaining major prominence.

However, the catamaran as a cruising sailer has limitations in lengths under 30 ft which may prevent it from seriously competing with a good single hull or trimaran as far as popularity is concerned. In lengths over 30 ft the catamaran could achieve considerably more acceptance if such things as the central cabin headroom, engine accommodation, and pounding of the central underbody problems could be solved.

The Tri-Cat hull configuration was conceived to eliminate these problems without adversely affecting the superior performance of the modern catamaran. Several years of study and model testing indicate that the Tri-Cat shape can do the job. There is now good reason to believe that the most popular cruising cats of the future will incorporate the Tri-Cat principle. □

RACING 'WILLS VENTURER II' IN 1968

by Tom Herbert 23 Oakwood Gardens, Seven Kings, Essex

Two years ago W. D. & H. O. Wills presented to the Society one of their 'C' Class catamarans, *WILLS VENTURER II*. She and *WILLS VENTURER III* are the latest 'C' Class design from the board of Rod Macalpine Downie. Our boat is sloop rigged and has additional centreboard cases fitted to enable her to carry a Una rig if necessary. She is easily recognised by the square chisel-shaped bows and the angled main beam carrying the mast. The crossbeams hinge at the centre to enable her to be trailed.

Early in 1968 I towed her on a trailer through the narrow streets of Brightlingsea to the boat park, and opened her out to her full 14 ft beam. She had spent the winter out in the open and we found plenty of work to do. After several weekends of painting, sewing, and checking the gear she was ready to go, just in time for the National Championships.

Roy Bacon sailed her, and she finished the series in second place, *LADY HELMSMAN* winning the National Championship. Roy is a top class helmsman and a veteran 'C' Class man and he drove *WILLY II* hard and skilfully. When the racing was over, the 'ground crew' found plenty of work to do, and several more weekends were spent on repairing the trampoline and going over the boat and gear.

We had a delightful weekend sailing her round the Blackwater, mainly to initiate me into the mysteries of handling her, because Roy would not be available for the remaining races.

In the light winds during this first weekend I found that she handled beautifully and is an ideal day sailer. The main problem is manipulating the boat down to the water and finding 14 ft of foreshore to launch her. Once afloat however the boat seems to shrink in size and is very manoeuvrable. There is very little sensation of speed, and I was surprised to find that we covered 2 miles on a close reach in 5 minutes, 24 miles per hour. This was in a nice steady force 2-3 wind. Typical cruising speeds in force 2-3 winds are Brightlingsea to Bradwell (about 4 miles) in 20 minutes. The return journey on a reach took 12 minutes.

The World Championships were cancelled due to lack of support, so our final races were for the European Championships held at Sheppey. Three 'C' Class boats entered—*LADY HELMSMAN*, *WILLY II* and the one new boat this season *EARLY BIRD*. Unfortunately *EARLY BIRD* was suffering from 'teething' trouble, and we all gave up racing for two days to get her raceworthy. We sailed two races in very light winds, and although we were last over the finishing line on both occasions, we were not completely outclassed in spite of our inexperience and *WILLY II*'s reputation for being a heavy weather boat.

WILLY II's sails are cut rather flat, and the foresail we found to have very little curvature at all. Her reputation as a good heavy weather boat was earned before we took over, and I am sure that with some recutting of the sails, and the addition of sail curvature control on the mainsail, she would perform much better in lighter weather.

WILLS VENTURER II being sailed by John Fisk during the International Cat Week 1966
Photo: Joyce Doughty

The hull design is excellent both in light and heavy weather. We proved this during the tuning up sessions for the Little America's Cup, when *WILLS VENTURER III* was fitted with *LADY HELMSMAN*'s number one wingsail to evaluate the new fabric-covered wing mast on *LADY HELMSMAN*. In the light conditions prevailing (force 1-3) *WILLS VENTURER III* beat *LADY HELMSMAN* by about the same margin that *WILLS VENTURER III* lost with her normal wing mast during the final trials. These experiments proved conclusively that *LADY HELMSMAN*'s number one wing sail is the best yet, and suggest that the *Wills Venturer* hull shape is comparable with the *Hell Cat* 3s type (*Lady Helmsman*) in light conditions.

Now, at the end of the season, *WILLY II* looks decidedly second hand. The trampoline deck is split beyond further repair, the hulls need stripping and drying out. The centreboard cases are leaking slightly and the rear beam is deteriorating due to corrosion between the alloy beam and the stainless steel hinge.

What has a season's racing cost and what have we learned? It has cost the small syndicate running the boat about £70 for eight races. This is cheap and was done on a tight budget. All the work except sailmakers repairs was done by the syndicate and occupied a good many weekends and odd days. We have learned a lot, though much we knew already.

Summarising:—

1 The *Wills Venturer* hullshape is excellent in light weather, and is comparable with the *Hell Cat* 3s shape.
2 The Una rig, particularly the wing mast rig is superior to the sloop rig in light to moderate weather in spite of the extra weight of the wing mast. In heavy weather the sloop rig seems to have the edge.
3 The wing mast really shows its superiority when tacking downwind in light weather. Under these conditions the sloop rigged boats do not have enough power to accelerate to the point where they can carry their apparent wind downwind with them. In case this sounds rather obscure, the technique for sailing downwind is to put the boat on a reach, and as the boat accelerates the boat is made to bear away downwind in a curve, keeping the apparent wind on the beam. Eventually a lull in the wind, or too much helm will cause the boat to lose its wind, and one either tacks or repeats the exercise on the same tack. *WILLY II* needs a force 2-3 to enable her to tack downwind effectively. *LADY HELMSMAN* and *EARLY BIRD* 'take off' much sooner, and were swooping downwind very nicely in force 1-2 winds.
4 The performance of wing masts in light weather indicates that they are very efficient. Why does their performance tail off in heavy weather? Is the weight of the mast too much for the boat and crew to handle? Do they generate too much power for the existing hull designs? Is the efficiency of the wing sail reduced by more turbulent airflow and excessive pitching?
5 The superiority of the existing wing masts is marginal. A very light boat with an aerodynamically clean Una rig or a semi-elliptical lugsail could possibly compete successfully against them.

During the winter we have a lot of work to do on *WILLY II*. She has been rather neglected in the past, and although structurally sound apart from the rear beam she deserves a good refit. The sails also need attention, and modifying to improve her light weather performance.

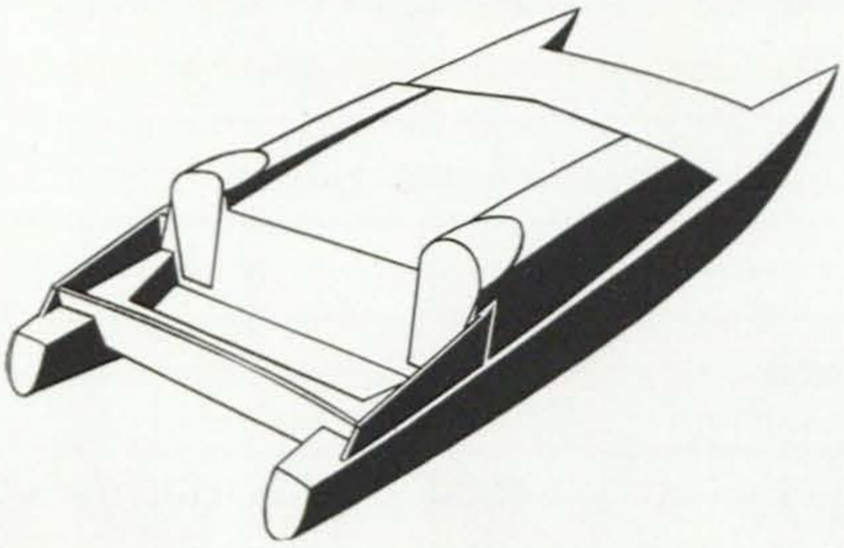
The proposal to form the North Sea Catamaran Racing Club at Point Clear (across the creek from Brightlingsea) gives us the incentive to race *WILLY II* next year. We hope that launching facilities will be less crowded and that regular 'C' Class races will be held. There should be plenty of

continued on page 33

DACAPO 24: A family cruiser from Sweden

Designer: Heinz-Jürgen Sass Eriksövägen 23, Vaxholm, Sweden

LOA	28 ft 5 in	Sail area	387 sq ft
LWL	24 ft 8 in	Weight	2,910 lb
Beam	14 ft 2 in	Displacement	4,260 lb



DACAPO 24 is the latest in a series of four boats which range in size from 23 to 35 ft. It has been designed to provide enough room for a family of 4 to 6. To give the boat pleasing lines the coach-roof has been kept low. In fact the roof is so low that the helmsman can see over it when sitting in the cockpit. The centre of the roof is planked with ½ in teak to give added strength and more 'eye appeal.'

To get full head room in the galley and chart room a 'plexiglass' dome is fitted over each, or alternatively, sliding hatches can be provided. The chart room has space for extra storage and it is fitted with a table large enough to take unfolded charts.

The boat is divided in the middle by a longitudinal bulkhead which at the same time is the centreboard case. Forward in the starboard hull is an extra bunk, and aft of this there is a settee with a folding table to make a dining quarter. Situated by the hatch is the large galley with plenty of storage space. Two cabins are situated on the forward part of the wing and each includes a double bunk. Aft of the main cabin is the toilet, complete with lavatory, wash basin and hanging locker/s.

The cockpit extends across the full width of the boat. Use is made of the rear constructional beam by incorporating seats with built-in lockers. The centre locker contains safety equipment and opens outboard so that it is easy to reach in the event of a capsize.

The centreboard is placed in the longitudinal bulkhead to get simple and effective construction. Advantages of this centreboard are: an effective plan with high aspect ratio, no long openings in the hulls, low weight and easy handling.

The lines of the hulls were drawn to get a low wetted area with a nearly semi-circular section. When fully loaded the transom is slightly beneath the water line. At low speeds this may not be so good but at high speeds and in open waters it is advantageous. The spray deflectors (knuckle type) and the wide transoms should prevent pounding. Plastic foam bouyancy is placed in the extreme ends of both hulls. A low sail plan is used to produce a safe boat for family sailing. The alloy mast is rotating. A genoa can be sheeted to a track on the outside of the coach roof.

Hulls are GRP and all other parts are of wood to keep down weight and costs. The GRP hulls will be available to amateurs for home completion. □

RACING 'WILLS VENTURER II' continued from page 31

opportunity to tune up against the best of the fleet and learn much more about hullshapes, structures and rigs in this exciting class.

The 'C' Class has the reputation of being very expensive to build and race, and they are supposed to be fragile. However, Dereck Nunn reckons that *EARLY BIRD* cost about £500 including the wing mast, and should have a life equal to any other high performance craft. *WILLY II* has had a hard life during her three years and is still structurally sound. These boats are lightly built but are not fragile, and they are superb day boats. □

CATAMARAN DEVELOPMENT*

by Robert B. Harris, NA 11 East 44th St., New York, NY, USA

HULL FORMS†

Two diverse sets of experiments in sailing multihull development were begun simultaneously in early 1947 by two separate teams of designers and builders at points halfway around the world from each other. The results created two schools of thought regarding multihull forms. In Honolulu, Woodbridge Brown was working with asymmetric hulls without centreboards. His experiments culminated in the successful daysailer, *MANU KAI*, a 40 ft catamaran marconi rigged sloop used as a pleasure craft to carry passengers short distances off shore from Waikiki Beach. Meanwhile, Roland and Francis Prout's efforts in England were concentrated on a series of small day racing catamaran sloops with symmetric hulls and centreboards. Their boat, the 16 ft 6 in *SHEARWATER*, is a development class with a world wide membership.

Several modifications of symmetric and asymmetric hull forms were subsequently tried in various experiments, many of which are continuing today. While individual claims have been made regarding certain advantages held by one or the other of these modifications, no reliable fullsize or model test series has been conducted to substantiate any such claims. Many theories abound, and the results of various mixed multihull races seem to point toward definite conclusions—though at no time has there been sufficient qualitative data collected to support these conclusions. Furthermore, none of the model tank tests that have been conducted to date on multihulls have gone beyond the investigation of upright resistance in smooth water. While the information from such tests is of some value for downwind performance, it is useless for determining sailing multihull speed made good to windward. Also, little testing has been done at speed/length ratios over 2 : 8.

Daysailers and racers

Examination of day racing results reveal only minor variations in hull forms. Any conclusive evaluation of comparison would have to be broadly expanded in a standard model test series based on a parent model. Sufficient money for controlled tests has not been made available because there has been no time for supporting interest in multihull racing to grow. Thus, until that interest develops, progress will depend largely on trial and error. For

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* Abridged from *An Introduction to the Design of Multihull Sailing Craft*, a paper prepared by the author for The Small Boat Symposium conducted by The Society of Naval Architects and Marine Engineers on February 8, 1968.

† Comments in this section, unless otherwise noted, are applicable to all multihulls, whether the main hull or float of a trimaran or proa, or the hulls of a catamaran. Symmetry and asymmetry refer to equal or unequal division, respectively, of the volume of a hull or float about its theoretical centreline plane. Displacement length ratio $\triangle/(L/100)^3$ refers to the total displacement and the length of the craft, unless specifically noted. The displacement/length ratio for one hull of a catamaran may be determined by dividing the number by 2.

example, the day racers which have won the most races have the following similarities in hull form:

1 Fine entry with included angles from 10 to 14°.
2 Semi-circular below water sections with maximum area positioned slightly forward of amidships.
3 Beam/draft ratios of approximately 2 : 0 (minimum wetted area sections).
4 Gently swept up buttocks, usually terminating at the light water-line plane.
5 Transom sterns slightly immersed at full static displacement.
6 Twin centreboards and rudders.

To put it more technically, the best performing day racers operate at displacement/length ratios in the region 18 to 25, at overall length/extreme beam ratios of from 1 : 39 to 2 : 25 for catamarans, hull and float waterline length/beam ratios of 13 : 5 and 18 : 0 respectively for trimarans, and from 15 to 18 for catamarans, with beam/draft ratios averaging 2 : 0. At such ratios the largest portion of the resistance is frictional throughout the speed range, and with hull spacings equal to or greater than half the length of the waterline it has been shown that there will be no wave reinforcement between the hulls.

Completely symmetric, minimum wetted area forms seem to be the fastest for the day racers operating at extremely low displacement/length ratios, where the majority of the total resistance is skin friction. However, it is possible that if each section of such form was aligned along longitudinal planes, for instance, so as to cause all of the longitudinal curvature to be inboard or outboard, that some reduction of residual resistance might be obtained. However, in view of the magnitude of hull separations and other considerations set forth in the succeeding paragraphs, it does not seem likely that such variations on the very light displacements attainable in day racers will prove beneficial to higher speed.

In a few instances diversions have been chosen to simplify construction and reduce first costs; for example, the use of sheet material versus formed pieces. But, the performances of such craft were so far less satisfactory that few day sailers are so compromised any more. Hull sections other than semi-circular have been tried with the idea of increasing the average speed around a triangular course, such as planing forms. Attempts at planing multihull sailing forms for this purpose have so far been unsuccessful for any one, or all, of the following reasons:

1 Lack of sustained wind to maintain planing speeds.
2 Inefficiency of planing forms except at planing speeds, particularly true when going to windward.
3 Difficulty of maintaining ideal trim angles due to variation of wind forces acting longitudinally through the centre of effort of the sails.
4 Adverse variations of bottom loadings due to shift in displacement from one hull to the other when heeling, in addition to change in angle of attack.
5 Reductions in manoeuverability.
6 Loss of speed due to slamming in a head sea occasioned by full forward sections of low deadrise desired for planing at low speed.

Day racing catamarans on the wind often sail with the weather hull flying and if the hulls are designed for planing on one hull while the other is flying a

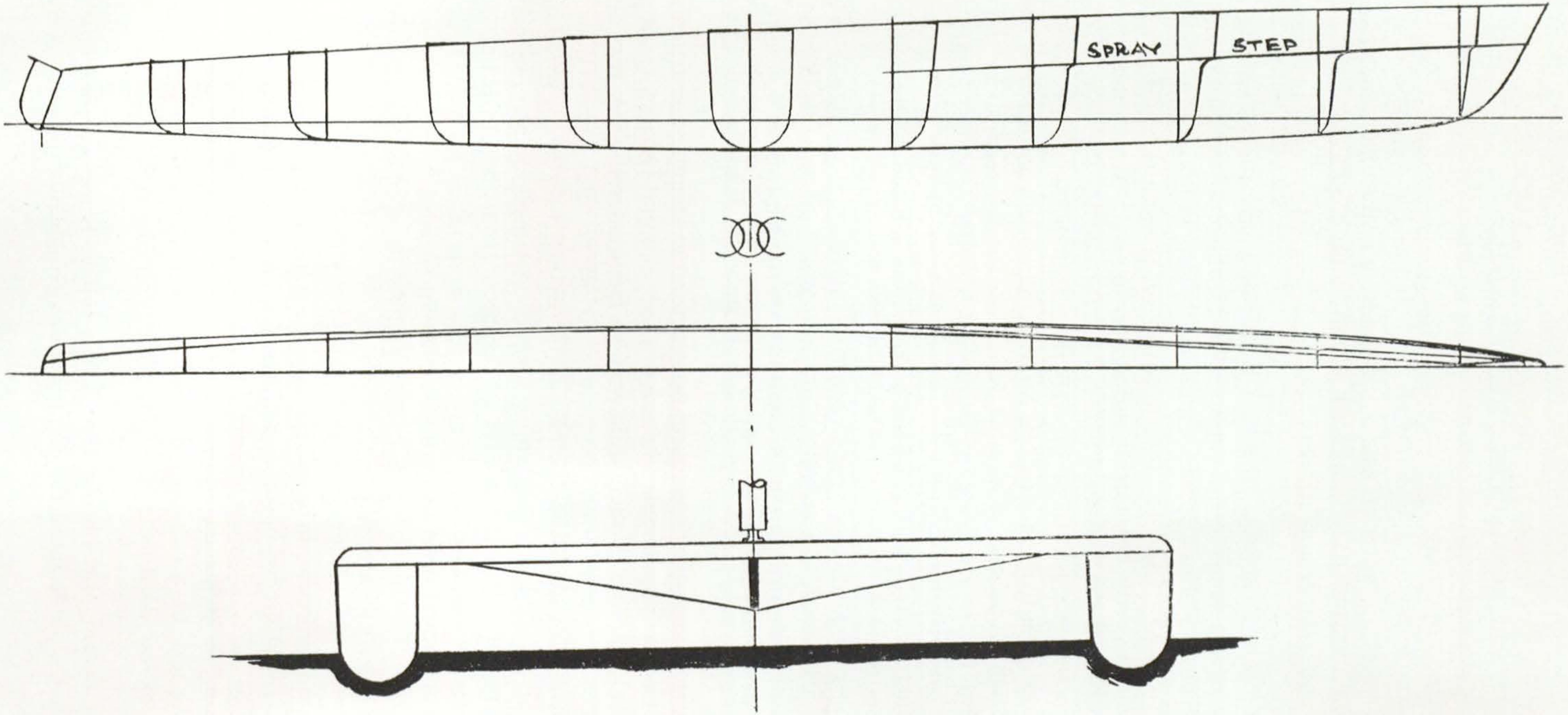

Figure 1 Typical lines of a modern day racing catamaran

hull, then the proportions will be incorrect for sailing on both hulls, and vice versa. While the efficiency of planing catamarans may be improved and greater sustained sail power developed from better rigs, it seems unlikely that the all around performance will match that of the types which have underbodies similar to the lines in fig. 1. Considerable controversy remains over the treatment of the sterns, whether they should be transom or canoe type, but from performances to date there appears to be little to choose between them.

Spray steps (fig. 1) are often seen incorporated into the lines of cruising catamarans. They might better be referred to as displacement steps, because their real purpose is to give sharp increase in reserve buoyancy forward. This is done to maintain a finer entry at low and moderate speeds, while tending to counteract the tendency in such fine bowed craft to bury the lee bow in heavy winds and higher speeds. As such they are effective, but also respond from dynamic lift to reduce pitching, as well as reducing side wetting and spray.

Possible advantages in asymmetric configurations are the elimination of centreboards and daggerboards needed in most symmetric arrangements for lateral plane. This would be true only for day sailers where speed was not the primary object. Savings in cost and weight are thus obtained, and the problem of beach objects jamming a centreboard are eliminated—an important consideration for those sailing off stony beaches.

Since the majority of the hulls on day racers and sailers are connected by tubing or other open beams stiffened by wire trusses, and because the separations are so large in comparison to the beam of the individual forms, no particular advantage is gained in asymmetry by flaring the insides of the hulls to reduce the connecting beam lengths. Furthermore, doing so adds weight, a most critical area in day racing design.

Proponents of asymmetry* once claimed that substantial windward lift was gained from heeling a catamaran, so that an asymmetric hull on the heeled side would act like a lifting foil, while the windward hull would be nearly out of water, causing little opposition. This was found to have four disadvantages resulting in configurations which were less manoeuverable, less safe, and slower than symmetric arrangements, namely:

1 The low aspect ratio of the foil attained in this manner produces excessive drag.
2 Narrower, deeper and chined hull sections associated with asymmetric forms contain more wetted area which is permanently fixed.

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* William R. Mehaffey, Consulting Engineer, Chicago, Illinois, experimented in 1958 with a 30 ft catamaran sloop with asymmetric hulls in which at the predetermined angle of heel of 10 to 15° in 20 mph winds, approximately 1,400 lbs of lift to windward was attained from the lee hull, at which point the hull speed was approximately 12 mph. Her displacement/length ratio was approximately 44 and length/extreme beam ratio was 2 : 5.

Since this experiment, length/extreme beam ratios for catamarans of this size and displacement have decreased to about 1 : 85 with proportionately higher initial stability. Racing results have shown that the asymmetric hulled catamarans can point higher, but have so much more total drag that their speed made good to windward is lower than symmetric round bottom centreboarders.

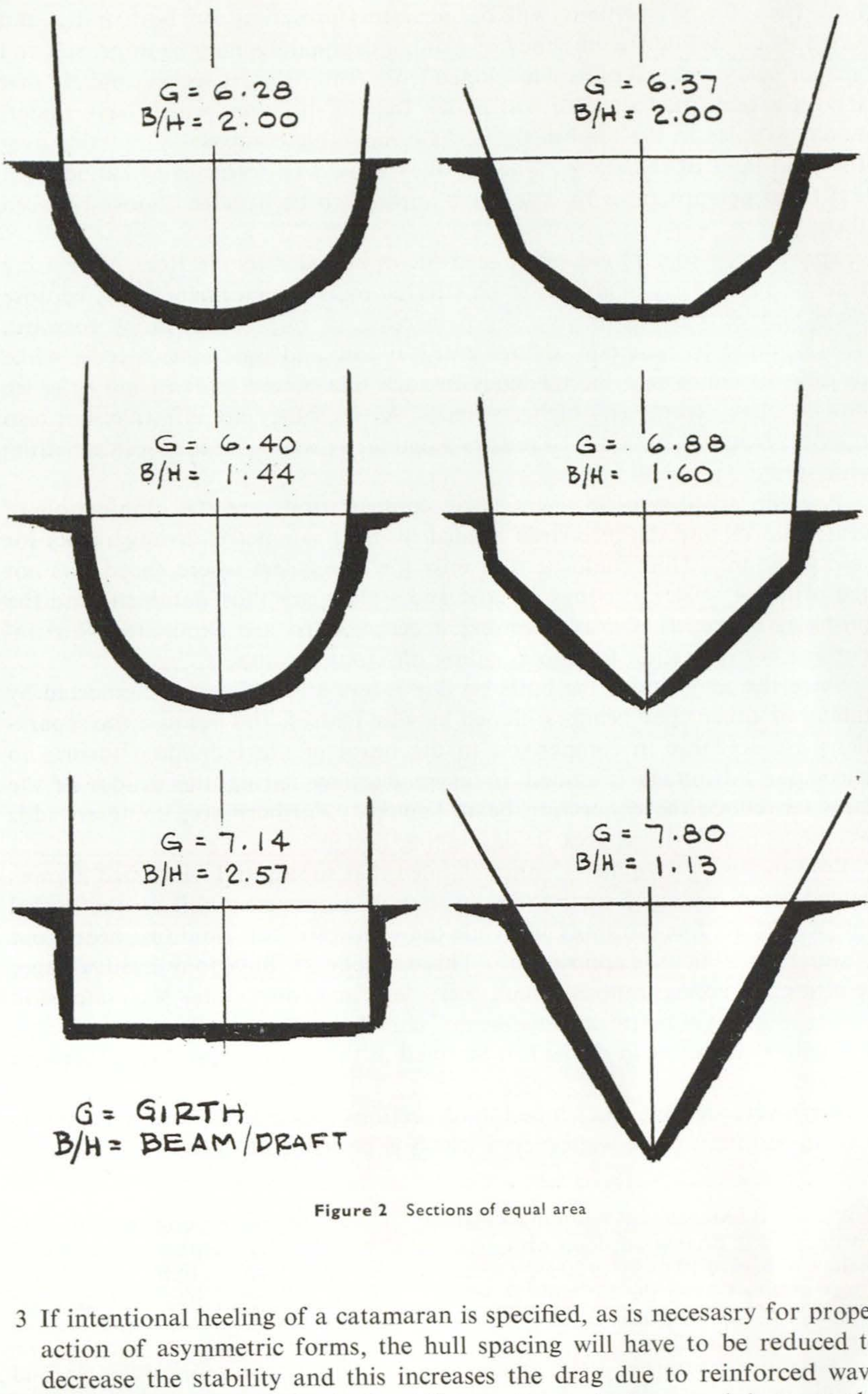

Figure 2 Sections of equal area

3 If intentional heeling of a catamaran is specified, as is necesasry for proper action of asymmetric forms, the hull spacing will have to be reduced to decrease the stability and this increases the drag due to reinforced wave formations between the hulls. Water pile up is increased because the greatest longitudinal curvature must be on the inside of the hulls.

4 To reduce the beam is to decrease stability, safety and sail drive.

Offshore cruisers and ocean racers*

To a far greater extent than monohulls, the shapes of individual catamaran hulls are independent of transverse stability and subject to less change of flow because of relatively low average angles of heel. An infinite variety of hull sections are possible which can be as beamy and shallow, or deep and fine as the designer may select. Typical sections drawn to the same scale of equal area with girths proportional to that of the semi-circular section are shown in fig. 2. While most designers agree on the minimum wetted area form as being best for day sailers and racers, opinions vary as to what is best for the offshore cruisers and ocean racers.

First of all, a distinction must be made between day racers and cruising multihulls on the basis of the way they are sailed. The former, operating over closed, protected courses, often sail on one hull with advantage. Since the crew weight may run as high as 50% of the total displacement, this attitude may be controlled by rapidly shifting crew weight and adjusting the sails. Failure to do so may mean capsizing, but assistance under these conditions is usually nearby. On the other hand, cruising boats must be designed for, and sail in, the oceans beyond the areas of timely assistance. Also, it is too fatiguing for the crew to remain in a ballasting position for long periods of time, and it is not practical for the watch to be constantly adjusting sail. Great care is taken, even on ocean racers, to avoid lifting a hull, especially in heavy seas where the risk of capsizing is greater. Therefore, in day racers where hull characteristics may be determined on the basis of one hull supporting from 60 to 100 percent of the total displacement, cruising catamarans will be proportioned more nearly on a 50-50 basis. In any case as compared with day racers displacement/length ratios will be higher. Through the addition of cruising boat equipment, Froude numbers will be lower, freeboards increased for safety and comfort, and hull forms varied for reasons of sea keeping, draft, speed, and internal arrangement.

A distinction between offshore cruisers and ocean racers must also be made when discussing hull forms, because of the substantial differences in displacement/length ratios. (The same differences apply to monohulls, except that they are smaller on account of the addition or subtraction of ballast, which in turn is compromised by rating rules and adjustments in sail area). The same distinction may be made between light and heavy cruisers. It arises because the displacement/length ratio of a heavy cruiser may be twice that of a light cruiser. Because light cruisers may be equipped with one or two outboard motors, a small light auxiliary generator, no mechanical refrigeration, the very minimum of fuel and water, untrimmed plywood fittings of the lightest possible scantling, few lockers, and the lightest of transistorized solid state electronic equipment, the total displacement is low enough to substantially reduce the mass moments of inertia with

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* Cruising multihulls may be defined as having accommodation for sleeping, eating, and in general for living aboard for short or extended periods. Some cruisers will be lightly equipped like ocean racers and others more heavily, tending to create broad differences in displacement/length ratios and Froude numbers. Hull forms vary considerably more in cruisers than in day sailers and racers because considerable differences of opinion exist on what the best form is to satisfy these variations.

subsequent reduction of hull scantlings. On the other extreme, heavy catamaran cruisers of the same length may be equipped with twin diesels, a diesel auxiliary generator, enough fuel for a 1000 miles under power, enough water to supply four toilets with showers and the galley for an extended period, deep freeze and chill boxes, air conditioning and heating, hi-fi, radar, loran, and innumerable other luxuries not found on the ocean racer.

On ocean racers the designer's primary object is to produce a hull that will permit the yacht to get from point A to point B in the least amount of time. This will be true for whatever displacement/length ratio he may have to work to, since the purpose of most handicap rules are set up to take weight differences into account. On heavy cruisers where there is no intention to race, the owner would still like his yacht to be as fast as possible. However, he will often allow serious compromises in speed to achieve some particular advantage. He may want very shallow draft, a high proportion of auxiliary power, and perhaps complete protection for propellers and shafts with skegs and balanced rudders, all of which tend to add to the resistance. In any event, the best designers will struggle to produce the form of least resistance and most efficiency to perform the service intended, but it is in the ocean racer that the greatest attention is given to hull forms in terms of speed.

The addition of accommodation immediately raises the displacement/length ratio, calling for more waterline beam and more draft, which results in proportionately higher wetted area and righting moment. Since stability is a function of weight times the distance between the centre of buoyancy of one of a catamaran's hulls and the centre of gravity of the yacht, it is obvious that the hull spacings may be reduced. As a practical matter, in most cases hull separations of cruising multihulls are insufficient to avoid wave interaction. Concurrently, the displacement/length ratios have increased to the point where the residual resistance accounts for a substantially larger portion of the total resistance than on extremely light day racers. These conditions give rise to three important basic decisions in terms of hull forms.

The first concerns lateral plane, the second, wave interference between the hulls, and the third, (closely related with the second) the individual hull or float characteristics. It is between these factors that most of the controversy has arisen amongst the leading designers over the most effective hull forms for ocean racers. If there is insufficient evidence on which to describe the ideal racing form, there is even less for the ocean racer, because so many more variables can effect the outcome of long distance ocean-crossing races. However, the following general observations may shed some light on this simulated approach to multihull design.

While the symmetric, minimum wetted area, full rounded sections with centreboards have proven the most efficient for the day racer, there is some evidence that the same may not be true for the ocean racer. It is simply that the full rounded sections do not provide adequate deadrise in the faster ocean racers to permit the maintenance of high speed in the seas, which are normally created by winds in which those speeds may be obtained. The pounding that results from sections of too low deadrise can be destructive to the hull and rigging and can produce severe crew discomfort, preventing sleep and making footing difficult, if not dangerous. In the day racer any amount of discomfort can be tolerated for short duration of time, but crew efficiency would soon dissipate in the face of prolonged discomfort in the cruiser.

Although displacement/length ratios of ocean racers are higher than those of the day racers, they are still considerably lower than those of ballasted monohulls. At the same time, freeboards are proportionately higher and drafts proportionately less than monohulls. The net result is that to have sufficient lateral plane, very large centreboards must be employed and/or what lateral plane the hulls offer must be shaped to produce the most resistance to side motion as is possible at the lowest resistance. Large centreboards have the disadvantages of adding substantial weight, higher original cost, and difficult and costly maintenance, while often interfering with the living quarters of many medium sized craft. On the other hand, use of low aspect ratio fixed fins or chine shapes in the hulls in association with hull asymmetry can induce more resistance and offer greater resistance to turning. The latter point in ocean races is, however, not as serious as it would be in day racing where much more manoeuvering is required, and where at sea, directional stability becomes more significant, especially in carrying spinnakers, running, and reaching. Because the wetted area of such combinations is greater at all times than on the minimum wetted area forms, fixed fin, deep keel, chined and/or asymmetrical forms will be slower in light air and smooth sea.

The reader must bear in mind that the argument in process herewith is confined to ocean racers. As already mentioned, radical compromises are often made in cruiser hull forms for special services which could minimize or even cancel out higher speed producing factors.

Choy* argues strongly in favour of asymmetric catamaran hulls with the maximum curvature inboard and hard chine outboard and, for all practical purposes, a canoe or double ended stern, similar to the lines shown in fig. 3A, as being the best solution to the problems stated for hull forms of ocean racers. He notes the following advantages of the configurations:

1 No centreboards are required for best speed made good to windward in wind speeds over 8 knots.
2 Less wave making resistance because of finer sections, entries, and exits.
3 Reduction in leeway due to wave action on the bows—less lateral drift.
4 Less induced drag by means of reduction in lateral wave formations.
5 More seakindliness and seaworthiness because the prescribed hulls ease through the wave formations with minimum fuss.

Bearing in mind that ocean racing catamarans sail between 85 and 90 percent of the time with the displacement evenly distributed between the hulls, and during the remaining time the leeward hull rarely bears more than 55 or 60 percent of the total displacement, it might appear that there is no reason why the hulls could not be reversed, thus putting the maximum longitudinal curvature outboard, and the chine inboard. Since for all practical purposes, catamarans are being sailed in an essentially upright position, it might, as a matter of fact, reduce the resistance. Recent tank tests on the upright resistance of catamaran forms showing reductions in resistance have been

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* *Catamarans and Common Sense. Motoboating Magazine.* Article by Rudy Choy, March, 1963.

where the curvature has been outboard and the inboard sides relatively straight, and wave interaction was present. On the other hand, in view of the fact that the effect of symmetry versus asymmetry may constitute such a minor effect by comparison to sail area, weight, and length, it may not matter if the chine is on the centreline as Meyers* used in his mathematical approach to the development of catamaran hull forms, fig. 3B.

Choy's forms have the advantage, however, of placing the hull's centre of buoyancy as far outboard as possible in relation to overall beam, which helps in keeping deck areas and weight to a minimum while attaining maximum stability. Also, by having most of the sectional slope inboard, the span of transverse beams connecting the hulls is kept to a minimum.

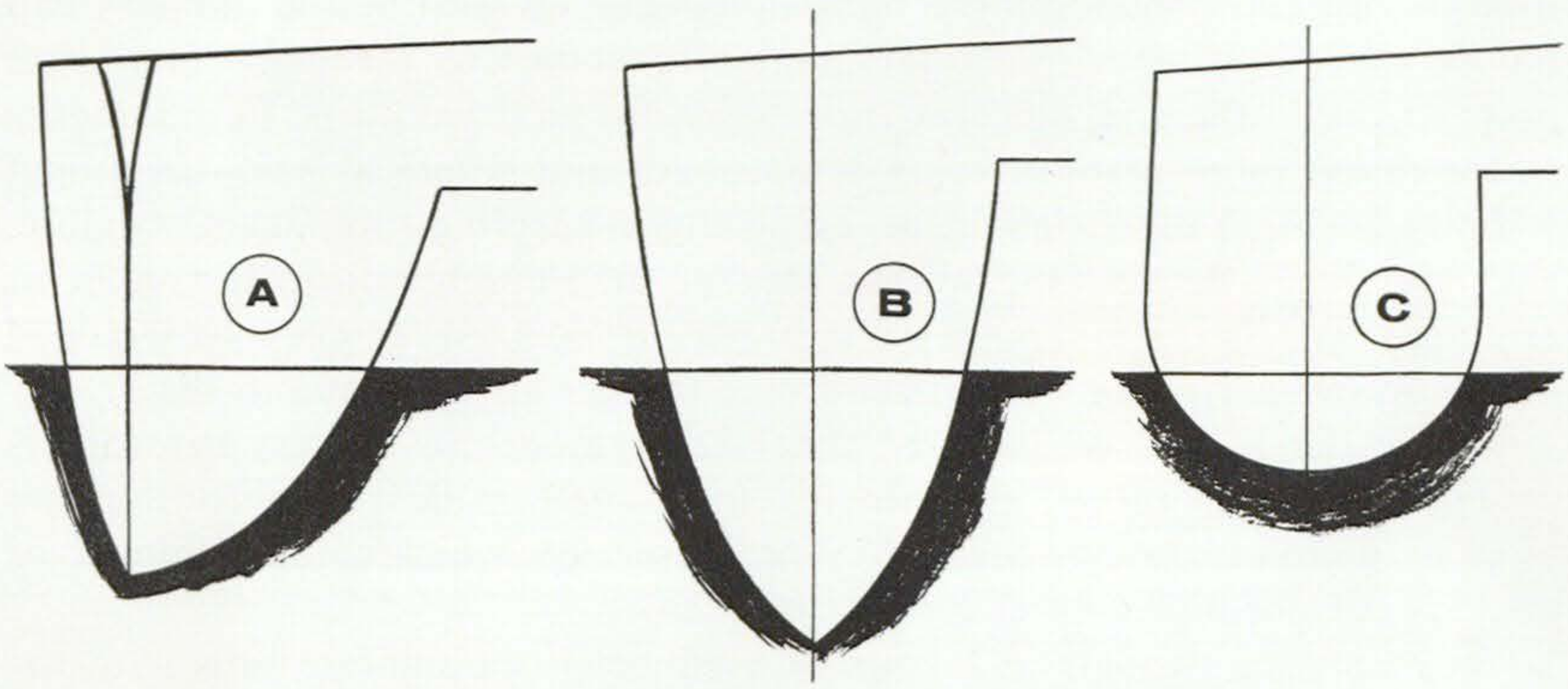

Figure 3 Hull forms of ocean racing catamarans

In both cases the chines contribute to lateral resistance and permit the use of smaller centreboards for racing to windward, by comparison to the semi-circular hull section forms. (On recent 12 meter design and several other modern ocean racing monohulls, leeway angles have been reduced by veeing the keel bottoms to a sharp edge at the centreline, indicating a total advantage in speed made good to windward in spite of the slightly higher induced drag).

GLASS SLIPPER, the winner on corrected time of the 1966 Transpacific Race from Los Angeles to Hawaii is a 50 ft loa canoe stern catamaran sloop, 40 ft 6 in on the water, 20 ft extreme beam with midsection similar to fig. 3A, hull lwl/b ratio of 6 : 67 and a hull beam/draft ratio of 1 : 20. The displacement/length ratio of each hull, consistent with the ratios just given, is 56. By contrast, *IROQUOIS*, the winner of the 1966 Round Britain Race is a 30 ft loa transom stern sloop, with ovular midsection similar to fig. 3C, 26 ft 3 in lwl, 13 ft 6 in extreme beam, lwl/b ratio of 7 : 66, and b/h draft ratio of 3 : 72. Her displacement/length ratio is 62.

Neither of the rules under which these two catamarans raced factored wetted area, waterline beam, absence or presence of centreboards or propellers.

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* *Mathematical Yacht Hull Lines*. By Hugo A. Meyers. Submitted to SNAME, April, 1966. Figure 5.

SAILS AND RIGGING

Major problems in multihull sail and rigging plans are similar to those of monohulls, but are compounded by a speed range more than double that of a 12 meter yacht. Present rating rules place few restrictions on mast and sail combinations even for some ocean racers and permit everything from conventional soft sails and fixed rigs, full batten sails in combination with rotating masts, to completely solid wings.

Inspired by sailing iceboat rigs, the quest for greater speed under sail has brought forth many unusual rig combinations. With the stability that multihulls offer but with much greater resistance than iceboats, particular attention has been given to developing higher sail lift/drag ratios using wing masts. To date these have taken the form of symmetrical airfoils which are stayed from a single point. This permits them to rotate up to about 60 or 70° off the centreline, so that when set at the proper angle of attack they closely resemble the wing of a plane. Wing masts have now grown to such a large percentage of the total sail area that the remaining area that is sail essentially performs the function of a flap in a wing. The wing masts have been built mostly of thin plywood, fibreglass sheathed to protect and strengthen the extreme fibres, and braced and sparred internally, similar to aircraft wing construction. The stays put large compression loads in the masts, however, and when strong enough to resist buckling with suitable factors of safety are strong enough to resist any other dynamic loads. The rotation of the masts is sometimes automatically performed by wind forces in the sail, but assisted in light air by use of a tiller or block and tackle at the base of the masts.

Most of the new rigs resulting from such experiments are confined to day racers, but as time passes and more experience is gained in handling these rigs, particularly as means are found to control them under severe wind and sea conditions, more of the innovations will be used on ocean racers and offshore cruisers.

Wide sheeting bases and high initial stability of multihull craft have caused considerable changes in thought regarding sheeting arrangements, working of headsails and spinnakers, sail construction and weights, and mast staying. For example, the sheeting base is quite often wide enough to set a spinnaker without the aid of a pole. In the future, spinnakers cut especially to take advantage of this condition could completely eliminate the necessity for a pole and greatly facilitate their handling, particularly when gybing.

In the smaller jib headed cruisers, chainplates for attachment of the shrouds to the hull are often positioned well inboard in order to keep the athwartship distance between them in the same proportion to the base of the fore triangle as is common to similarly rigged monohulls. Thus, overlapping headsails (genoas) can be sheeted near enough to the centreline of the ship for best close-hauled trim to go to windward. As yacht size increases it becomes desirable to locate the chainplates on the outsides of the hulls to create more favourable staying angles from the mast, reduce compression loads, and permit smaller, lighter masts and supporting beams. With extreme beams ordinarily double and righting moments five to eight times greater than most monohulls, it becomes important to minimize the strains wherever possible.

Due to the catamaran's high initial stability, standing and running rigging, sail weights, and spars have to be increased over those of monohulls of equal length in proportion to the righting moment. Unfortunately, it is the larger, heavier multihull cruisers whose wetted surfaces are proportionately larger than monohulls that could use the added drive of large overlapping headsails going to windward. 'A' frame bowsprits and bumpkins are being attempted on catamarans to get added sail area, but lengthening the hulls is preferred. It is a common struggle with monohulls and multihulls alike to keep displacement/length ratios low. However, the consequences in multihulls of not doing so are more severe, where widening the hulls increases the resistance

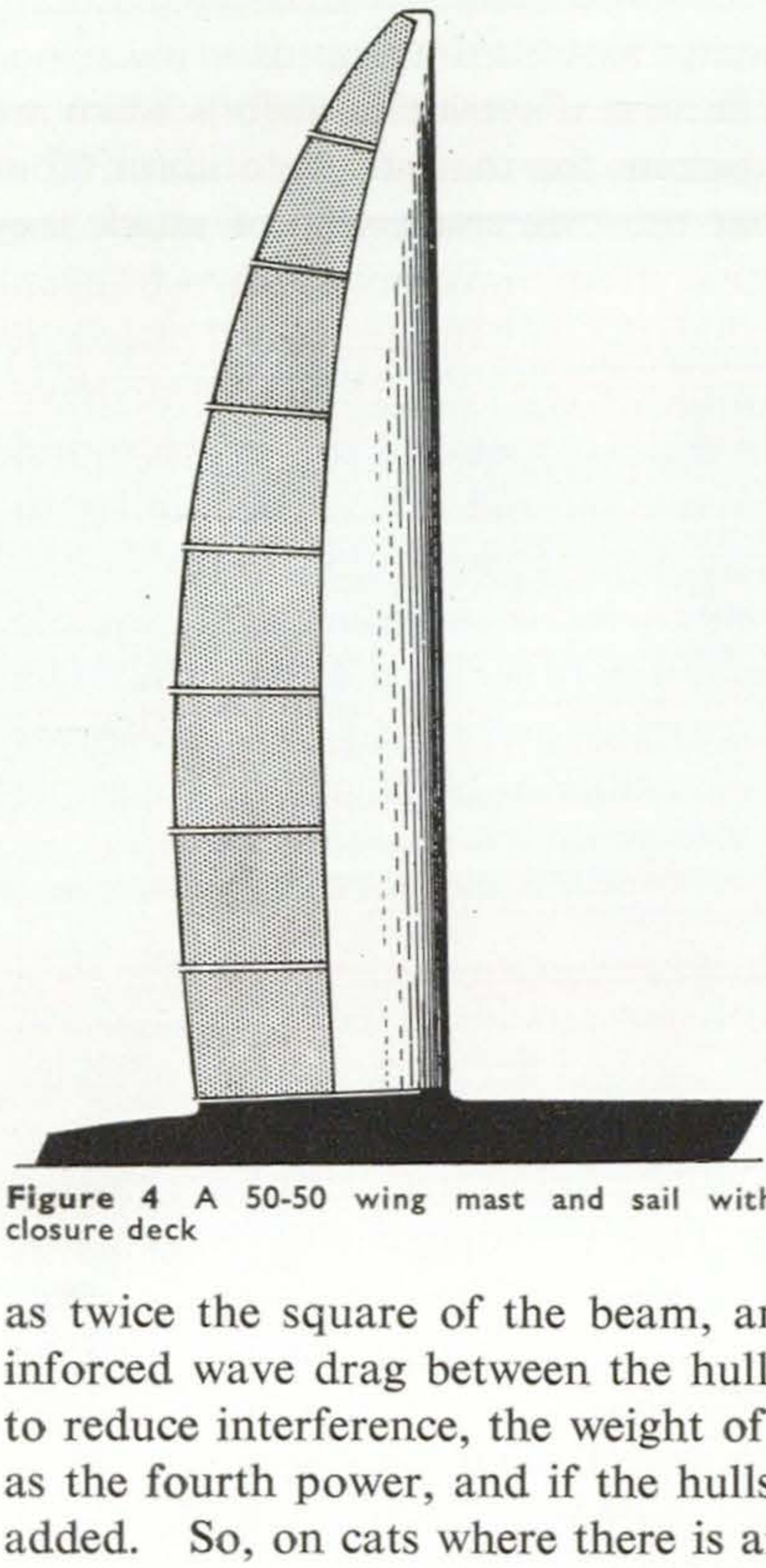


Figure 4 A 50-50 wing mast and sail with closure deck

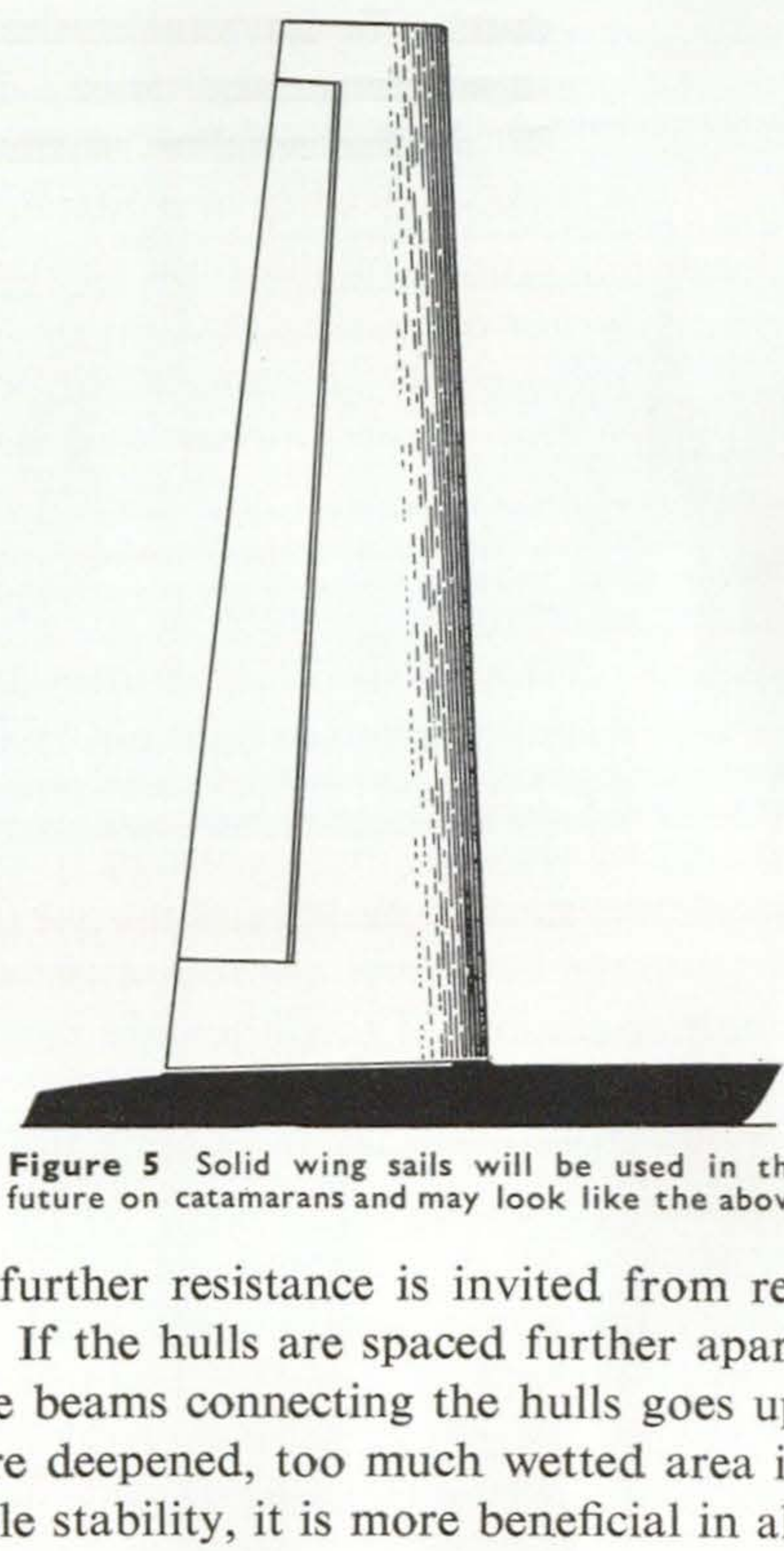


Figure 5 Solid wing sails will be used in the future on catamarans and may look like the above

as twice the square of the beam, and further resistance is invited from reinforced wave drag between the hulls. If the hulls are spaced further apart to reduce interference, the weight of the beams connecting the hulls goes up as the fourth power, and if the hulls are deepened, too much wetted area is added. So, on cats where there is ample stability, it is more beneficial in all airs to add length to get more sail area. Generally, owners will settle for bowsprits and bumpkins because it is cheaper than adding length to the hulls, but it is better to avoid them by keeping the yachts light. A good rule is to keep a generous third of the total length of a hull free of any accommodations or stowage.

The most prominent evidence of advanced rigs taking advantage of the stability and speed of which multihulls are capable may be found in International Yacht Racing Union's 300 and 500 square foot sail area, 'C' and 'D' class catamarans. Capable of speed/length ratios of 5 and better, these craft are currently raced with full length batten sails and rotating 'wing' masts, whose surface area divided by 2 may be as high as 50 percent of the total actual sail area. (In size and proportion the wing masts bear little resemblance to those of iceboats with which they are often compared, because the fastest multihulls operate at ratios of boat/wind speed of 1 : 2 to 1 : 2·5, while iceboat ratios may be three to four times higher, see fig. 4). Wing theory predicts that solid wing symmetrical aerofoils with large trailing edge flaps will produce the highest lift to the least drag, fig. 5. Designers are moving rapidly in this direction and have only been deterred by lack of time, money, and testing facilities. There appears to be a problem of weight, however. Present 50-50 rigs may be put up at about ½ pound per square foot of allowable sail area in the 300 square foot size. Preliminary investigations show that only with highly expensive aircraft construction will the same weight per square foot be maintained in a 100 percent solid wing sail. Hope of weight reductions may be expressed by saying that it does not matter what shape or material is used, as long as it provides the same or more lift than the competitor's rig.

The extreme length/beam ratios of day racing multihulls, viz., up to 1 : 78, renders decks large enough on which to mount a variety of wing shapes with complete closure at the deck if it becomes desirable. There is some evidence that creating an end plate for the base of the wing in this manner will effectively increase the aspect ratio, which will result in more lift with no increase in heeling moment, see fig. 4. Racing sail and wing mast combinations in 1967 have aspect ratios of 4·3 (span squared divided by the area). Modern glider aircraft wings, designed also for maximum lift and minimum drag, have equivalent aspect ratios of 12½. This is twice that recommended for optimum performance by the Eiffel experiments on rectangular aerofoils without thickness, (like a regular sail and small mast combination) as noted by Morwood in *Sailing Aerodynamics*. Morwood suggests, however, that the maximum coefficient of thrust over several points of sailing and varying wind speed can be achieved using the USATS 10 aerofoil section based on a rectangular profile with aspect ratio 6 : 1, which would give up to four times the thrust of a conventional Bermudian soft sail plan (mainsail and jib).

It is only because of the added stability of a day racing catamaran over lightly ballasted or unballasted single hull craft that the use of wing mast and full batten sail rigs with aspect ratios of 4·3 are feasible. Unless the aspect ratios can be raised without adding to the heeling moment it seems unlikely that more efficiency will be sought in this direction. Increased aspect ratios, however, are if anything more valuable in light airs, and means to increase it during light air and decrease it in heavy air may be useful for optimum all around performance.

One thing that the wide bases of catamarans make possible are segments of circular sheet tracks for roller slides, which when connected to the boom with a vang maintain rigid vertical restraint in the sail. Wide beams permit maintaining prescribed shapes of sails in this manner over 90 percent of the courses sailed.

Most of the high speed rigs used on the day racers are unsuitable for cruisers. Ocean racers are beginning to use full batten sails and swivelling masts where rules permit, but for the heavier cruisers and private charter yachts the racing rigs which have just been reviewed lack flexibility required for safe handling at sea.

STABILITY

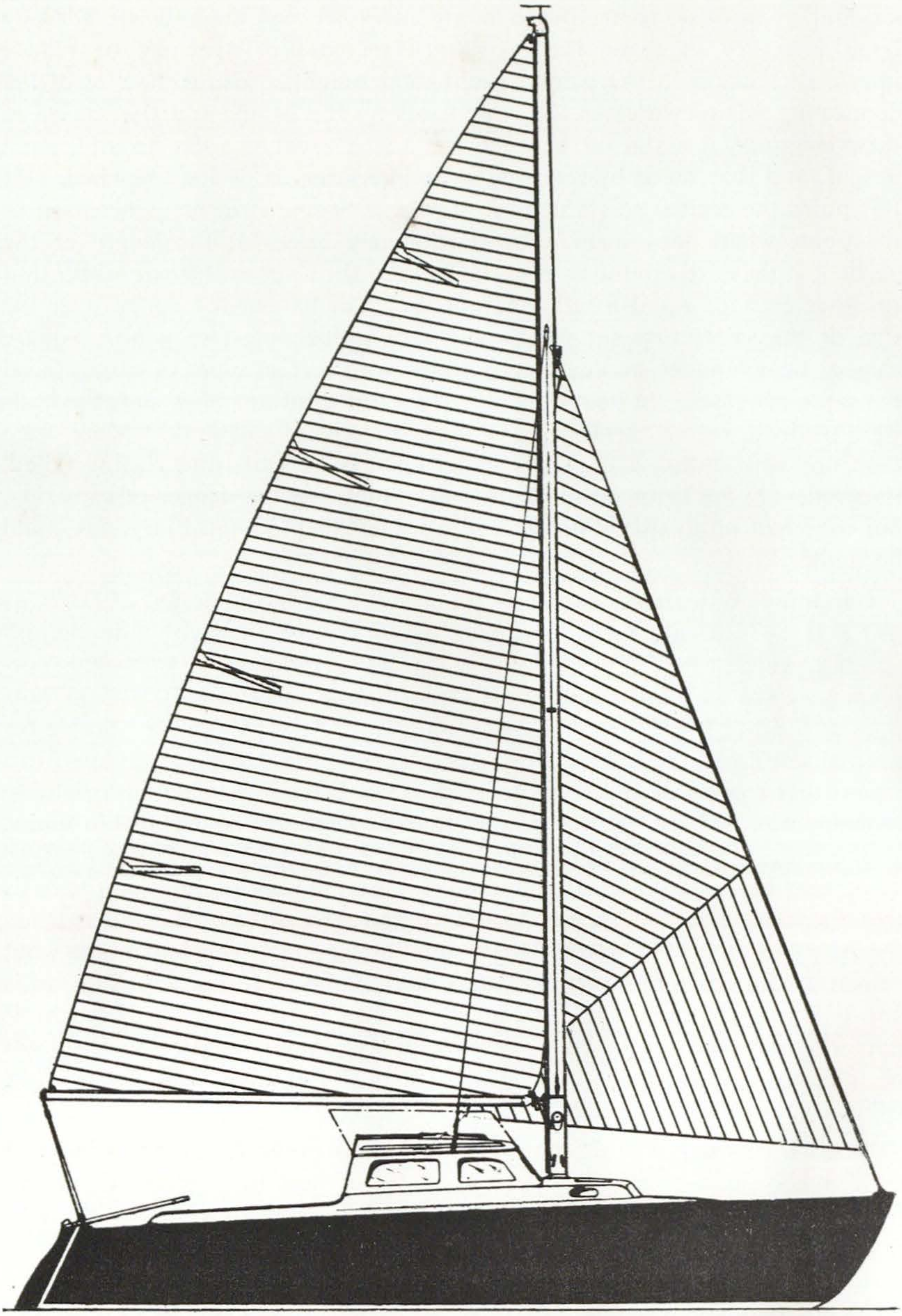
The stability of multihull craft is a function of hull spacings, weight, and height of centre of gravity which is assumed to lie on the centreline of ship, except in small craft where shifting crew weight to weather is a large enough proportion of the total weight to be considered. The righting moment created by the disposition of these factors equals the heeling forces of the wind to create a state of equilibrium. Generally, any righting arm created by a shift of centre of buoyancy in a catamaran's hulls is so small that it is neglected.

Catamarans receive their stability under sail by reason of the division of displacement equally into the two hulls set well apart, with maximum stability at zero angle of heel. Theoretically, this indicates that because the stability decreases continuously with increased angle of heel, a steady wind force capable of raising the windward hull will capsize a catamaran unless additional righting moment is applied or the heeling force is reduced by luffing, or sail is reduced, or course is changed. In small cats luffing and adding righting moment may be done simultaneously. The crew hikes further out to windward to increase the righting moment and/or the sheet is slackened to reduce the effective sail area. In the large cats where there is often not enough crew weight to provide a sufficient additional righting moment, wind forces are reduced by running off downwind, accompanied by slacking the sheets. Again in smaller cats, by playing the sheet and shifting weight, the weather hull may be kept slightly oscillating at any height off the water short of the point of negative stability. In the hands of a skilled cat sailor capsize is unlikely. The crew would not have to hold the position any longer than he pleases, and if he should capsize it would usually be in an area where there was assistance nearby. On the other hand, since no such chance of capsize may be taken at sea, great care is taken not to raise the weather hull to the water's surface. Any sign of this is regarded as the point at which sail must be shortened if it is found that one must constantly run off or slack sheets in order to maintain the proper angle of heel. Course and sail settings will be determined by the strength and duration of the new wind. In ocean racing larger numbers of crew will be available for standby on deck, but unless they are over-zealous, inexperienced, or just plain stunt seekers, they will not permit the hull to come out of the water.

Weights of multihull craft of the same length may vary widely, just as it may in a monohull, depending upon type of construction and material, amount of fuel, water, power, auxiliaries and equipment. In monohulls of similar type and length, where it is assumed that beam and draft vary little, the amount of ballast will be varied for stability. This will be supplemented by righting moment due to the normal weight of the craft coupled about the heeled centre of buoyancy to maintain equilibrium with the sail force. In the multihull, on the other hand, the hull spacings are varied to accomplish the same thing in lieu of the ballast. While some designers have used ballast from 10 to 15 percent of the total displacement, usually in fin keels of small light multihulls, the idea has generally been abandoned in favour of increased beams. A problem arises on larger multihulls, particularly catamarans which are more heavily loaded, where the hull spacing for sufficient stability may be so small as to cause serious wave interferences between the hulls attended by large increases in resistance. Arbitrary increase of spacings to reduce interference causes a sharp increase in total weight, because the size of the connecting beams varies as the mast loads on the beams and the square of their lengths. A stand off between the added resistance due to additional weight, and that saved by reducing wave interferences, is soon reached. At this point the craft is so stable that mast and rigging sizes have increased to the point where they seem disproportionately large for the length of the yacht. If they are arbitrarily reduced to keep their appearance in proportion to other craft of equal length, the possibility of having the rig go over the side or the sails blow out may occur in a sudden blast of wind. Square riggers, heavily laden and extremely stable with certain types of cargo, faced the same problem. In heavy squalls, if the sails did not blow out, the hulls were strained, seams opened up and many foundered and sunk. More often than not with cotton sails, the sails let go first or spars and rigging failed, thus relieving the loads on the hulls and minimizing the danger of capsizing, but they had no auxiliary power and were left helpless until jury rigs could be made.

Conditions of extreme stability were encountered in the design of *QUICK-STEP II*, a 72 ft catamaran, (see page 62), in conjunction with suitable hull spacing, which when fully loaded has a righting moment of 1,500,000 foot-pounds versus the 72 ft monohul with a righting moment of only 220,000 foot-pounds. Since it was felt that terylene (dacron) sails of weights suitable for normal craft use might not blow out even under extreme conditions, this meant that rigging or spars would have to fail before the maximum righting moment was realized, if their size was to be kept within reasonable limits. In the end, both spars and rigging strengths were allowed to fall from 10 to 15 percent below that actually required to raise the weather hull, on the basis that the crew would have had to reduce sail well before the wind reached the point of imposing parting loads on the rigging. The maximum wind velocity required to raise the windward hull of the 72 footer with full sail is approximately 60 mph. It is assumed that structural strains in the yacht at potential hull speed in the heavy seas which such wind would raise, could not be tolerated nor could the crew stand the mental and physical strains such wild actions would produce.

When a catamaran heels more profile area is presented to the wind just as if freeboard were added. At low angles of heel the additional heeling force from wind acting on the heeled profile or added wind resistance is negligible, except to racing multihull yachts. At larger angles of heel, permissible in small catamarans the additional heeling force acting on the underside of the connecting structure, in addition to the side force and drag created by the windage, becomes a significant factor in the overall stability and performance. For this reason, many recent offshore racing catamarans are being built with large areas between the hulls left entirely open, except for safety netting. Wind forces acting upon raised hulls and wings at large angles of heel are substantial, especially in conjunction with the light displacements possible in offshore racing craft. This should be taken into considerations of stability comparisons.



STARLIGHT, a 26 ft catamaran cruiser (see fig. 6)

Some cats have been fitted with various buoyancy devices, either fixed or inflatable, at the masthead. It is generally agreed that the fixed devices are unsightly and add weight and wind resistance high up where it is most unwanted. Therefore, the inflatable type is receiving more attention. Such a device was fitted to the catamaran that won both the first Round Britain and Crystal Trophy Races from England in 1966 and 1967, respectively.

Very little has been done with liquid ballasting systems on multihull craft, due to the added complexity, original cost, and maintenance of the required pumps, tanks, and other equipment—not to mention the disadvantage of the additional weight. Most multihull owners prefer to rely on the inherent stability of the design and their ability to control the angle of heel with change of course and sail changes, and to avoid the possibility of turning upside down in the event of capsizing by the addition of masthead buoyancy.

HABITABILITY

Multihulls present their own design problems and solutions pertaining to comfort aboard. As in monohulls, a compromise must be arrived at that is satisfactory both in terms of habitability, seaworthiness, and speed. The solutions are different in each size range for both catamarans and trimarans. Of particular interest and importance is the problem of head room versus wing height in catamarans.

Individually, practices in ventilation, headroom, lighting colour scheme, berth length, seating, and general access currently acceptable in monohull craft are being incorporated in carefully planned multihulls.

On the smaller catamarans narrow hulls create special problems in the general arrangement of living quarters. Passage fore and aft in the narrow hulls is restricted by protruding berths etc. Headroom is difficult to obtain while keeping a low outboard profile, workable deck, and at the same time trying to create a protected lounge area. A partial solution for the small catamaran appears in the arrangement shown in fig. 6, where standing headroom is provided by raising a trunk over each hull. Berths do not interfere with access to the galley or toilet and a protected lounge area with sitting headroom is created by raising a dacron hood over the U-shaped seating area installed between the trunks. With a removable table between the seats, the area may be used for eating, the seats converted to berths, and with the hood down, is a useful extension of the cockpit. Also, with the hood down when under way movement fore and aft is not difficult by stepping up to the deck over the seats, and there is no interference with the working of the sails. In smaller catamarans for overnighting the trunks may be dispensed with and only the U-shaped seating area kept with collapsable hood.

Several small catamaran designs from abroad are in production with deck houses, which nearly span the full beam of the craft to provide sitting headroom between the hulls and protected access from one hull to the other. McAlpine-Downie's *IROQUOIS* illustrates this arrangement (AYRS Publication No. 59, page 49).

Deck houses raised between the hulls with standing headroom in catamarans of less than 50 ft in length appear disproportionately high in comparison to a normal freeboard and have the further disadvantage of raising the main boom to awkward heights. Any attempt to lower the floor of the wing structure to reduce the height will result in pounding and/or increased frictional resistance from frequent wetting. It is quite obvious that continuing to lower the wing will result in a barge form. In 1962 an unofficial 47 ft catamaran entry in the Storm Trysail Club's Block Island Race, upon re-entering the Sound from rounding the Island, at which point she was over three hours ahead of

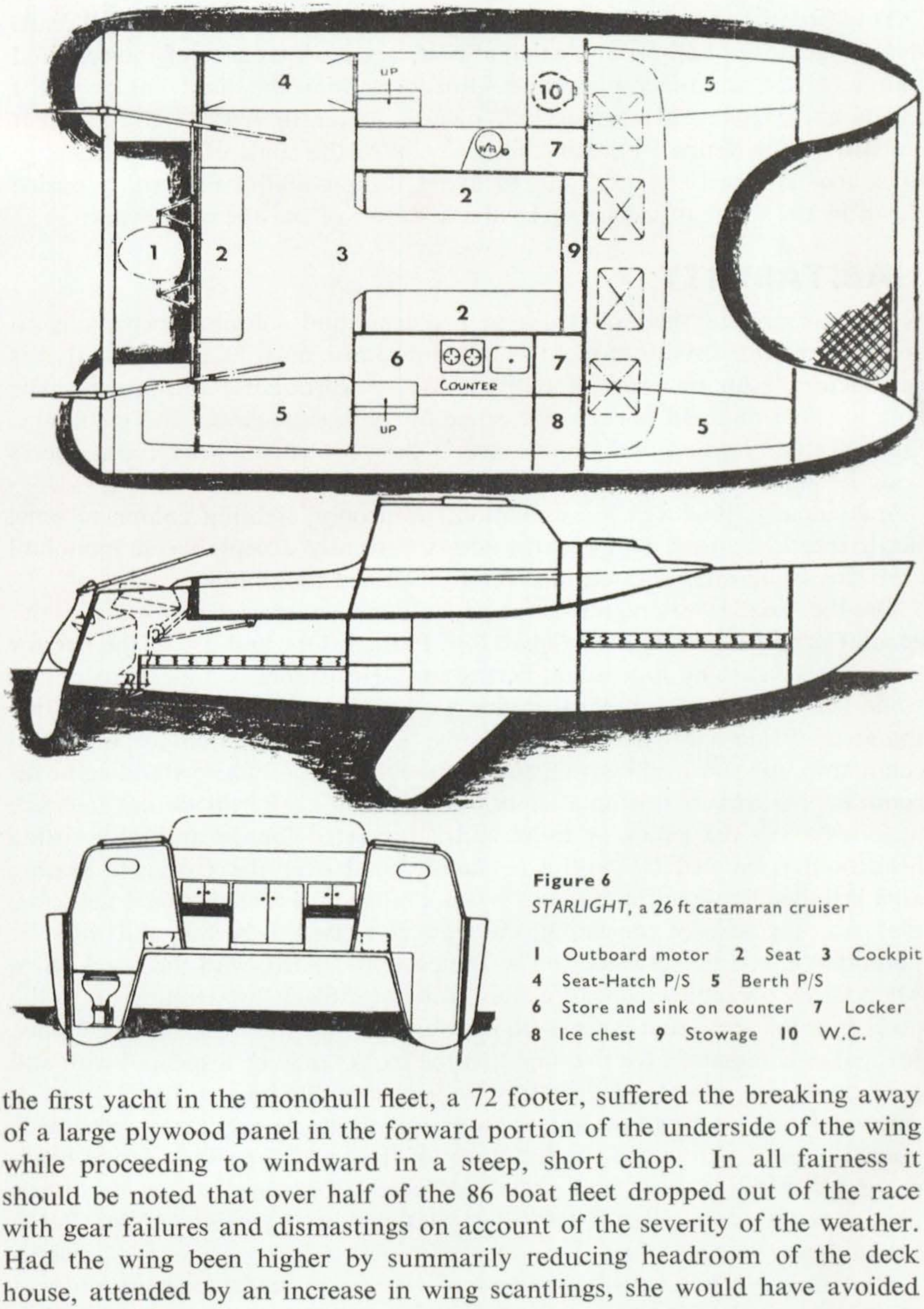


Figure 6
STARLIGHT, a 26 ft catamaran cruiser

1 Outboard motor 2 Seat 3 Cockpit
4 Seat-Hatch P/S 5 Berth P/S
6 Store and sink on counter 7 Locker
8 Ice chest 9 Stowage 10 W.C.

the first yacht in the monohull fleet, a 72 footer, suffered the breaking away of a large plywood panel in the forward portion of the underside of the wing while proceeding to windward in a steep, short chop. In all fairness it should be noted that over half of the 86 boat fleet dropped out of the race with gear failures and dismastings on account of the severity of the weather. Had the wing been higher by summarily reducing headroom of the deck house, attended by an increase in wing scantlings, she would have avoided structural failure.

The connecting structure between the hulls should be kept as high as possible in relation to the freeboard and required strength, but based on a percentage of the clear width between the hulls, suggested minimum for a 15 to 20 ft waterline craft would be 16 to 20 percent and 25 percent for larger craft. Large fillets at the hull and wing joint and deep longitudinal external stiffeners are recommended to reduce the amount of area of zero deadrise.

Many existing catamarans are overloaded, manifested to a large extent in going deeply overdraft and bringing wings too close to the water. For the most part, sufficient human comforts commensurate with the time spent aboard can be obtained without jeopardizing performance as long as the number of persons to be accommodated is kept within the limits normally seen on monohull craft of equal length. Owners are tempted to use all of the available space so much more in evidence on multihull craft. A good rule of thumb is to keep $\frac{1}{3}$ of the total volume of the hulls empty.

CONSTRUCTION

The majority of sailing multihull cruisers in use or under construction today are custom built, planked with sheet or cold moulded plywood and strip plank wood, sheathed on the outside with fibreglass reinforced plastic, and framed with plywood, sawn, or laminated wood. Framing is largely longitudinal with plywood web frames, wood stringers, plank floors, and bulkheads. Heavy reliance is placed on glue bonds with numerous light fastenings, like ribbed nails and staples, to obtain gluing pressure rather than mechanical connection. Hull connections are generally composed of plywood box beams, wood trussed and flanged with extensions of the webs into the hulls in the form of transverse bulkheads to distribute the loads over the depth of the hulls. Major longitudinal strength members such as keels, shelves, and bilge stringers are usually laminated wood or plywood and sawn wood.

As multihull craft grew in popularity after World War II and small racing classes, particularly of catamarans, were introduced, moulded fibreglass reinforced plastic was used for their production, while in the larger craft, aluminium and steel were being tried. Light aluminium alloy extruded tubing has become the most popular material and shape for connecting the hulls and floats of the day racers. Entire aluminium alloy welded hulls and hull connections are being designed for the larger multihull yachts. To date, steel has been used for the most part on commercial power catamarans for fishing and oceanographic research. In 1951, *COPULA*, a steel catamaran of 48 ft, designed and built in France by Captain Christian, crossed the Atlantic to New York. Twenty four foot high seas were met during the 31 day crossing, eight days of which she lay becalmed off the Azores. The designer reported that due to her heavy steel construction she was sluggish and pounded badly on the underside of the connecting structure between the hulls. In 1965, *RABBIT*, a 33 ft steel monohull sloop, designed by Richard Carter won the Fastnet ocean race. Although both craft had $\frac{1}{8}$ in shell plate, the catamaran suffered because of the large amount of shell area. While with different lines and less deck area, the steel weight of a catamaran of this size can be reduced by a small percentage, the total structural weight would be greater than the monohull because it is impractical to weld shell plate thinner than $\frac{1}{8}$ in. (We have recently heard of one welder who claims that thinner plate can be successfully welded without excessive distortion or burn-out by using a water spray behind the welder and adequate stiffening, but we have seen no yachts produced in this manner). Generally, in multihulls, welded steel hulls are practical above 75 ft, but even then lighter plywood fibreglass covered decks and wood or aluminium deckhouses would be recommended.

On the other hand, all welded aluminium alloy is well suited for multihulls with shell plate thickness down to $\frac{1}{8}$ in. Below $\frac{1}{8}$ in shell plate distortion is excessive and not strong enough to resist puncture by local impact as from docking or coming alongside another craft.

The advantage of aluminium alloy's favourable weight/strength ratio is readily appreciated for which there is much supporting evidence by its extensive use in construction of monohull yachts, high speed power boats, and large ship superstructures. However, its greater advantage in multihull construction by comparison to monohull construction may be less obvious, especially with the catamaran. First, on both trimaran and catamaran, there are two and three times as many points of abrupt change in direction of exterior surfaces as on a monohull, at which points the redundancy of wooden connections make strength analysis and joint performance uncertain. Higher factors of safety introduced by using larger members, more bracketing, and doubling result in further weight. Filleted and rounded joints using laminated wood members can improve such joints considerably, but rely heavily on good gluing and careful workmanship. Both end in higher construction costs.

The foundations of the catamaran for twin centreboard boxes, twin rudders, twin engines, and duplicate separate tanks are usually planned for metal construction on a wooden boat. Because of the conglomeration of types of metal used in wooden hull structure, which could raise serious problems in electrolysis, metals other than aluminium are usually specified for these parts, such as stainless steel, galvanized mild steel, monel and silicon bronze. All of these, in addition to their separate natures from the basic structure, are materially and structurally heavier than aluminium.

In comparison to the monohull, proportionately higher weight savings in the use of aluminium alloy for multihulls is realized, again especially in the catamaran, because of the beams required to connect the hulls. The large compression loads of the masts are concentrated in the midspan of the main transverse beams which connect the hulls. In order to maintain deflection at tolerable levels, wood members must be quite large and are heavier than aluminium by the ratio of their weight, strength, and stiffness.

Moulded fibreglass construction is being used in multihulls up to between 40 and 50 ft, with basically the same techniques as are now practiced in monohulls, viz. moulded hulls, plywood bulkheads as transverse stiffening and fibreglass sandwich decks, usually with end-grain balsa cores. Because of the higher percentage of surface area, total structural weights of moulded fibreglass multihulls above 30 ft will be higher than monohulls of equal length. Total displacements are lower than monohulls because of the ballast required for the stability of the latter. Fibreglass covered plywood construction is generally lighter than moulded fibreglass, and laminated cold moulded wood is the lightest practicable construction. To prevent fracturing thin laminated wood skins, one or two layers of very light fibreglass reinforced plastic is placed over the outside surfaces.

Considerable experimentation with fibreglass reinforced plastic-faced sandwich construction using foam plastic cores, particularly the polyvinyl chlorides, is in progress on multihulls. Application of heat below boiling temperatures which can be practically applied, allow rigid sheets of polyvinyl chloride to bend to any desired curvature in a plastic state, but return to their former rigidity after cooling, while maintaining the new shape. Composed of a non-interconnecting cellular structure with no open volume between the cells to prevent water absorption, and with considerably higher shear, peel resistance and tensile strengths than former foam plastics, much more extensive use in boats is predicted, especially in multihulls, where it is particularly desirable to reduce the weight per square foot of their large exterior surfaces.

In the absence of ballast, multihull cruising craft may be kept extremely light in displacement, especially if they are auxiliary powered with outboards and have little fuel and water. In fact, it often happens that scantlings must be arbitrarily increased to withstand local damage. The author recalls a 22 ft catamaran day racer designed in his office in which the outer skin of the plastic sandwich construction was so light that one could practically put his finger through it, yet is was amply strong to resist water forces and the other loads normally imposed while sailing.

However, with newly developed PVC cores with higher impact strength of between 7 and 10 lb density, higher local loads are spread over a greater area reducing the possibility of puncture, and if puncture occurs no leaking will ensure due to the closed cellular structure of the core. Thickness thus far tried varied considerably. That used in *GLASS SLIPPER* was 2½ in thick versus ½ in thick on *TORIA*.

In some instances, in order to reduce further structural weight, terylene (dacron) canvas and netting has been substituted for deck areas between the hulls and the transverse beams. Considerable weight savings can be made in this manner. This also reduces the windage and the amount of solid structure exposed to wave slapping between the hulls.

MECHANICAL SYSTEMS

Catamarans require dual propulsion, plumbing, and steering systems, making them more costly in construction and maintenance, and heavier and more complex than trimarans.

Because of the higher speeds possible in the lighter multihull cruisers, it is desirable to have retractable propellers and shafting in order to reduce parasitic resistance, which at 20 knots in a catamaran with dual systems can approach 15 percent of the total resistance. The smaller cruisers and ocean racers have for the most part solved this by using outboard motors in various arrangements which can be swung up clear of the water when under sail. A more sophisticated and costly solution is the use of inboard-outboard stern drives which may be rotated 180° out of water when under sail.

Outboard motors have the disadvantage of usually requiring long shaft extensions for proper propeller submergence, which are difficult to stabilize and vulnerable when extended. Motors arranged to retract in self-closing wells just forward of the rudders afford some efficiency for manoeuvering, protection from the elements, noise isolation, and slightly reduce the chance of propeller emergence when pitching over the usual transom hung units. Generally, the methods for retraction, opening and closing of the thru' hull port, and general mechanical arrangement have not been sophisticated enough to operate in a trouble free manner. Since auxiliary power is often used in emergency, the unreliability of inadequately engineered and designed installations cannot be tolerated.

The complexity of extension and retraction of either inboard-outboards or outboards and the arrangement of their mutual action and location for manoeuverability and propulsion make them less attractive and reliable. A variety of dissimilar metals used in construction in cast aluminium housings does not permit long life and durability in the toughest conditions of a marine environment, that of being half in and half out of salt water.

Manufacturers are reluctant to change their inboard-outboard units to suit custom installations in catamarans. These units are usually short shafted to the engine and must be hung on the transom. Furthermore, the manufacturers will not sell their inboard-outboard units separately from the engines, which places further restrictions on their use. Their weight and proper arrangement at the transom calls for submerged transoms which retard turning under sail, are not particularly attractive, and create water noise. The centre of gravity of the engine so far aft increases the mass radius of gyration, raising the pitching angles. Increased pitching reduces sail drive, can be uncomfortable to the crew, and cause pounding on the underside of the wing structure.

On the basis of the foregoing, standard, permanent propulsion systems with fixed propeller and shaft fitted with folding or fixed two bladed propellers, and variable pitch and controllable pitch propellers are being reconsidered. The necessary penalty of parasitic resistance is being accepted in favour of reliability and flexibility in choice and arrangement of engines. This is particularly true where diesel engines are becoming ever more popular because of the lower volatility and cheapness of diesel fuel. V drives and belt drives provide adequate flexibility in arrangement.

Engine compartments widely separated in catamaran hulls require special attention to the handling and distribution of fuel, in terms of transverse trim, especially since one hull may have an auxiliary motor-driven unit. It is sometimes possible to put auxiliary generating units in one hull and batteries in the other while refrigeration and airconditioning units may be divided up according to their respective weights. However, fuel transfer pumps must be provided to maintain proper distribution and fresh water transfer pumps should be provided for the same reasons and emergency use.

Catamarans are usually fitted with two rudders because of the difficulty of mounting and the vulnerability of single units between the hulls. It is also preferable to have a rudder in association with each engine in each hull. Normally, twin rudders in monohull craft are turned in unison with tillers and a crossbar, but in a catamaran it is not possible to do so unless she is decked over all the way aft. The system used on the 72 ft catamaran which was not decked over all the way aft, included a quadrant for each rudder inter-connected through dual steering wheels with flexible cable. A hydraulic autopilot consisting of two rams was installed in conjunction with one rudder stock, which actuated the other rudder in unison through the cables. This was done in preference to mounting the hydraulic rams in line with the transverse cable run between the rudders to assure that there would always be one rudder operating in case of a cable failure, and in view of the fact that one rudder acting as a slave in follow-up of the ram-operated rudder would be easier to maintain in similar angular movement.

In view of the large beams of multihulls, the general desirability of reliable and adequate auxiliary power for use in entering and leaving ever more crowded ports and in emergency situations, puts a greater responsibility on the designers to make the necessary compromise in cost and sailing performance to satisfy this demand.

WINDWARD PERFORMANCE

Considerable criticism has been levelled at multihulls for their inability to sail to windward as well as can monohulls of similar size and sail area. In the author's opinion, much of this is deserved, because in many instances insufficient lateral plane has been provided and more often poorly distributed. Most multihulls are lighter, draw less water, and have more windage because of higher freeboards and larger exposed area above water than monohulls, Therefore, more lateral plane is required. The amount varies with speed, sail area, hull form and appendages. As has been stated in this paper for other performance criteria, insufficient qualitative test data exists from which to choose the best combinations when taken in conjunction with other parameters. Meyers* suggests that for semi-circular symmetric ocean racing catamaran hulls with twin centreboards and rudders, that the lateral area of each centreboard or skeg should be 1 per cent of the sail area; this in conjunction with twin rudders where the lateral area of each rudder should be 8 to 10 per cent of the total lateral plane. He also notes that the board areas of asymmetric hulls can be much smaller, but that the extra hull wetted area more than compensates for the smaller boards.

General practice seems to follow Meyer's rule. However, in the author's opinion, an increase of centreboard area to 1½ per cent of the sail area would result in better speed made good to windward for fuller bodied, heavier cruisers.

One-of-a-kind races, in which monohulls have raced with multihulls, show that if the angle between the direction of the true wind and the actual course sailed is increased when sailing to windward, approximately from 4 to 7° over that of the monohull, there will be a sufficient increase in speed to more than compensate for the extra distance travelled. Also, the average speed made good to windward will be greater.

Although with comparatively lighter hulls and substantially higher initial stability, cats of considerably less length will best larger monohulls to windward in breezes above 12 knots in relatively smooth seas. Experience has shown that a 17 ft catamaran, capable of 15 knots on the reach, cannot beat a 12 meter yacht to windward, because there is simply too much difference between the former's speed to windward and reaching. On the otherhand, the windward speed of multihulls increases rapidly with length, with proportionately lower increase in pounds of boat per square foot of sail than the ballasted monohull.

So, for this reason a 32 ft catamaran could make an average speed made good to windward of 1.2 to 1.5 times that of a 12 meter in protected water. □

* *Theory of Sailing with Application to Modern Catamarans*. By Hugo Meyer. Presented to SNAME, S. Calif. 1964 meeting.

A STABLE DIVING PLATFORM

Designer: J. J. Stenger

Reprinted from *New Scientist* 6 June, 1968

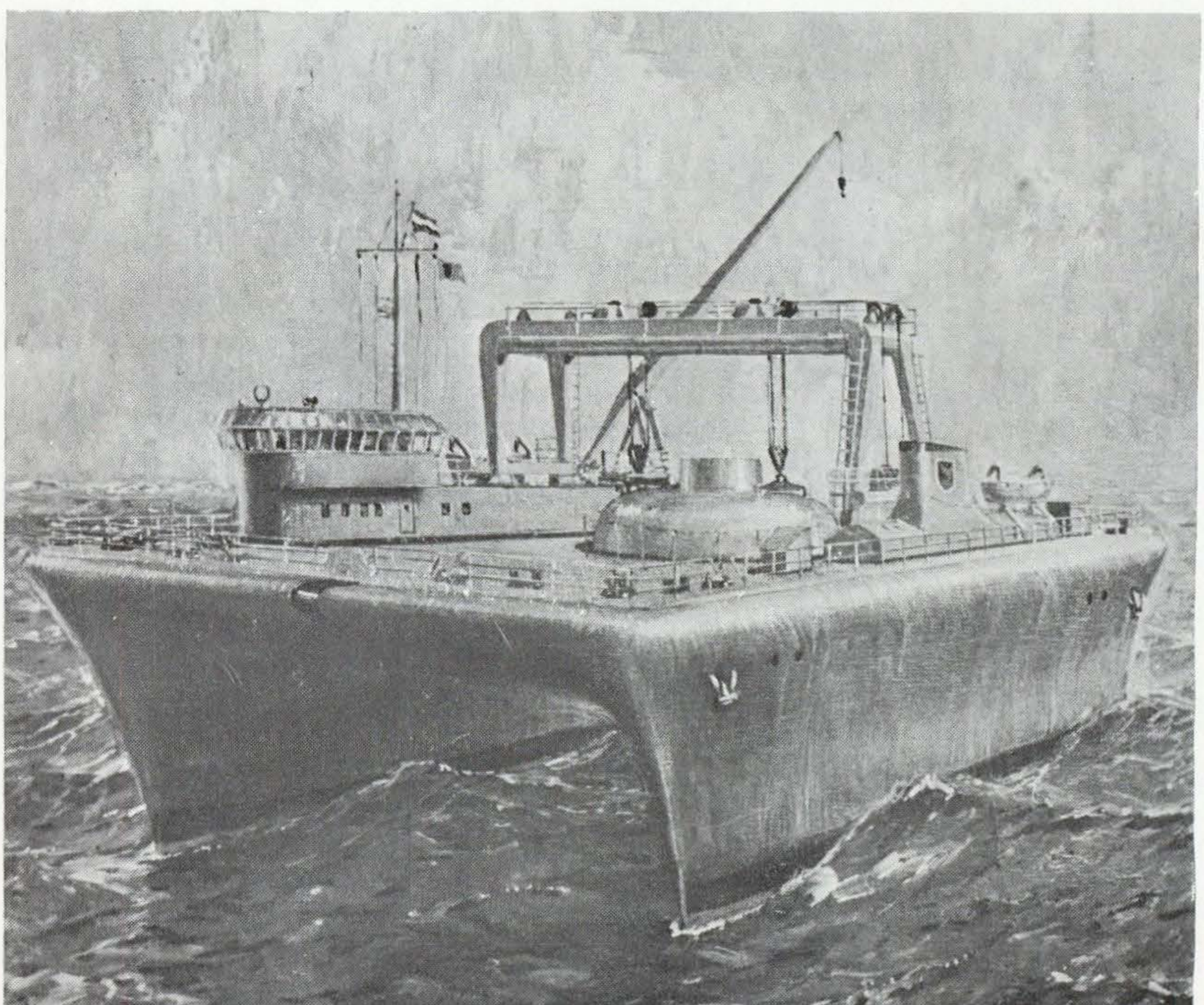
A twin-hull vessel, which will be a floating base for a large diving bell and other facilities for human operations on the North Sea bottom, is under construction at Boele's shipyards at Bolnes, Netherlands. A model of the huge catamaran was shown at the Offshore Drilling and Production Exhibition (ODPEX) held in Rotterdam, 20 to 24 May 1968. The catamaran is being built for a group of companies active in offshore operations in the North Sea, the Netherlands Offshore Company.

The designer, J. J. Stenger, increased stability by connecting the two hulls of the catamaran under the water line by two 'wings' which dampen wave motions. Tests in the Netherlands ship model basin at Wageningen have shown that the catamaran's pitching and rolling is less than 50 per cent of conventional ships' pitching and rolling, Boele's shipyards reported. Therefore, it will remain operational up to wind force 5, which means it can operate 80 out of every 100 days.

A portal crane with a hoisting capacity of 75 tons will straddle the 55.1 x 131.2 ft (16.8 x 40 metres) deck on which also a 20-ton lifting capacity pivot crane will be installed. The portal crane will be used to lower large diving bells of the type being developed by Royal Dutch Shell for undersea work. □

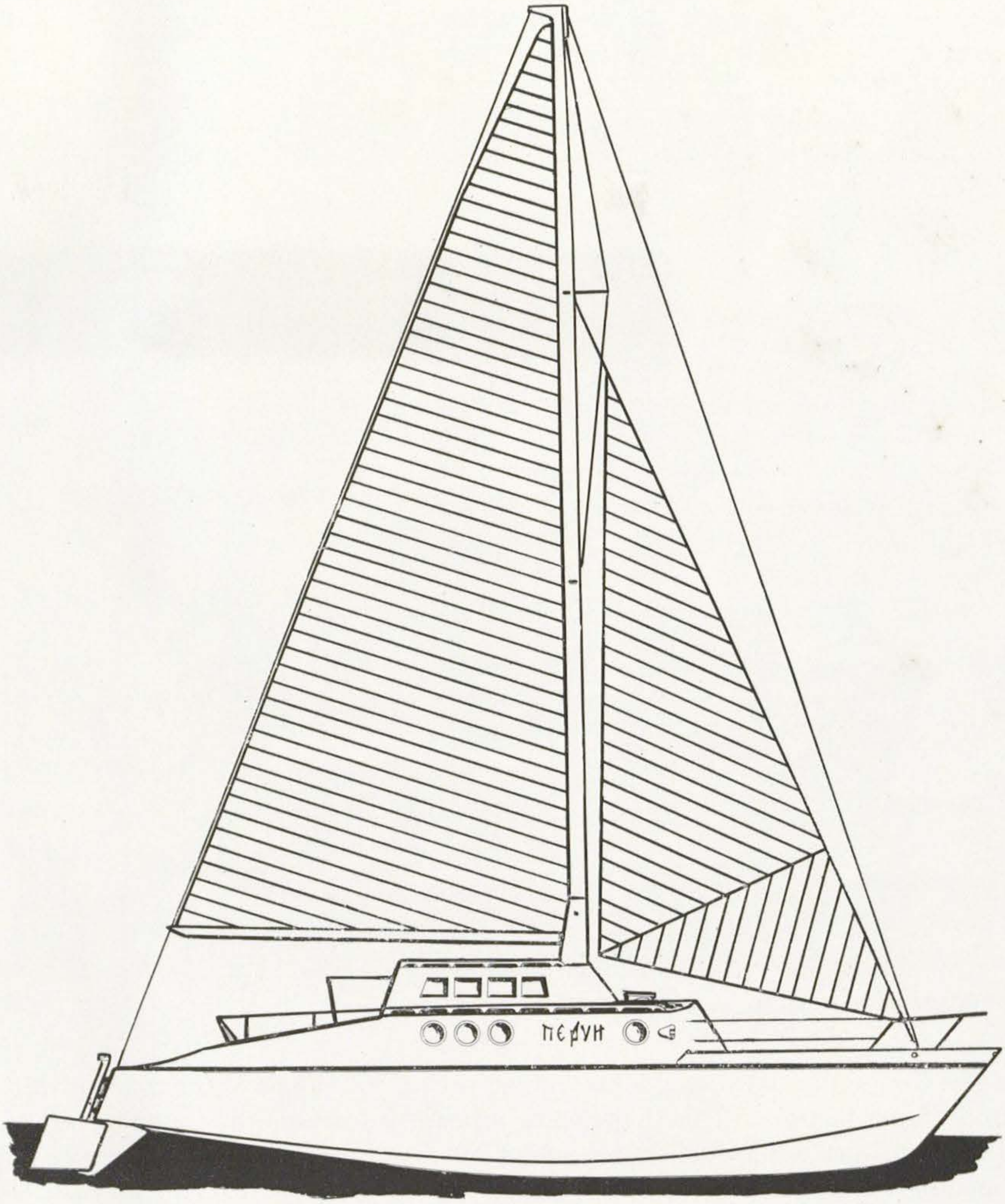
An artist's impression of the stabilized catamaran

Photo: Gercofoto, Rotterdam



'PEROUN' – a cruiser from the Ukraine

by J. Perestyuk Vishchdubechanska 41, Flat 207, Kiev-140, USSR



PEROUN was launched on the 11th June 1967 and it has already had a test-run on the route Kiev-Odessa-Kiev. It was brought ashore for the winter and at the moment is preparing for a longer voyage, this time to Batumi (this is a Black Sea port in Georgia, not far from the Turkish border).

PEROUN was designed using as prototypes the best foreign two-hulled sailing boats. However we often had to find new solutions because we did not have drawings or detailed data about these boats, and also because of the technological limitations such as difficulty with the welding of thin sheets of light alloy. In deciding the lines of the hulls, for example, we had to go for

PEROUN on her maiden voyage to Odessa

a less than optimum shape, a hard chine with a 105° angle V for the 'midship underwater section. This shape made it possible to avoid the stamping out of shaped frames and, most important of all, to dispense with the problem of bending the plates into compound curves. However it was very difficult to avoid welding deformations on the flat smooth surfaces of the shell. We had to recourse to heating to correct the errors, but of course this did not give the best result.

The catamaran is wholly made out of the AMg-5B alloy. The framework was made up of elements of standard shapes, or else elements were stamped out with a press.

The basic measurements were chosen according to statistical data: 13.2 metres maximum length; 5.8 metres wide. The hulls at the middle point measure 0.7 metres across at the waterline and 1.0 metre at deck level, and the distance from the bottom of the 'bridge' to the water level is 0.6 metres.

There are 11 berths on the catamaran, most of which are situated in the deck house on the bridge. In the front part of the hulls you have the captain's cabin and that of his second in command, and in the back parts a toilet and the galley. We carried a full crew when we sailed, and we can categorically state that there was no reason to complain of being cramped. Of course the warm weather meant that we could stay on deck the greater part of the time, but when we sat down to eat in the deck-house, there was room for everyone at the table.

The catamaran performed well on the water. The first joy it gave us was when after launching, it floated exactly on the waterline which we had calculated. We did not test it in stormy weather if only because during the voyage the wind did not reach Force 5 more than once or twice. But apart from that we had our sails to worry about, for they would not have stood up to the first fresh gust. The catamaran rises on to the waves well but the waves knock under the bridge section.

Manoeuvrability of the craft was satisfactory. Coming about can be carried out relatively easily even in a weak wind, although then you have to hold the foresail aback. The speed and gliding qualities of the catamaran were undoubtedly affected by the low quality of the sails, both the material and the sewing. But all the same at Force 3 or 4 we easily outdistanced a *Flying Dutchman*.

In this year's sailing we intend to test the craft in more various conditions, and, most important of all, with good sails. □

SAILING 'YANKEE FLYER'

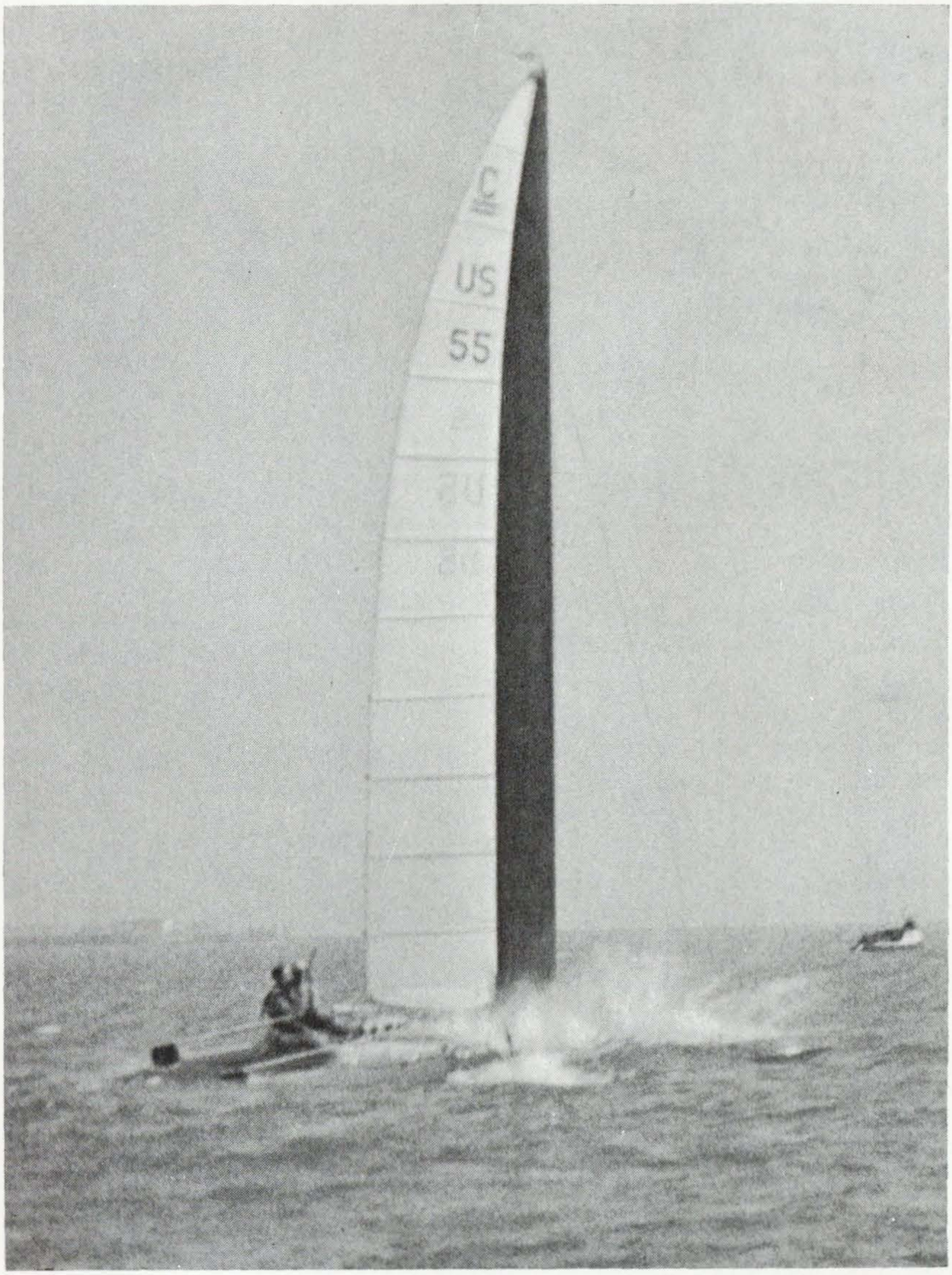
by Greer Ellis Box 77, Pelham, New York 10803

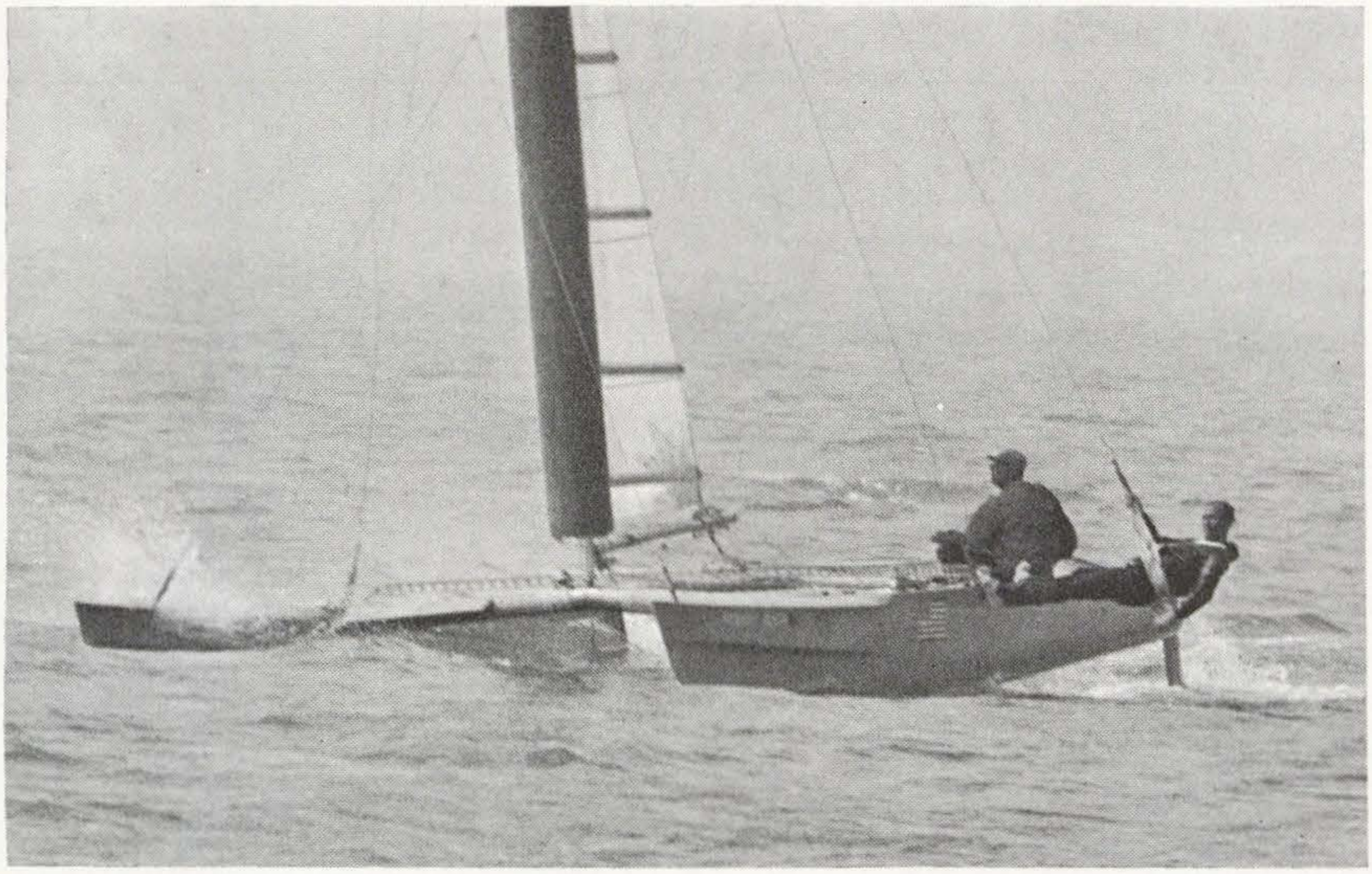
Sailing the 'C' class catamaran *YANKEE FLYER* this summer was the greatest soft water experience I've ever had. In a ten mile breeze she'll do about 9 mph on a 45° upwind course, 13 mph on a 90° reach and 8 to 9 mph broad reaching about 50° off from straight downwind. The 'C's are just hot enough to make tacking on broad reaches pay off when heading for the downwind mark. Means you work hard all the time to sail a good downwind leg and makes them a lot more interesting.

YANKEE was built to the maximum 'C' Class specification of 25 ft length overall, 14 ft beam and 300 sq ft sail area which includes all cloth, mast and boom. *YANKEE* has 42 per cent of this area in a wing mast. Largest section near the bottom is 40 in wide and 16 in thick, teardrop shape. Height of the working section is 38 ft 6 in. An adjustable tube below the working section was usually set so the top of the mast ran 40 ft above the deck. A lot of power, really too high up. She would hike in a ten mile breeze and I never did find the combination to get her to drive well in breezes over 15 without wanting to flip or push her thin bows for the bottom. (High water mark went about 4 ft up the mast). Obviously *YANKEE* is a light weather boat and she proved to be unbeatable in breezes under ten.

Since most of the elimination races were in light breezes, we came out on top and were selected to go to England. *LADY HELMSMAN* and her skipper, Reg White, are quite a combination who deserve their top reputation. Although Thorpe Bay has generally more wind, tide and waves than we have here at home, we got good breaks from the weather. The two light wind days went to us and the two heavy days went to them as just expected. The three days with moderate winds, where everyone hoped for close racing, were our downfall. Overconfidence and poor sail cut lost the first. A boom fitting breaking at the start lost the second. The real heartbreak was the third where the main front beam collapsed and the works folded into a

'High water mark went about 4 ft up the mast' *Photo: Joyce Doughty*





Greer Ellis helming *YANKEE FLYER* with Bill Hooten on the wire *Photo: Joyce Doughty*

pretzel* just when we were ahead. (The British also ran into trouble and were knocked out of this race). Final score 4-2, Britain. They also deserve a cup for hostmanship—we had a terrific time.

Back to technicalities—cat rigs are catching on to ice yacht techniques. Single high aspect ratio sail, aerofoil shaped swivelling mast with cloth coming off tangent to the lee side are right down the skeeter† alley. Differences are the increasing size of the catamaran wing masts and the stiff upright posture catamaran rig *v* the sloping, sloppy skeeter rig. I believe the differences are correct and we will not see much successful intermixing of these characteristics.

Here is the reasoning:

Around 2/3 of the drag holding the catamaran back is water friction so the rig must produce power. A large wing mast and relatively small sail is essentially a symmetrical aerofoil with flap giving a high lift coefficient. The increased air drag, which always accompanies high lift, can be tolerated by the catamaran. On the other hand, runner friction on a skeeter accounts for only about 1/10 of the total drag. The remaining 9/10 is air friction over hull and sail. So a skeeter needs aerodynamic efficiency rather than brute power. A wing mast could help a skeeter push through soft ice in light air but would be more hindrance than help on good ice in a good breeze.

Its sloppy rig helps keep the skeeter from skidding and hiking. A sloppy rig leaning to the side on a cat would push the lee hull down more and increase water friction. Anyway it's disconcerting to go bouncing over the waves with a rig flopping all over the place.

A backward sloping rig might help a cat upwind but would be miserable downwind because even a 'C' class tacks downwind with its sail way out to the

continued on page 105

* A crisp knot-shaped biscuit flavoured with salt

† Ice yacht

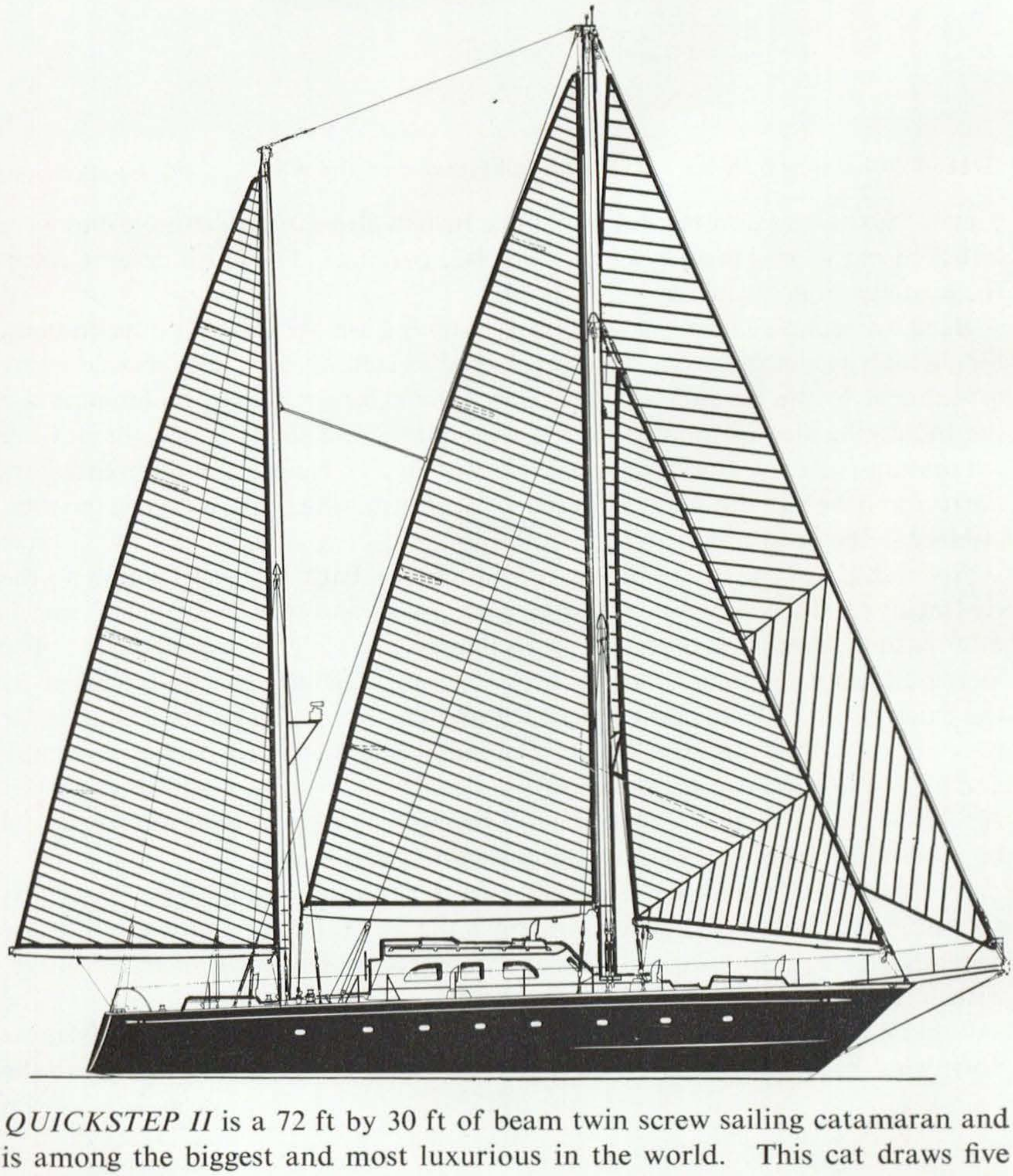
'QUICKSTEP II'

Designers: MacLear & Harris, Inc. 11 East 44th Street, New York, NY, USA

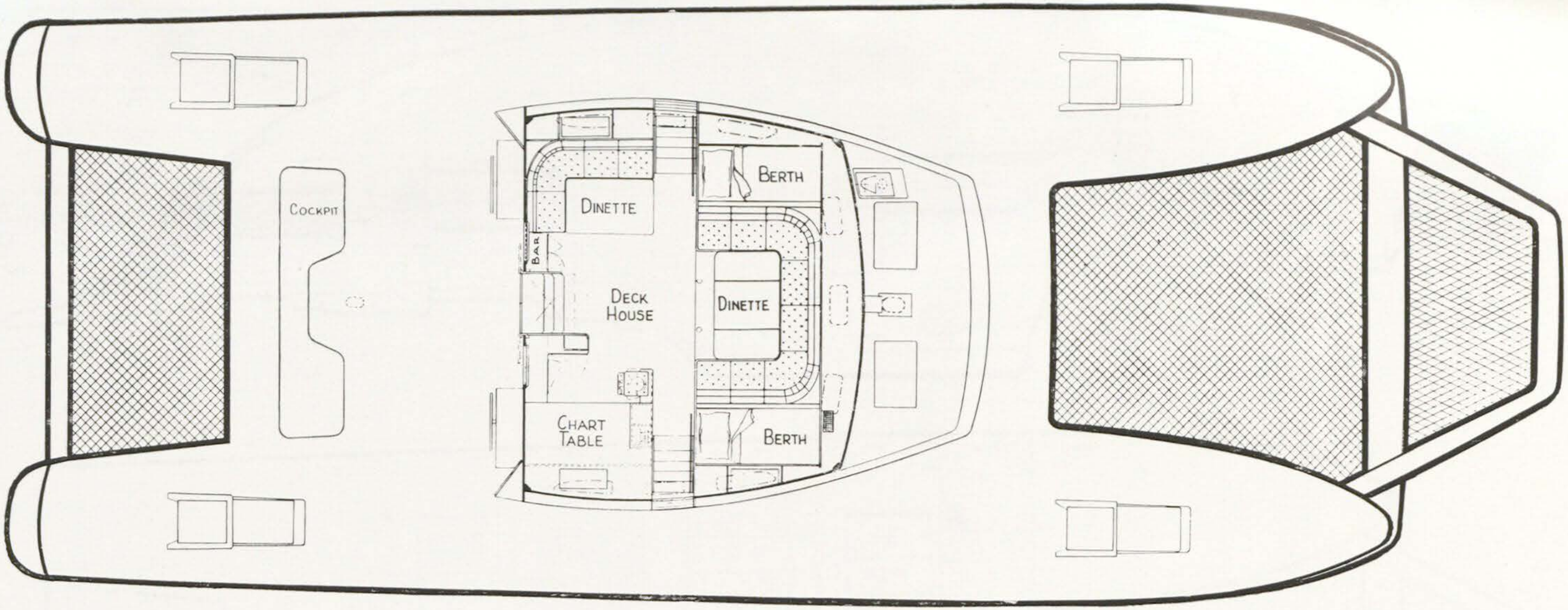
LOA	72 ft 4 in
LWL	60 ft 0 in
Beam, extreme	30 ft 0 in
Beam, hull	7 ft 0 in
Draft, boards up	5 ft 6 in
Draft, boards down	11 ft 6 in

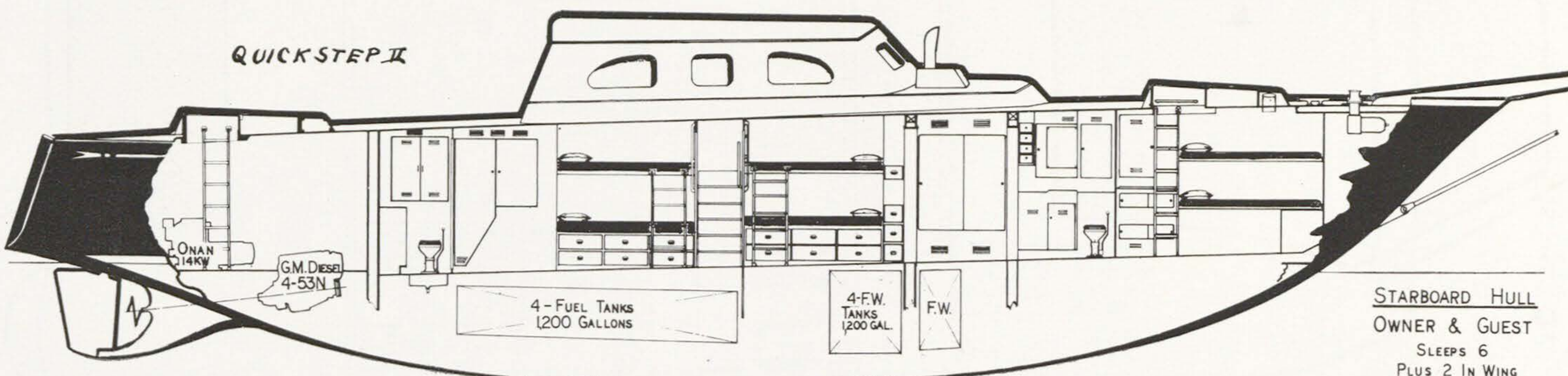
Sail Area: 2,800 sq ft
Engines:
(2) GM Diesels 130 HP each
Steering stations, port & starboard

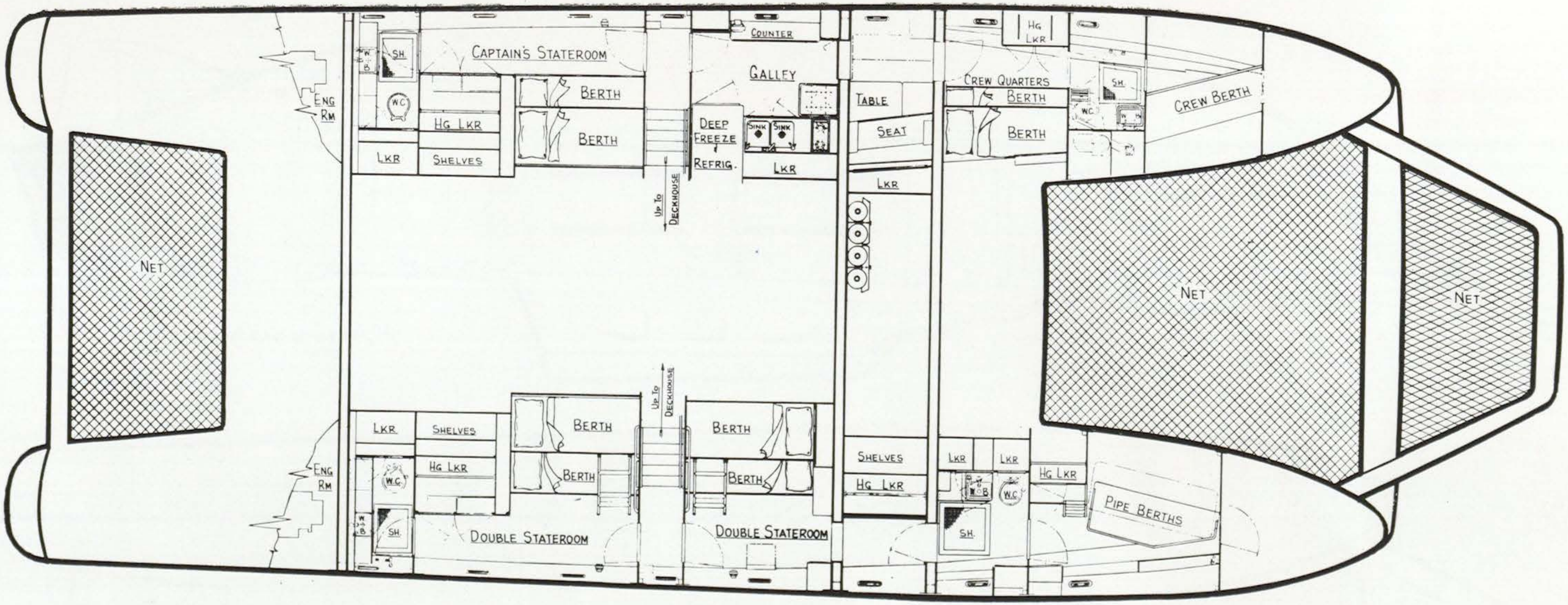
Fuel: 1,200 gallons
Water: 1,200 gallons
Cruising speed: 12 knots
Generator:
Onan 14 KW
(2) 32 v alternators
Air Conditioning:
3 tons Grunert
Heating: Reverse cycle
Radar: Decca RM 314

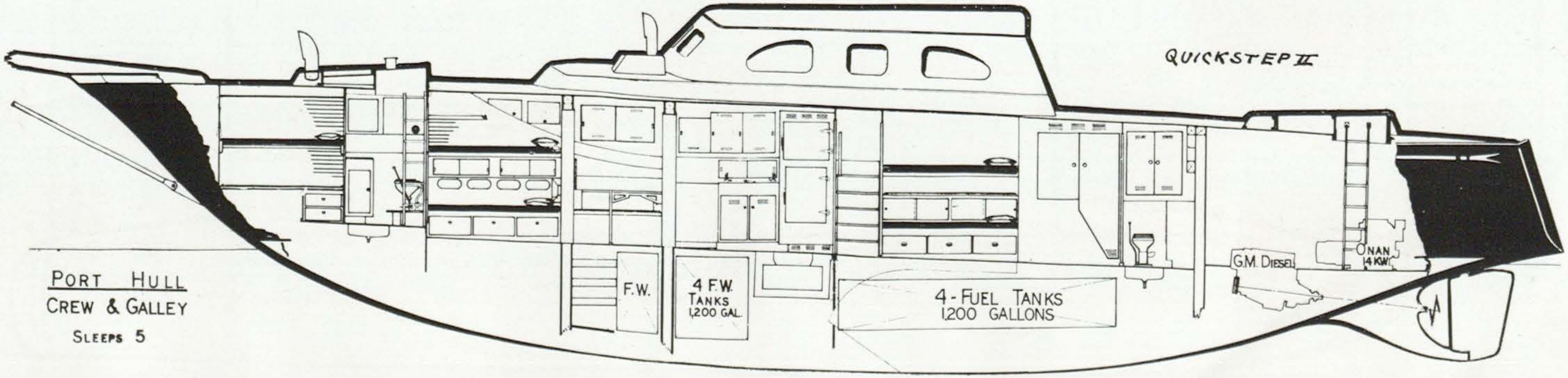


QUICKSTEP II is a 72 ft by 30 ft of beam twin screw sailing catamaran and is among the biggest and most luxurious in the world. This cat draws five and a half feet compared to seven to ten feet in a keel boat of the same length.


Cockpit
Dinette
Bar
Deck House
Chart Table
Berth
Dinette
Berth


QUICKSTEP II
Onan 14KW
G.M. Diesel 4-53N
4 - Fuel Tanks 1,200 Gallons
4-F.W. Tanks 1,200 Gal.
F.W.
Starboard Hull
Owner & Guest
Sleeps 6
Plus 2 In Wing





PORT HULL
CREW & GALLEY
SLEEPS 5

QUICKSTEP II was built in Taiwan (Formosa). She will be deck cargoed to a Florida or Gulf port and towed to a Florida yard where she will have her engines installed and her rig stepped.

This large catamaran is basically a three level craft. The deck is single level (except for the cockpit well). Three steps lead down to the deckhouse level and from the deckhouse one can go down to the lowest level which is in each hull.

There are two engine rooms, one in each hull. In addition to the two propulsion diesels there is a third diesel engine for generating electricity. A work bench and fairly complete set of tools will be handy when in isolated cruising areas.

QUICKSTEP II is an enlarged version of two existing 52 ft catamarans that have been in commission for three years. They are heavy enough to have tremendous stability and their chance of capsizing is less than the chance of overturning a train.

Accommodation

While the craft has thirteen bunks she would normally have about ten persons sleeping aboard on a two week cruise. Six in the owner's party and four in crew might be average although eight and five are possible. There are four complete toilets, each with shower. Hanging lockers and drawers are very generous. Bunks are long and wide.

The crew and galley are in the port hull and the owner's party occupies the starboard hull and the deckhouse.

The deckhouse has windows or ports on all four sides and is light and airy. It has two dinettes, a large chart table, a bar, and two comfortable bunks. The two berths and the large dinette can be closed off by a curtain across the deckhouse to form a private stateroom at night. There is a ladder on each side of the deckhouse leading down into each hull.

Speed

QUICKSTEP II will be exceptional because of her long cruising range and fast passage making ability. Her average cruising speed under sail or power is expected to be between 10 and 12 knots whereas a single hulled auxiliary of the same length when bound on long passages would be lucky to average 8 or 9 knots. Whether the catamaran can average 10 per cent or 20 per cent faster depends on the loading of the craft in question, as well as the point of sailing. For example in a following sea *QUICKSTEP II* can surf for a minute or two at a time at 12 to 22 knots. A single hulled 72 footer might hit 11 to 14 knots for 15 seconds. Under such conditions a heavy cruising catamaran can average 20 to 30 per cent faster. On the other hand in light weather going to windward a single hulled ocean racing boat with big genoas might be faster at speeds below 6 knots. At such times this type of generously powered cruising catamaran can turn on both engines and maintain a speed of over 11 knots. Thus *QUICKSTEP II* is a fast passage maker that can average faster than an ocean racer and go further than a power boat of comparable price and size.

QUICKSTEP II will be available for charter in the Caribbean for many of the winter months, so quite a few people will be able to test her. □

CLASS 'C' RACING CATAMARANS*

Part I: Rig Development

by Major General H. J. Parham, CB, CBE, DSO,
and
A. Farrar, MRINA

Of all sailing catamarans the 'C' Class are, so far as the 'power plant' is concerned, the most highly developed.

In their lastest stage, they have reached a form wherein mast and sail have been combined into one aerofoil which in its general shape conforms to those which have been used on aircraft such as gliders and sailplanes.

These so called 'wing sails' have, in their most advanced form, shown an unquestionable superiority over the more conventional rigs with which the 'C' Class catamarans were equipped.

The development of these wing sails has been relatively rapid because, since they conform in general shape to the aerofoils used for flying, much of the great store of aeronautical data can be usefully drawn upon when designing them.

The line of thought leading up to the latest rig

The rig which now equips the present holder of the International Catamaran Trophy is the outcome of a line of thought which accepts that a sail is a wing erected vertically. This idea is now fairly widely accepted and everything in the authors' experience shows it to be so.

The desirable properties of the sailing rig may be illustrated by considering the allied phenomenon of flying. To support the weight of the aircraft the wing must deflect air downwards and flying is most efficient when the air drag is at a minimum. A direct measure of this efficiency is the 'slope' down which a glider will coast when propelled by gravity. Over the years, the gliding slope has improved from about one in three to about one in forty for the latest sailplanes. These thus require a thrust of only one fortieth their weight to fly level. This is illustrated in fig. 1.

In the case of wind propulsion, the air passing over the sail has to be deflected to produce, not vertical lift as in the case of the aeroplane, but a horizontal force as nearly as possible normal to the apparent wind. It can never be quite at right angles but the nearer this ideal is approached the bigger will be the proportion of the total sail force available to drive the yacht forward.

Fig. 2 illustrates the development of sail propulsion in the same way that fig. 1 shows the development of the aeroplane. The poor performance of the old sailing ships in the close hauled condition was due largely to excessive air drag from the sails, rigging and hull and to high water drag. The result was that such craft could barely make up to windward at all. The latest racing yacht, on the other hand, can sail a course within about 30° of the wind.

*A paper read in Southampton at a meeting of the Royal Institution of Naval Architects, arranged in conjunction with the Southern Joint Branch R.I.N.A./I.M.AR.E. on December 15, 1967.

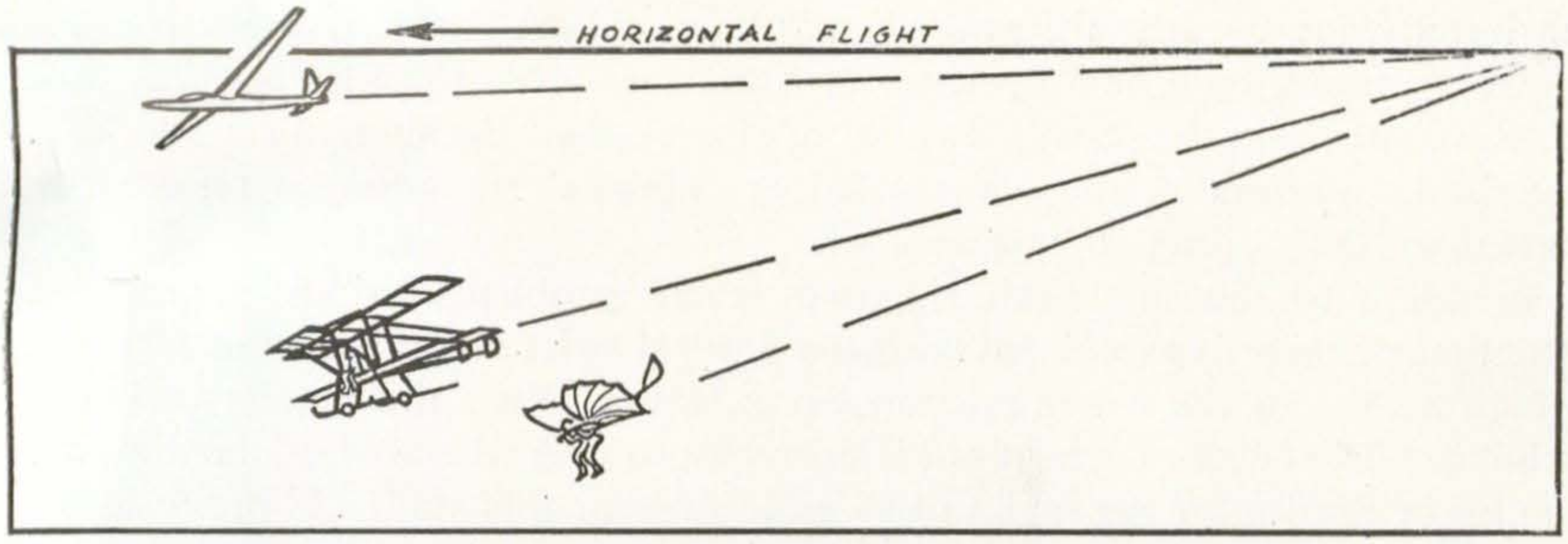


Figure 1 Reduction of drag improves gliding angle

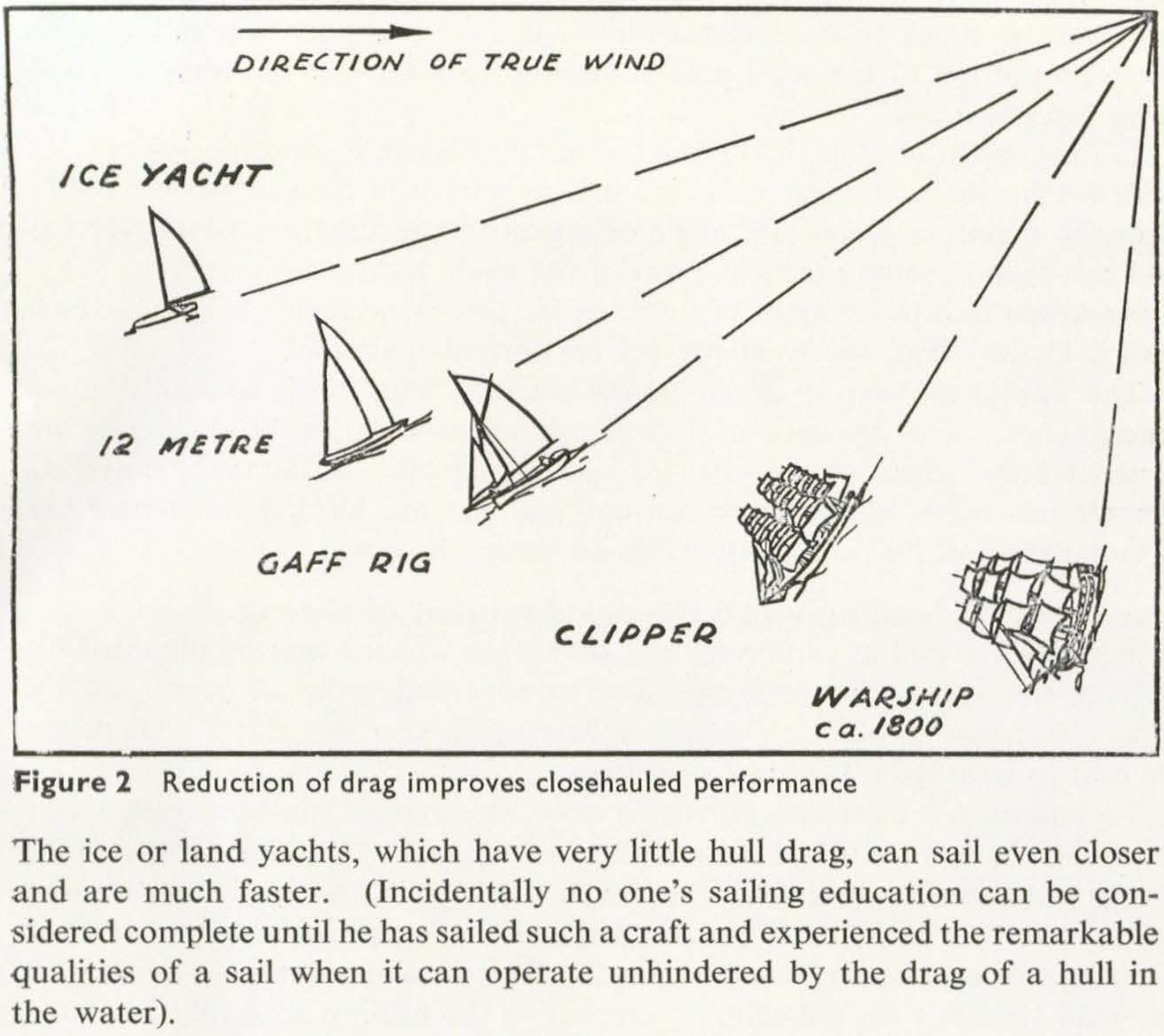


Figure 2 Reduction of drag improves closehauled performance

The ice or land yachts, which have very little hull drag, can sail even closer and are much faster. (Incidentally no one's sailing education can be considered complete until he has sailed such a craft and experienced the remarkable qualities of a sail when it can operate unhindered by the drag of a hull in the water).

The faster the sail propelled vehicle goes, the more the apparent wind comes from ahead and the greater its velocity. The latter may have advantage in that it increases the sail forces but the former effect rotates the total sail force so that less is available for driving and more is employed in uselessly trying to heel the craft. There is no escape from this predicament and the best that can be done is to strive, by efficient design, to make the sail thrust as nearly as possible at right angles to the apparent wind and at the same time to reduce drag from all sources, both in the rig and from the hull and it's crew.

It may be inferred from what has been said that when designing a rig for high speed sailing it is wrong to use the equivalent of the slotted wing which the bird or aeroplane uses for slow speed flight. The example of the 'clean' unslotted wing used by the seagull, sailplane or high performance aeroplane when cruising should be followed. A direct corollary of this is that headsails be eliminated and the so-called 'Una' or single-sailed Bermudian rig adopted. By similar reasoning, the two-masted or 'biplane' rig must be rejected as having excessive drag for a given lift.

In going to the single-sail rig, two severe problems evince themselves. The first of these is associated with the natural twist along the span of a sail which results in the lower portion being stalled when the upper section is driving. The effect of a headsail is normally to twist the flow of the air over the lower portion of the mainsail so as to prevent this stall. If the headsail is to be eliminated from the design it is necessary to get rid of the major portion of the twist, because a sail only works well over a fairly small range of angles of attack to the relative wind. If the lower part of a sail with its large proportion of the total area is allowed to stall, it produces very large drag forces indeed.

In the context of twist, it is often though that because wind speed increases with height above the water surface it is necessary to have a twisted sail in order to maintain a constant angle of attack to the apparent wind over the full sail span. Some practical experiments made by the authors some years ago showed that the amount of twist needed to deal with this 'wind gradient' was a lot less than the twist present on normal mainsails.

The second problem in designing the efficient 'Una' rig is to abolish mast interference. The presence of a conventional mast seriously affects the air flow over the whole of the vital lee side of the sail. In fact, the so-called 'streamline' masts which carry conventional rigs are located just where the accumulation of ice on a wing brings an aeroplane down.

Experiments leading up to the development of the rig

Experiments aimed at exploiting any advantage which might be obtained by solving the above two problems were commenced some 20 years ago by Major General Parham. The highly developed 'C' Class rig of today may be said to stem from the results of these.

To remove the mast interference, a deep, streamlined built-up mast which provided the front third of the sail was investigated. This was free to pivot on an inner mast and the aft two thirds of the sail was fabric which 'fish-tailed' over when the craft was tacked, twist being prevented by a vertical torsion tube connecting boom and gaff. This arrangement* was very good in small sizes but the difficulty of supporting the trailing edge spar provided a size limitation.

Another attempt to eliminate twist and reduce mast interference was also carried out in 1948 with a sail of more or less normal Bermudian shape set on a mast which was bent across the wind to a curve which was about equivalent to that taken up by the leach in a normal rig. This rig† gave almost the same angle of attack to the sail all the way up the mast and a smooth contour at the lee side of the leading edge, and 19 years subsequent experience of sailing with it has shown the rig to be sound and efficient. It is, however, difficult to scale up to sizes much over 100 sq ft.

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* AYRS Publications No. 14 *Wingsails* and No. 33 *Sails* 1960.
† AYRS publications No. 3 *Sail Evolution* and No. 41 *Yacht Research II.*

TABLE I

	British Defender and Rig	Challenger and Rig
1961	*HELLCAT II* Conventional sloop	*WILDCAT* (USA) Conventional sloop
1962	*HELLCAT I* Conventional sloop	*BEVERLY* (USA) Conventional sloop
1963	*HELLCAT III* Conventional sloop	*QUEST* (Australia) Conventional sloop
1964	*EMMA HAMILTON* Conventional sloop	*SEALION* (USA) Una rig
1965	*EMMA HAMILTON* Very high aspect sloop rig	*QUEST II* (Australia) Sloop rig incorporating a narrow wing mast
1966	*LADY HELMSMAN* Una rig with wing mast	*GAMECOCK* (USA) Una rig with wing mast
1967	*LADY HELMSMAN* Una rig with wing mast	*QUEST III* (Australia) Una rig with fabric sleeve fairing on tubular mast

It is worth noting here that the antagonists of plain 'Una' rigs, developed along the lines briefly described above, level the charge that such an unslotted configuration cannot produce such large forces as one with 'high lift' devices such as a jib or genoa and that this will have a particularly bad effect when sailing off the wind. The forces are undoubtedly increased with this slot but their line of action still places the arrangement at a disadvantage. The unslotted wing (or sail) will always produce a thrust more nearly normal to the apparent wind than its slotted counterpart. Practical experience with such a configuration indicates that, even when broad reaching, it is best to have a sail which thrusts as near as possible in the direction of required motion. This is not surprising when it is remembered that any rearward rotation of the force increases the sideways component which is automatically reacted by side force produced by yawing the hull, keel, rudder etc. and producing increased drag as a result.

These experiments by General Parham, undertaken privately and solely for the enjoyment they gave, came to the notice of Austin Farrar who had, in addition to boat designing, become increasingly interested in the 'power plants' of sailing craft.

He succeeded in combining the two rigs described above and, in so doing, solved the problem of how to scale up the rig to the size (300 sq ft) required for 'C' Class catamarans. The result was the rig of *LADY HELMSMAN* which successfully defended the Trophy in 1966 and 1967, further notes on which will be found later in this paper.

The development of the 'C' Class rig

The early development of the 'C' Class rig owed nothing to the ideas previously discussed, the sailplans being mere variants of the conventional sloop rig. It is true that, from the very beginning, the mainsails were fully battened but this sprung more from a long history of such sails in 10 sq metre canoes and

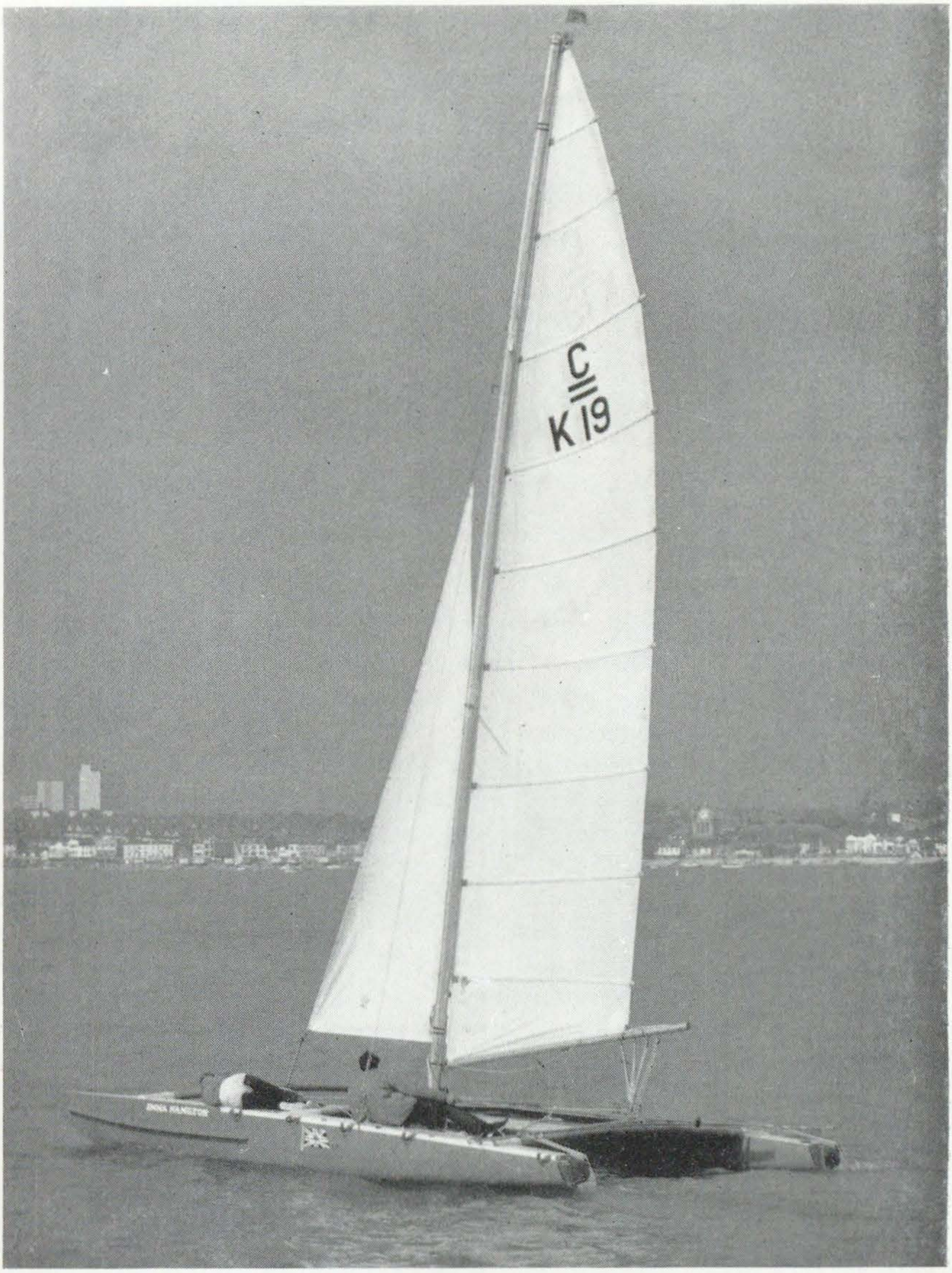


Figure 3 *EMMA HAMILTON* with tall sloop rig. (Note bending of mast controlling flow of sail) Photo: Joyce Doughty

the lake sailing *RENJOLLEN* of Manfred Currey than from the wing sails of Major General Parham. Table I summarises the rig types used since the first International Catamaran Trophy races of 1961 and this illustrates the above point.

It is well known that the British Catamarans have retained the Trophy over the period from 1961 to the present day and it is therefore interesting to note from Table I that the first use of a 'Una' rig was in an American craft, *SEALION*, during the 1964 series and that she was beaten with a conventional rig. In the light of what has been discussed earlier, this might seem something of an anomaly but it must be remembered that the conventional rig in the British craft *EMMA HAMILTON* was at the peak of its development while the single sailed rig in the American craft was relatively undeveloped. This was reflected in the shaping of the sails, which on *EMMA HAMILTON* were both cut with the so-called 'flow' or maximum camber well forward to allow for its moving aft somewhat with increase in wind strength. The 'Una' mainsail on *SEALION* on the other hand, was shaped so as to form almost an arc of a circle in section in light weather when it was very effective. Unfortunately, increasing wind strength caused the 'flow' to move aft so that the sail became an aerofoil in reverse.

The reason for the American sail being cut so flat in its forward part was probably due to the popular fallacy that a sail must present a positive incidence to the angle of the apparent wind or it will not fill. In fact, a well cambered sail will remain full with the front portion standing out at some 45° against the angle of the apparent wind.

Fully battening such a sail has the advantage that it holds the leading edge into the correct shape ready for the wind to fill it and this prevents inadvertent collapse of the section when momentarily sailing too close to the wind.

In 1965, *EMMA HAMILTON* again defended the Trophy, this time being re-rigged as a very high aspect ratio sloop as shown in fig. 3. Her rival, *QUEST II* of Australia, also had a sloop rig which was novel in that it incorporated a narrow wing mast. The rig of the Australian craft was as efficient as that of *EMMA HAMILTON* and she was, in fact, faster than the British defender. The eventual victory of the latter was, therefore, due to the superior racing tactics of the British helmsman and an unfortunate capsize on the part of the Australian rather than inherent superior performance.

It is of interest to note that even as late as 1965, *EMMA HAMILTON* with a relatively orthodox rig had, to gain selection as defender, beaten British boats *THUNDER II* and *MANTA C* and both the latter incorporated a wing mast 'Una' rig.

In 1966, a new British craft, *LADY HELMSMAN* defended against *GAMECOCK* of the USA. Both boats had 'Una' rigs with wing masts and *LADY HELMSMAN* proved very much the more efficient. *GAMECOCK*'s wing mast (which formed about a quarter of her total sail area) had a straight trailing edge carrying the fully battened sail in a luff groove and a tapered leading edge. On *LADY HELMSMAN*, the wing mast accounted for more than a third of her total sail area and was straight on the leading edge and an arc of a circle on the trailing edge. Again, the fully battened sail was carried in a luff groove.

A less obvious difference between the rigs lay in the sections of the two wing masts. *GAMECOCK*'s was approximately 6 in thick with a fine leading edge. *LADY HELMSMAN*'s was about 11 in thick with a large radius at the leading edge.

GAMECOCK's rig, with its straight luff, had been developed over several years in the USA, where several boats had used variants of it and it was closely related to the early wing sail of General Parham as originally conceived

20 years ago. Because of the great height of the mast (35 ft) it was not structurally possible to eliminate twist by using a boom top and bottom connected by a torsion tube as adopted by General Parham. Enormous loading on the mainsheet so as to pull down the leach of the sail was the alternative and this had to be maintained at all costs, since any twist was accompanied by an unacceptable knuckle line between mast and sail.

The development of the rig for the British boat by Austin Farrar was the result of several years work and stemmed from experience with the early wing sail and the curved mast rigs. Experience with both of these rigs led to the conviction that it must be possible to combine the best points of both

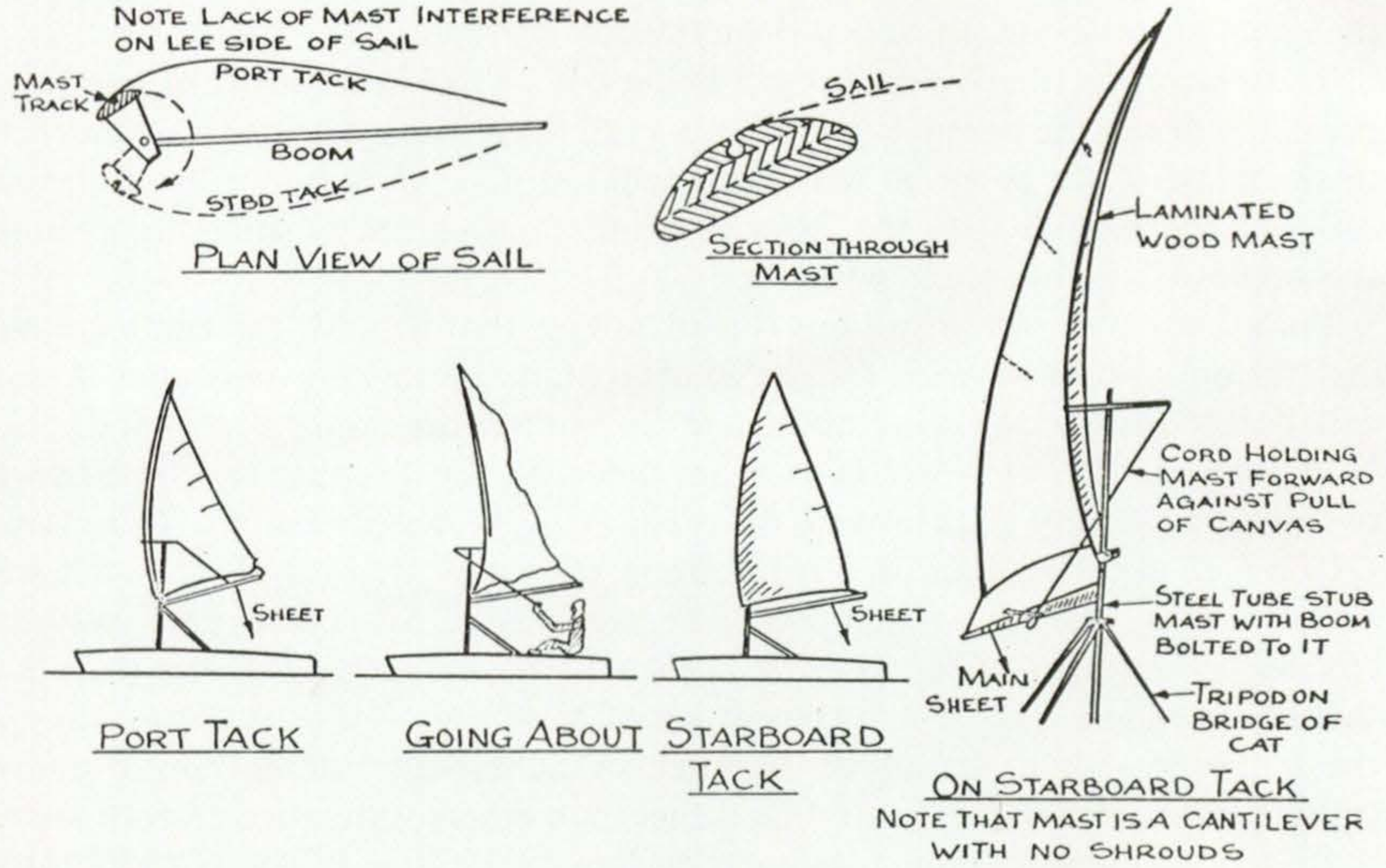


Figure 4 Tacking the curved spar rig

in an efficient rig from which twist was eliminated and yet was easy to handle and tack. (Tacking with the original curved mast rig involved rotating it manually through about 200° while the craft was head to wind, as shown in fig. 4). The broad line which development followed is best illustrated by considering in detail the changes in the rig of *LADY HELMSMAN* during its final teething period.

Tests with a $\frac{1}{4}$ full size model of the proposed rig showed a very early stall and indicated that the section of the initially proposed wing mast was too thin. A thicker section with a large radius at the leading edge was therefore adopted and the wider range of working angle thus achieved greatly helped the helmsman to avoid stalling the wing. Subsequent wind tunnel tests at Southampton University, the results of which are shown in fig. 5, indicated that an even thicker section than was, in fact, employed would be better still.

There has been a tendency to regard the wing mast section as an aerofoil in its own right. This is wrong however, since it forms only the front third of an aerofoil of which the sail makes up the remainder. In the completed *LADY HELMSMAN* rig, the whole bore a strong resemblance to, and was

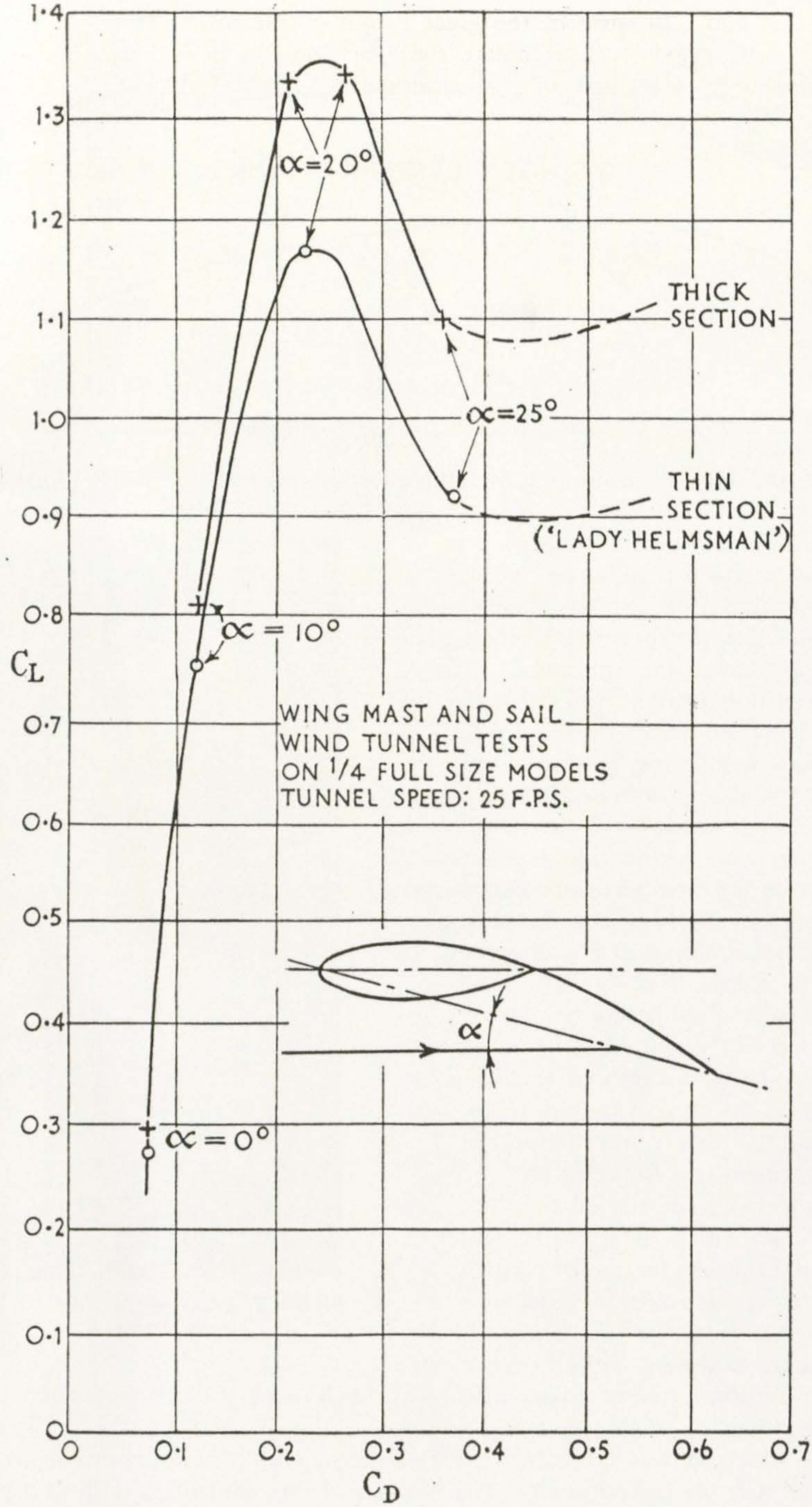


Figure 5 Effect of thickened wing mast on lift and drag characteristics

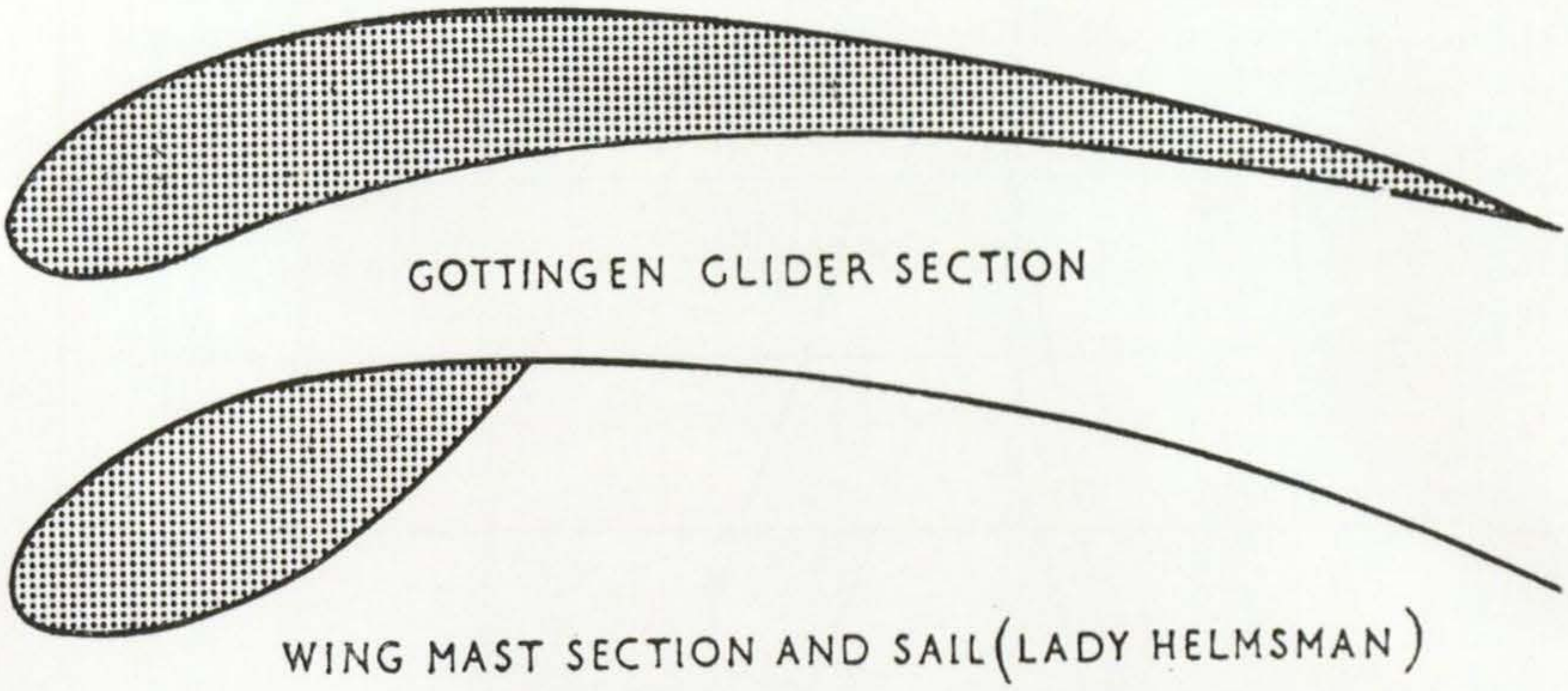


Figure 6 Similarity of wingsail and Gottingen glider section

based on, the Gottingen high lift glider sections of 1928. This is illustrated by fig. 6.

Turning now to the elimination of sail twist, this was achieved by a combination of techniques which included the incorporation of the curved trailing edge on the wing mast. The effect of doing this was to curve the luff of the sail across the wind when the mast was swung, so that its lee side formed a smooth continuous profile with that of the sail. As a result of this shaping, a quite moderate downwards thrust on the clew was sufficient to iron out most of the twist and the degree of success achieved in this direction may be judged from fig. 7.

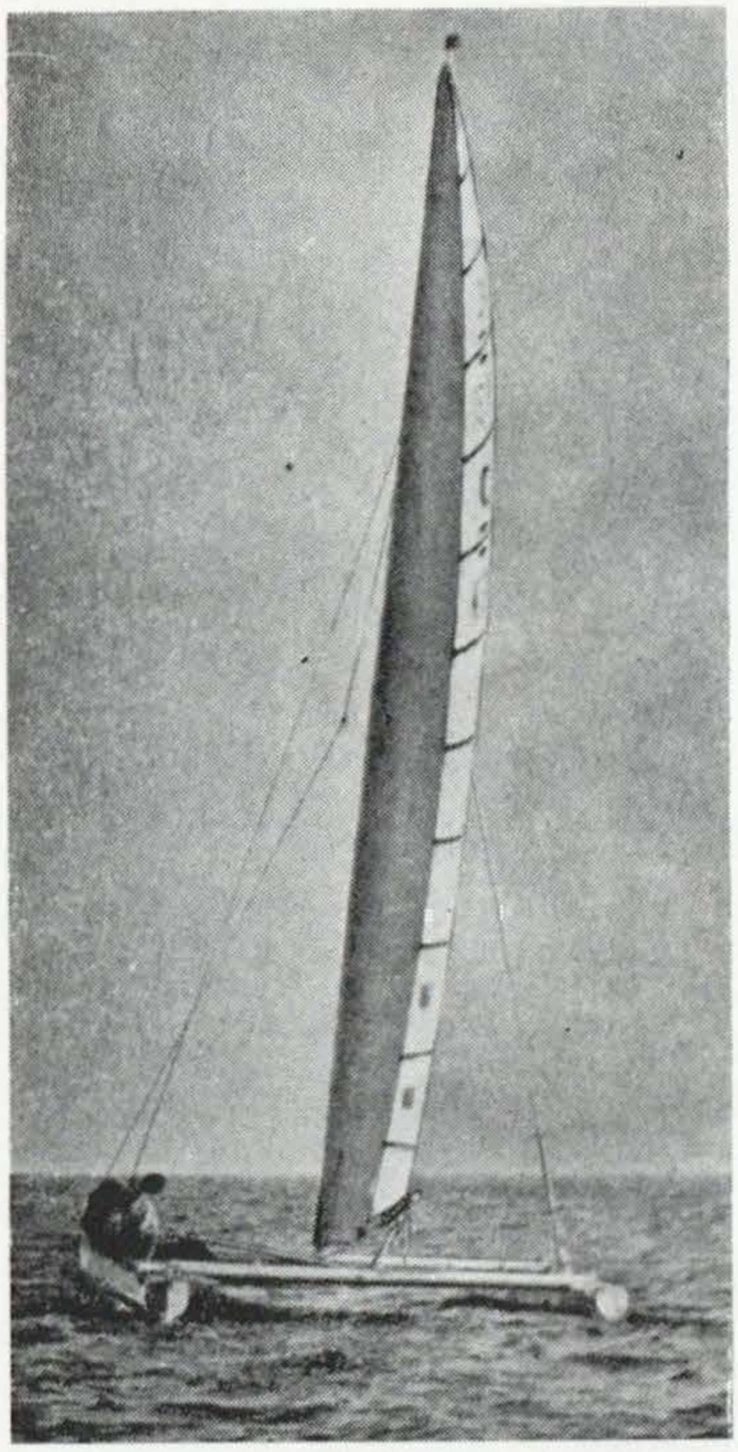


Figure 7 *LADY HELMSMAN* showing twist free sail

In the original design for the rig, the function of the conventional boom was carried out by a wishbone thrusting down on the clew of the sail from some way up the mast. In practice, the arrangement was found to be unsatisfactory since it left the helmsman with a 'safety valve' which lacked a fine graduation of control. Easing the mainsheet traveller to leeward without the clew being allowed to rise made the sail luff all over at once with a resultant loss of power which was much too complete for convenience of handling.

The wishbone was subsequently replaced by a conventional boom on which the sail was set loose-footed. The boom end was controlled with two purchases. One of these pulled down to a traveller on a circular track so as to act as a kicking strap and was led forward along the boom and controlled by the crew. The other was a centralising purchase and was controlled by the helmsman as shown in fig. 8. This arrangement allowed the clew to be eased upwards so that some twist was introduced into the sail when the wind strength increased to an overpowering degree. This had the effect of feathering the top of the sail while the lower part was still drawing and thus lowering the centre of effort.

The rotation of the mast so as to align its leeward surface with the sail was largely a natural result of the way in which the sail forces were applied to it and, in this respect, the curved junction between mast and sail was beneficial. Fine adjustment of the mast angle relative to the sail was achieved with a lever projecting aft of the mast centreline and connected to the boom by a purchase so that angular adjustment could be made.

It is of interest to note that a wing mast with a straight trailing edge, such as was incorporated in the American *GAMECOCK*, needs more accurate

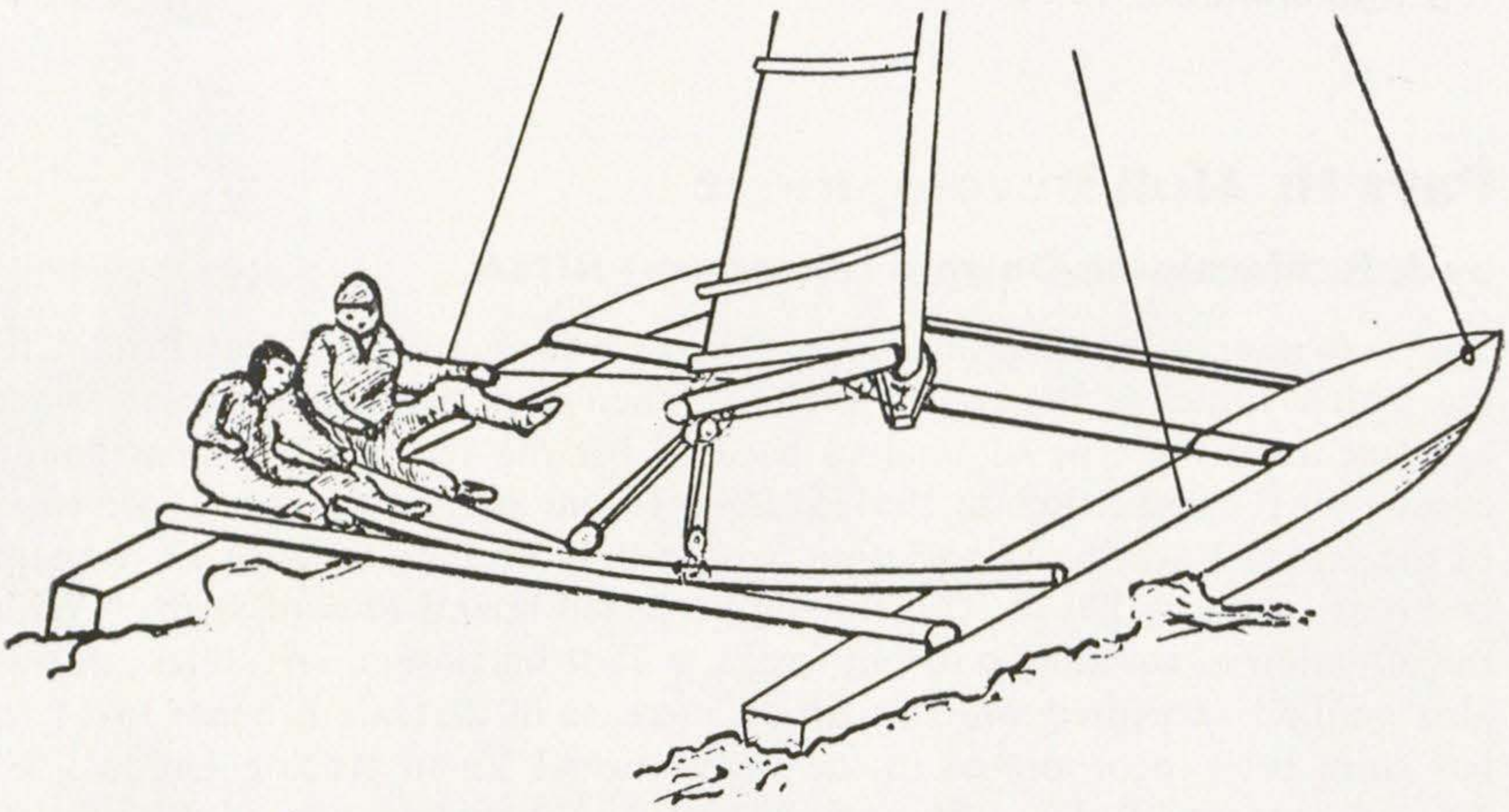


Figure 8 Sheeting arrangement on *LADY HELMSMAN*

adjustment of the mast angle than does the configuration with a curved trailing edge and in the process, the former can very easily develop a knuckle line in the sail and wing junction which spoils the aerofoil section.

With the rig described above, *LADY HELMSMAN* beat *GAMECOCK* in 1966 and also an Australian challenger, *QUEST III* in 1967. The latter craft had a 'Una' rig with a fabric fairing on a tubular mast which was attached to the actual sail with zip fasteners. The victory over this craft was gained in spite of her hulls and rig being substantially lighter than those of *LADY HELMSMAN* and it would provide useful data if wind tunnel tests were carried out on the fabric sleeved rig to determine its effectiveness apart from the hulls.

The outstanding success of *LADY HELMSMAN*'s rig might be construed as a triumph for design based on the scientific approach. It should be emphasised, however, that the many adjustments which go to make up what is known as 'tuning' can be more important than having the best design.

As an instance of this, *LADY HELMSMAN* was badly beaten in the World Championships in Bermuda early in 1967 through using a sail which had stretched out of shape. The 'flow' had moved aft and was producing more drag than lift—in other words, more side force in proportion to forward driving force than when in its prime.

Conclusions

In closing this brief description of the 'C' Class catamaran rig, the authors feel justified in drawing the conclusion that a modest contribution has been made towards the development of the sailing yacht rig.

With regard to the future, the authors are convinced that there is still much room for improvement of the wing sail rig. The structure could be lightened with advantage and the wind tunnel tests at Southampton University indicate that a more efficient wing mast section can be achieved. It is to be hoped that an opportunity to carry out these developments will occur in the not too distant future.

Part II: Hull Development

by J. R. Macalpine-Downie (Associate) RINA

The first international catamaran challenge was issued by Great Britain to the United States at the end of 1959. It then took more than a year to get agreement on the type of boat to be used for the series. The class finally chosen for the first match in 1961, in Long Island Sound, was the 'C' Division of the Royal Yachting Association, whose only limitations were 12 ft beam and a sail area of 300 sq ft, including projected lateral area of spars. With the intention of avoiding outright freaks, a 25 ft maximum overall length was also mutually accepted which, with an increase in maximum beam to 14 ft, has since been incorporated in the International Yacht Racing Union's 'C' Class Catamaran Rules. This has governed the development of the type to the present time and forms the context within which the following discussion should be considered.

General concept

In the beginning, there was a wide divergence of type between American and British catamarans. The former, influenced no doubt by successful production classes like the *Pacific Cat* developed for light conditions, especially on the Californian coast, were small boats around 20 ft long and 11 ft wide with fairly low aspect ratio rigs. The saving in wetted surface of the relatively short hulls resulted in higher potential performance in light weather, but they were unable to compete with the full-length boats in strong winds or broken water, and were discontinued. Construction of the early American boats was extremely (and sometimes disastrously) light, but the general concept was conservative, with ply bridgedeck floors and the general air of a sportified dayboat rather than a whole-hearted racer.

The original British challenger was the forerunner of the present type to the full limits of the rule, with only three cross-beams connecting the hulls and a terylene floor to save weight. Improvements in constructional materials and methods, and complete elimination of the polite remnants of ornamental trim, have since resulted in a considerable reduction of weight in 'C' Class hulls (though the opposite is commonly the case in rig) but the basic concept of minimum connective structure remains unchanged.

The Australian 'C' Class catamarans, first seen in this country for the third match in 1963, have been essentially in the same tradition as the British boats, although the challenger has in each case been double-ended rather than transom-sterned and to the full length limit on the waterline.

Hull construction

HELLCAT I, the first 'C' Class catamaran, is shown in fig. 9. She had hulls of 3/16 in total thickness and was constructed of moulded gaboon ply without internal reinforcement. This was two skins of special two-ply in transverse strips about 10 in wide, with the inner and outer shell veneers normal to hog and the centre veneers lapped to make an effectively continuous core. This method was originally developed for the amateur constructor and, in the 3/16 in thickness, required very careful laying-up to avoid undue thinning of the face veneer in fairing off. It was, for this reason, replaced by a total skin thickness of $\frac{1}{4}$ inch in later models built by commercial labour. The construction gives good transverse strength and stiffness and excellent sectional stability with almost negligible movement in removing from the mould. It has poor longitudinal strength, however. For the first boat, with dagger boards, it proved entirely satisfactory, but subsequently twice gave trouble in way of the longer slot necessitated by a tipping centreboard. Fig. 10 shows work in progress on the first hulls. Fortified u/f glue has been used throughout the series for the British boat.

A second, slightly modified version of this boat was built in polyester/glass in a conventional lay-up, only because the extreme rush precluded moulded ply and an attempted honeycomb cored hull proved unsatisfactory. $4\frac{1}{2}$ oz/sq ft total glass reinforcement in mat only was used, resulting in a weaker and considerably heavier hull. The American defender's hulls were also, though from choice, GRP, with a total glass content of under $2\frac{1}{2}$ oz/sq ft, very carefully laid up in thin cloth with hollow longitudinal stiffeners. She proved too weak and suffered severe damage, eventually tearing one hull in two from gunwhale to gunwhale.

These were the first and last serious contenders to use simple glass laminates. Low density core sandwich constructions have been rather more successful, especially in the United States where moulded wood veneers are too simple to have wide appeal. Polyester/glass and expanded polyurethane, either foamed in place or in sheet form, have generally been used, but it is questionable whether, in craft of this size, they stand to show any worthwhile superiority over wood. They have generally proved very expensive; one attempt cost more than $20,000 for the hull shells alone and weighed more than the wooden equivalent. At least one other project has come to a stop after using up the available money without finishing the shells. In view of the importance of rig, this argues some lack of perspective.

Perhaps the most successful composite laminate was the extremely light terylene/polyester and honecyomb core hull skin of the first Australian

Figure 9 *HELLCAT I*

challenger. This was about as light as 3/16 in gaboon ply, but still suffered patterning and delamination troubles, and was replaced by wood in subsequent boats.

Recent British defenders have continued to be built mostly in gaboon veneers totalling about 3/16 in, latterly with minimum density polystyrene foam bulkheads in the forward half to resist possible crushing loads due to nose-diving. These offer an extremely light and effective way of supporting thin skins, since the compressibility of the foam avoids hardspots. Peeled gaboon veneers have been used principally for their availability. Sliced agba veneers would be more pleasant to work and have greater durability, but gaboon has proved quite adequate, especially in view of the short life expectancy of the boat, and no glueing problems have been experienced. In choice of skin thickness, lightness must be balanced against damage risk which rises rapidly for a diminishing return in weightsaving. An entire 25 ft shell in 3/16 in gaboon may weight under 50 lb. It is robust and reasonably cheap, allows complete freedom of shape, and seems a generally satisfactory construction.

Interconnecting structure

Interconnecting structure consisting of two or three light alloy beams between the hulls, with a fabric floor, soon became standard for the 'C' Class. A netting floor was also tried but suffered from increased wind resistance (in the plane of the floor) and quite unacceptable drag if caught by a wavetop, as well as being excessively elastic for a good working platform.

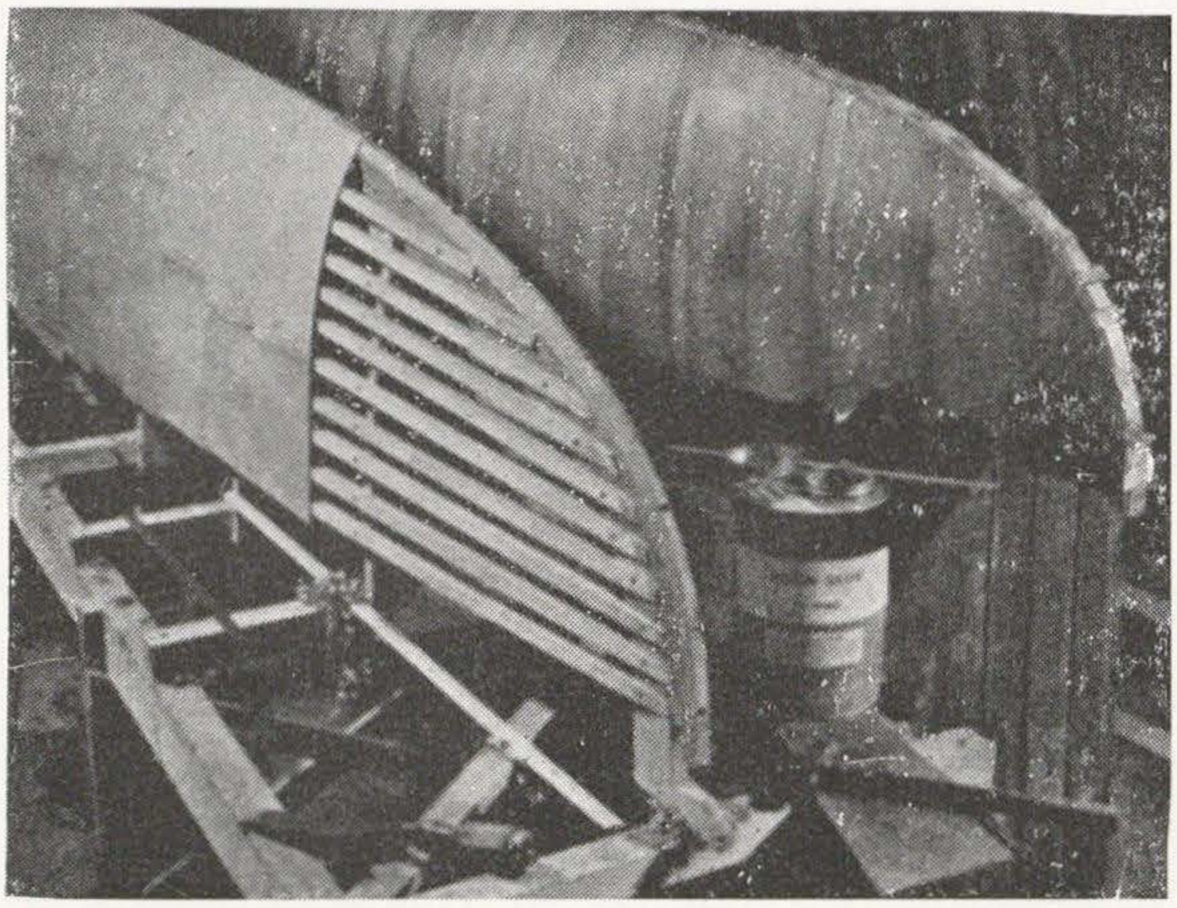


Figure 10 Construction of *HELLCAT I*

HELLCAT I used an alloy extrusion for the forebeam, which also carried the forestay, a wooden I-beam with $\frac{1}{8}$ in obeche ply fairing for the mainbeam, which carried the mast, and a wooden box beam carrying the mainsheet track aft. These beams slotted into the hulls and were secured by throughbolts so that the craft could be dismantled for transporting. The method proved structurally satisfactory but inconvenient in practice, due to the need to align the hulls quite accurately before the beams would enter their attachment arrangements. A folding system was later introduced using three alloy extrusions hinged at the centreline as shown in fig. 11. Since the main-load at the centreline is the downwards thrust of the mastheel, the only lock required is on the upper side of the rearbeam, to take the upwards pull of the lower end of the mainsheet. Provided the forestay is carried on a bridle, the legs of which go to the hulls, the centre of the forebeam is loaded principally in shear and a simple hinge without lock of any sort suffices. The mastheel load can be carried on the beam section alone if this is strong enough, but this puts the hinge under severe stress. Unless the beam is unusually deep, with consequent penalty in cost, weight and windage, working loads in the hinge can run towards 20 tons. The simple solution is to use a dolphin striker and heavy wire span across the underside. The striker length is fairly critical since loads will be unduly high if it is too short, and it will drag in the water if too long, but it has the great advantage of simplicity. Since the mainbeam is then in compression, no hinge is actually necessary and the section can merely be divided at the centreline, although a light hinge conveniently ensures the ends mating as the boat is unfolded. A number of privately owned 'C' Class catamarans using this system have now completed several seasons general sailing without trouble.

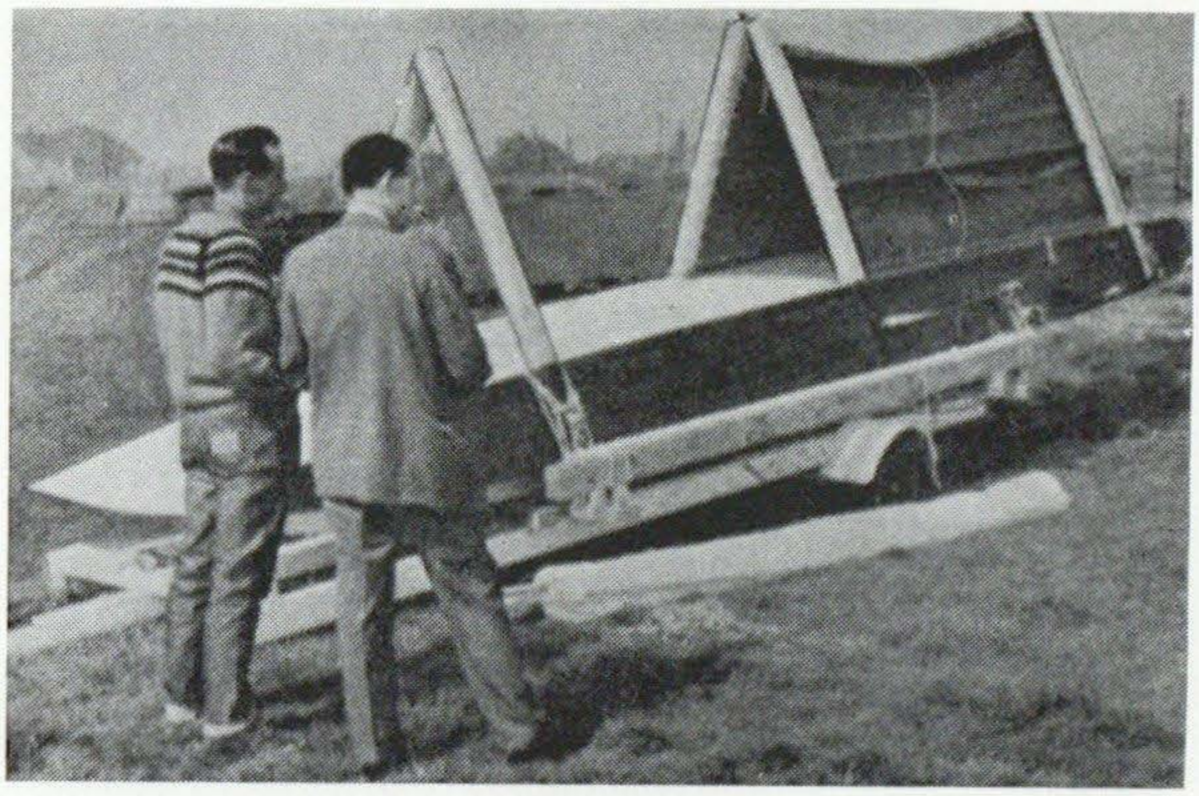


Figure 11 Method of folding craft for transportation

The recent tendency has been to ignore convenience entirely in favour of simplicity, and the hulls are often permanently connected. Light alloy beams have become standard. Despite widely felt concern about interhull loadings, standard ogival spar sections of weight well below 1.5 lb per ft have proved quite strong enough. These are either bolted or laminated into place using epoxy/glass. The general system seems to leave little room for major improvement.

Centreboard

With a few exceptions, the centreboards of the 'C' Class catamarans have employed conventional symmetrical sections. Most boats have had large boards of as high an aspect ratio as is compatible with strength requirements and reasonably slim sections. Both boards are normally used for windward work. NACA 0006, slightly modified in its overall proportions, has been used for the section in all the *Hellcat* series, partly because the relatively parallel-sided centre portion of the section helps mechanically. As a construction material agba has been preferred for its strength, lightness and stability, and has been block laminated with transverse gluelines to minimise warping due to local water penetration. Both dagger and tipping boards have been used. The former are attractive in reducing the size and weight of the case, and the weakening of the hull in way of the opening, but are very easily damaged by grounding and highly awkward to raise and lower under load without internal case rollers or other elaboration. Tipping boards have the greater practical efficiency of being easily operated, but suffer from two inherent faults in that, when half raised, they have lower aspect ratio without significant reduction of wetted surface and suffer distortion of the section. They also have a tendency to adopt an unfavourable angle of attack due to play in the case and bending in the length of the board. No clear overall superiority seems to have been established for either.

A very sophisticated attempt was made in the first American defender, *WILDCAT*, to use a system of asymmetrical laminar flow section boards and rudders, with both blades of equal size and equally bearing the load. These were raised and lowered on alternate tacks by a species of 'pithead' winding gear. They were designed and made to the highest standards in the Jet Propulsion Laboratory, Pasadena, using moulded polyester/glass halves assembled in a mould by inserting a machined balsa core plug into phenolic microballon/epoxy foam.

When fitted with these boards and rudders, even though they were small, *WILDCAT* showed a marked superiority over the other American boats. In very light weather, they gave only a comparable *apparent* performance to the large symmetrical boards of the British boat.

In the design of the *Hellcat* series, a sail balance has been sought that gives moderate weather helm loading, with the rudder in the centreline of the boat, so that both boards and rudders may have approximately similar specific loading.

Hull design

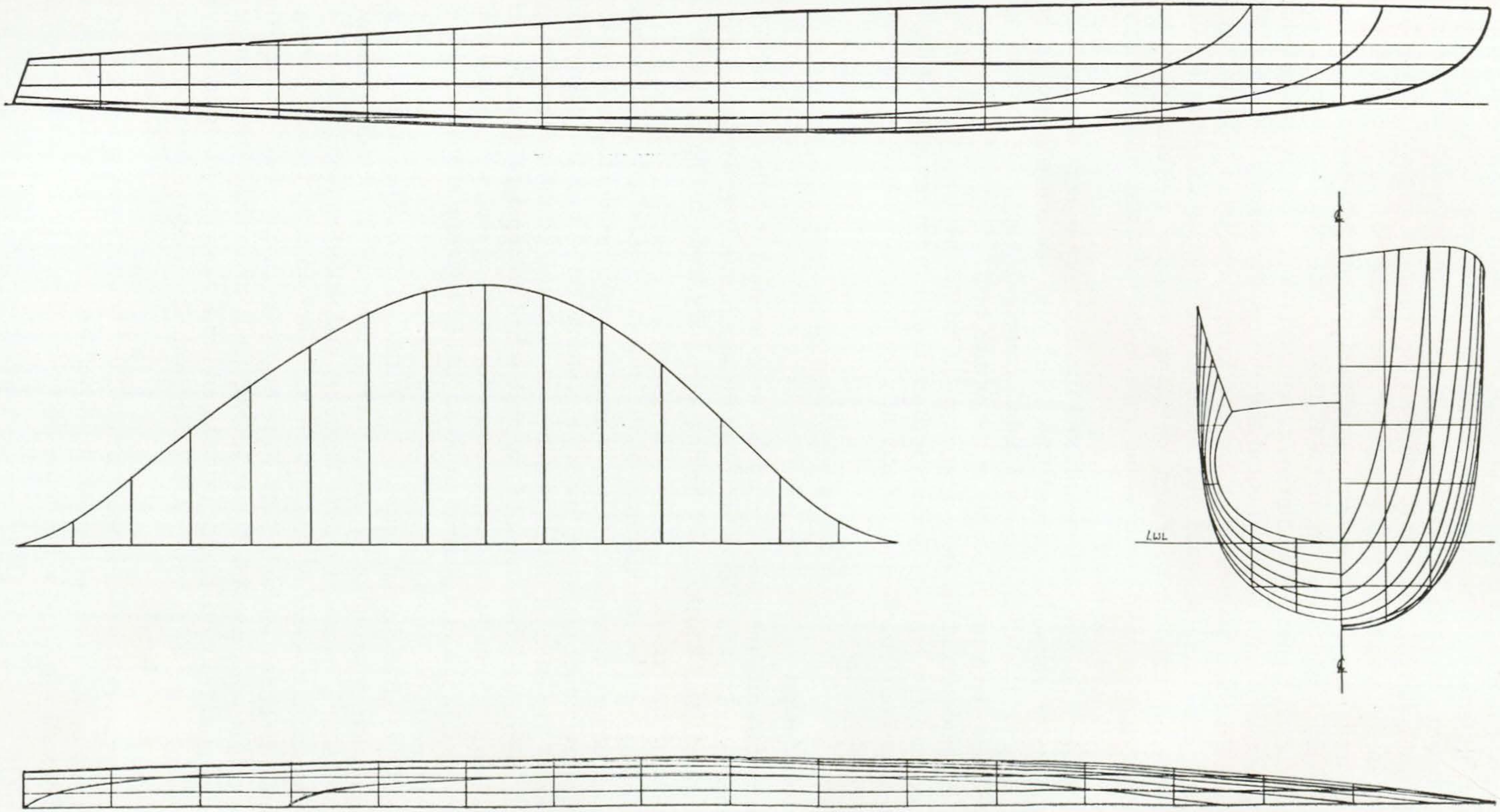
In considering the lines, it must be borne in mind that they are subject not only to changes in trim, both voluntary and involuntary, but to variations in displacements which, under heeling load, vary from double the static value to total emergence.

Fig. 12 shows the hull lines of the original *HELLCAT I*. Although the snubbed bow fitted the 25 ft length limit, the craft was, in fact, later shortened down to reduce the wetted surface by cutting one foot off the largely unused stern. The effect of this on performance was never established competitively, but contrary to what might be expected, it had no apparent effect on pitching motion. The hull lacked lifting power forward and even with the lower sloop rigs then in use, it was given to occasional bowburying in brisk conditions in unsympathetic hands.

Fig. 13 gives the hull lines of the *HELLCAT 3S*. They show an obvious derivation from those of *HELLCAT I*, with an immersed transom and considerably increased reserve buoyancy and waterline plane forward. The prismatic coefficient of 0.622 is probably not an ideal choice, placing too much emphasis on high-speed performance, especially since the rig loading usually associated with higher speeds, tends to increase the prismatic coefficient in the more heavily loaded, and hence more important, hull anyway. It is of some help, however, together with the wide immersed transom, in controlling pitching.

It seems reasonable, in the design of these boats, to seek a hull that is easily driven in light weather and can be driven hard in strong winds. Reduction of wetted surface is a paramount consideration, and the lines shown give,

Figure 12 Hull lines of *HELLCAT I*



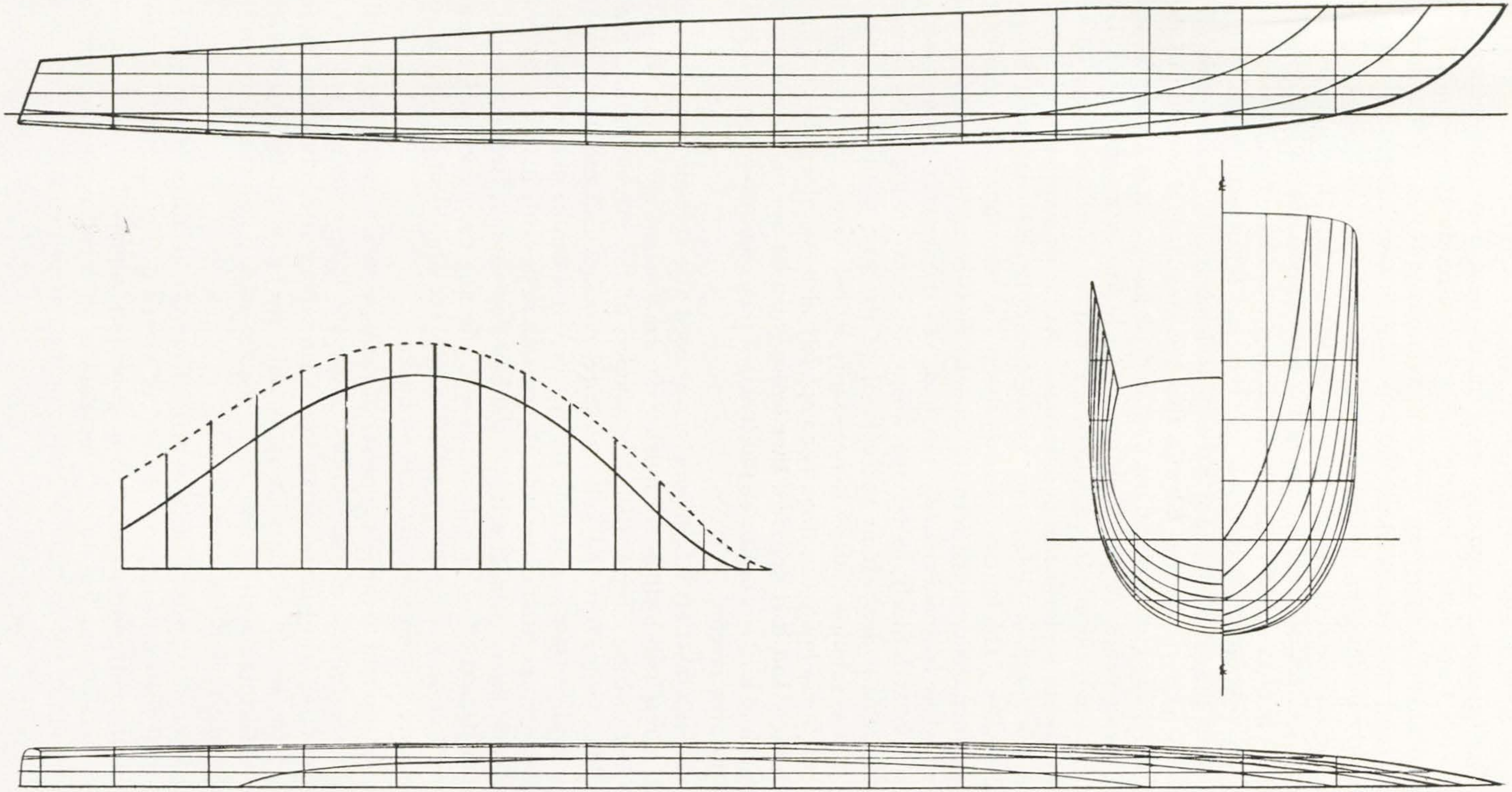


Figure 13 Hull lines of *Hellcat* 3S (*LADY HELMSMAN*)

despite the wide transom, only about $4\frac{1}{2}$ per cent increase over an 'ideal' hull of similar volumetric shape consisting entirely of semi-circular sections.

These boats are so long and light that simple residuary resistance weighs less heavily in hull design than such considerations as avoidance of unnecessary pitching and the mitigation of vices peculiarly associated with the type, particularly bowburying or difficulty in tacking.

Bowburying, or nose-diving, where at worst the bow may plunge in to a depth of six feet or more, stopping the boat almost instantly from speeds sometimes in excess of 20 knots, is a disturbing manoeuvre by no means devoid of physical risk, especially to a crew on a trapeze. It can result in the complete crushing of the entire forward part of an inadequately braced hull. The vice arises largely from the tall rigs that the great lateral stability of these boats allows them to carry and use even in brisk going. It is made still worse by the higher centre of effort and often much greater weight of the 'Una' rigs, now commonly employed, and by the need for a fine soft-riding bow for good windward performance in a seaway. As far as compromise allows, it can be minimised in design and, subsequently, largely controlled by good helmsmanship. The latter is often probably the best approach, since excess reserve lifting ability in the forward sections must be carried parasitically all the time when it is not actually required. In this respect, as in others, a successful boat is likely to be one where the vices arising from its speed potential remain just within the control of the best available helmsman. Some of the solution indeed is necessarily in his hands, since in extreme conditions these boats can become completely airborne along the full length of both hulls and it is apparent that hydrodynamics are unlikely to benefit them much in mid-air, nor to be much help if they come down point first like a well thrown javelin.

Moving the mast aft is still widely canvassed as a cure-all for nose-diving. In fact, it results principally in moving the dead-weight of the rig, while the forwards capsizing couple, (being a function of the magnitude and centre separation of rig effort and hull resistance) remains unchanged. Moreover, tacking requirements pose a limit on the amount it can be moved back, since helm balance necessitates moving the centreboards with it, resulting in an undersirable increase in directional stability due to increased separation of centres of lateral effort of hull and board. In any case, even with a heavy rig, the effect of moving the weight aft is only the equivalent of moving both crew members approximately half as much.

Attempts to add to the lifting power of the bow, by increasing the waterline plane or the fullness of the sections above the load waterline, tend to be expensive in terms of performance loss when sailing to windward in choppy water. The benefit of 3in wide spray rails, see fig. 9, in deriving dynamic lift, by deflecting the rising bow wave, is quite marked and they also serve to reinforce the bow if the worst befalls.

Sluggishness, or worse, in stays arises from the lightness of the 'C' Class boats, their high windage, and the loss of kinetic energy involved in turning such directionally stable hulls. It is sometimes supposed to be worse with greater overall beam, but no such tendency is apparent in practice, nor does consideration of the moment of inertia in the yaw plane make it seem likely.

It is minimised by greater weight, and hence momentum, which is widely undesirable from other performance aspects. Further helpful features are a more cut away forebody, wider angle of entry, a shorter waterline and more pronounced rocker, and a narrower waterline plane in the stern allowing the crew to raise the bow by moving aft while tacking, all features which militate against steadiness in pitch. Improvement can also be obtained by not placing the centreboards too far aft, which, as already noted, bears on the bowburying problem, and by sailhandling technique in stays. Careful design should reduce the problem to the point where tacking, though still slower than in conventional craft, is just as sure. No question of getting into irons should ever arise, even under extreme conditions, with a full length 'Una' rigged boat in competent hands.

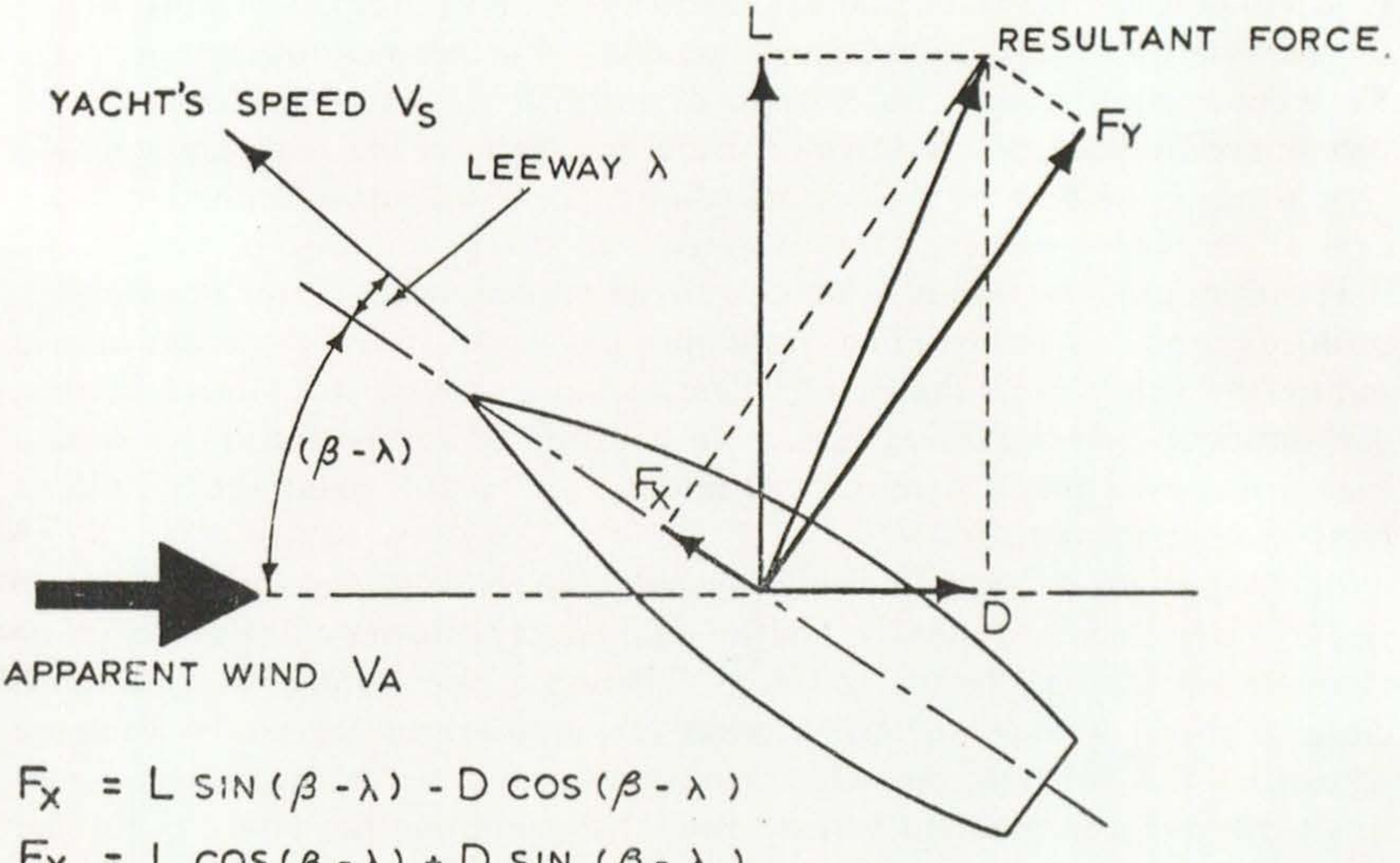
Pitching is minimised principally by reducing the height and weight of the rig, by extending the waterline and by deliberately mis-matching the pitching characteristics of the bow and stern. There are also feelings that, in some circumstances, it may pay to increase the moment of inertia in pitch by separating the crew and the helmsman, or to trim down by the bow. At all times, the reduced pitching which results from keeping the boat sailing fast is most striking.

The spray rails also alter the pitch characteristics considerably, although the effect this has on performance is not clear. The knuckles now often used in lieu are more elegant, less effective in deriving dynamic lift (and keeping the crew dry) but softer riding, and allow of increased reserve buoyancy without a coarse angle of entry at the load waterline. On balance they are probably, though not certainly, an improvement. There is a limit to the amount of reserve buoyancy that can be worked into the bow sections in this way, since the braking effect of immersing the coarser entry at speeds starts to do more harm that its static buoyancy suggests it should do good, both in slowing down the boat and in increasing the forwards capsizing load due to rig momentum. On the other hand, it is clear that we have by no means reached a limit to the reserve buoyancy that can usefully be built in by greater freeboard forward, especially if function is taken as the sole criterion, entirely without regard to appearance.

Design trends

The most recent *Hellcat* hull subsequent to the '3S' ('Lady Helmsman') series embodies differences along the lines suggested earlier. The sheer is positive, giving increased buoyancy forward, with greater freeboard in a knuckled bow which is slightly finer both above and below the waterline. This new form appears to be, as expected, marginally slower in light going, due to the increased wetted surface, and considerably superior in choppy conditions.

The developing 'Una' rigs are putting increased loads and requirements on 'C' Class catamaran hulls. With heights reaching towards 40 ft, and centres of effort, even higher relatively, than equivalent sloops, they are often extremely heavy as well. The large wingsail rig on *LADY HELMSMAN* at one time weighed nearly 250 lb—not much less than the stripped weight of the remainder of the boat. This poses interesting questions as to how far it



$$F_X = L \sin(\beta - \lambda) - D \cos(\beta - \lambda)$$

$$F_Y = L \cos(\beta - \lambda) + D \sin(\beta - \lambda)$$

Figure 14

will pay to accept increased rig weights and heights when the greater driving potential is weighed against the more powerful, and hence more difficult to drive, hulls required to carry them.

Doubtless in the next few years certain clearly advantageous trends will emerge. For the time being, however, it is increasingly essential for hull and rig to be jointly conceived to suit each other.

DISCUSSION

Mr. T. Tanner: I shall concentrate entirely upon what I call the aerodynamics of the problem contained in the first part of the paper. There are so many comments I would like to make that if I were to deal with them all tonight we should probably be here until midnight, so I will take a few which I think are of major importance.

The first one deals with the suggestion that you can regard a sail as a wing up-ended. This is useful for examining the aerodynamics of the sail if it is done very carefully but there are essential differences between wings and sails apart from the more obvious ones. A wing is required solely to give lift. Drag is the price you have to pay for this lift and it arises due to the viscosity of the air and the fact that the wing has finite aspect ratio. The sail is not required to give lift.

The forces developed by a sail can be represented by a lift L at right angles to the apparent wind and a drag D parallel to the apparent wind, as shown in fig. 14. Alternatively, the resultant force—I am assuming that we can exclude the vertical forces, and in a 'Cat' we can do this roughly,—has two components, one along the yacht's centre-line which I will call F_x, and one at right angles which I call F_y, so that one can represent the forces developed by a sail either in terms of L and D or in terms of F_x and F_y. I suggest that the purposes of a sail is not to produce F_y but to produce the driving force F_x, and the ideal sail would produce F_x without any F_y. So F_y, the lateral force, is the price one has to pay for the driving force. The lift contributes largely to F_y, and at the same time it gives the main contribution, the only positive contribution, to F_x.

F_y causes the yacht to heel over and so increases its water drag; it also causes leeway, and that again increases drag. So F_y is a drag-producing mechanism, the price you pay for F_x, and in this respect, the sail is quite different from a wing.

If you want an analogy—I do not see why you should need one!—the best is the sail of a windmill, where you find exactly the same equations if you write down F_x and F_y in terms of L and D and the relative wind angle. F_x is comparable with the torque which the windmill develops.

So my first point is that in this respect the sail cannot be regarded as a wing and, to go a bit further, I cannot see any connection whatsoever between a spinnaker and a wing.

There are comments which one could make on fig. 1, particularly. If you regard history, you will find that up to a certain date, the lift/drag ratios of aeroplanes increased and after this, they began to decrease. If you look at the planforms of the aeroplanes when the change occurred, you will find a radical change of aspect ratio. The lift/drag ratio for the modern high speed aeroplane is falling as the aspect ratio gets smaller.

Another point I want to consider is the suggestion on page 67 that for high-speed sailing, the 'Una' rig is probably better than other rigs. At Southampton University, we did some wind tunnel tests some time ago on a *Dragon* class rig with a hull. First we tested a genoa alone, than a mainsail alone, and then the mainsail with the genoa. We measured what I have called F_x the driving force, F_y the side force, and also the heeling moment. The results show that at a relative wind angle near 30°, and for each square foot of sail area, a genoa alone will produce about half the heeling moment, 10 per cent less side force and about 30 per cent more drive than a mainsail alone. This superiority of the genoa decreases as the relative wind angle decreases so that at 20° the mainsail alone produces, per sq ft of sail area, more than twice as much driving force as the genoa alone; but the tests indicate that even at these small relative wind angles, there may still be some advantage to be gained by putting some of the sail area forward of the mast.

I believe I am right in saying that *LADY HELMSMAN* showed considerable superiority over other boats and I have therefore taken fig. 5 and tried to make a comparison with other rigs. If the results of Marchaj's wind tunnel tests on a $\frac{1}{3}$-scale model of the XOD rig are plotted on this graph they show no appreciable differences. If then *LADY HELMSMAN* was so good, wherein lies the reason for this superiority?

Added in writing after the meeting.

The optimum windward performance of a yacht is clearly as much dependent on the hull as on the sails. For this reason, the evaluation of tank test data for a hull is based on its predicted performance assuming the Gimcrack sail coefficients. In this way, it is possible to make a direct comparison with a slightly different hull form, the predicted performance of which has been estimated on the same assumptions.

The problem of evaluating sail force coefficients is almost the exact counterpart of the problem of evaluating the hydrodynamic characteristics of a hull but as yet no 'standard' hull data comparable with the Gimcrack sail coefficients exist. In fact, it seems unlikely that with hulls as widely different as those of a 'C' Class catamaran and, say, a 12-metre yacht, it will ever be found reasonable to represent them by the same 'standard' data.

In the absence of such data, the only satisfactory way of making a comparison of the sail coefficients for different rigs is to carry out complete performance estimations using the most appropriate hull data available. Thus *LADY HELMSMAN*'s rig might be compared with the XOD rig on the assumption that they were both used on the hull of a 10 square metre class canoe; the hydrodynamic data of the canoe was established by full scale tests at the National Physical Laboratory*.

Mr. P. V. Mackinnon, MA, (Associate) RINA: I would like to talk about this as a restricted class of racing yacht, because that is what it is. We have had earlier restricted classes—the *National* 12 ft, the *International* 14 ft, the *Merlin* and others—and this is a big and exciting restricted class. I only hope it will develop in the way those other restricted classes have developed. I do not suppose there will be so many, but long may it continue development.

I refer to that because, of course, yacht racing depends entirely on the class rules and I am going to make one or two points on which the authors might like to comment about these class rules.

The first is that the rig seems to be getting a little bit out of hand as regards height, and the authors might like to express an opinion whether class racing as such would be improved if a height limit were imposed by the rules.

Passing to the second part of the paper, a similar question might be asked of Mr. Macalpine-Downie—whether he thinks that class racing, as racing, would be improved if a minimum weight was laid down for the hull structure? The authors' comments on that point would be of great interest.

If I may pass to one or two observations which have occurred to me, not unrelated to Mr. Tanner's remarks, it seems to me that the reason why the 'Una' rig came in, first on ice yachts and then on 'C' Class racing catamarans, is that none of them is troubled with the problem of running or broad-reaching. All their sailing is done with apparent wind well forward of the beam, and it is because of the running and broad-reaching problem that I believe the two-sail rig has held its own in racing for so long.

To make a direct comment on something Mr. Tanner has said, I think that when one works it out one finds that the racing conditions for 'C' Class catamarans are such that low air drag or high lift/drag ratio is the one factor which is important in the rig. I was watching Mr. Tanners' slides very carefully and it seemed to me that lift/drag ratio was the one factor in which *LADY HELMSMAN*'s rig was at any rate not inferior. I throw that out as a possible help to the authors in answering Mr. Tanner's remarks.

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* Tanner, T.: *Full Scale Tank Tests of an International* 10 *Square Metre Class Canoe.* Trans. RINA, Vol 103, 1961, p 25.

The next point I would like to refer to is the question of angle to the true wind at which these boats sail to windward. I gather from Mr. Farrar that, on occasions, this may be as little as 26°. I am surprised at this because Barkla pointed out in one of his papers that a really easily driven hull tends to require to sail wider than a conventional one, rather than closer, and Mr. Tanner has even pointed out that, under certain conditions, if the 'drag angles of rig and hull remain constant with varying wind speeds, so that the beta angle—the angle between course and apparent wind—is constant, then the most effective angle at which to sail to windward is more than 45° by half the beta angle. I have a feeling that this applies to ice yachts and possibly to 'C' Class catamarans in light wind, and the authors may have something to say about that.

My next point, still on rig, is to suggest to Mr. Farrar that possibly the only way to get it down to a reasonable weight is to build the whole thing as an inflatable structure, which has the further advantage that it is much more sea-worthy because the crew can immediately take it down by opening a valve. I do not think this is an original idea, and I believe it will come.

Coming back to the question of rule-making, I would like to tell you how, as far as I remember it, these limits were fixed. Three hundred square feet was chosen as what we thought would be enough to keep two men fully occupied in sailing the boat. This was in the early days when we envisaged catamarans with two sails and fairly conventional rigs and layouts. We picked on 300 sq ft in that way. We picked on a 14 ft beam because the standard road clearance in Great Britain is 16 ft. We thought they would be able to travel on trailers on their sides, and it is interesting to hear from Mr. Macalpine-Downie that they are now going back to non-folding and non-demountable structures, so perhaps our choice of 14 ft may justify itself.

Finally, I would like to suggest that in the design of the inter-connecting structure between the two hulls, not enough use has been made of what I believe are called 'space frames'.

Added in writing after the meeting.

I should have made it clearer that it is only for 'C' Class catamarans, and not for yachts in general, that I suggested that high lift/drag ratio for the rigs is the primary requirement. The lift/drag ratio of the hull, and the ratio of yacht speed to wind speed, are both so much higher than for other yachts that a high lift/drag ratio for the rig becomes important.

Mr. J. Fisk: I would like to approach this problem from the practical angle, and I must first say that today I have been baffled by all the mathematics.

May I ask the authors to comment on the rig: whether they really feel that the weight can be reduced, and whether the control of the flow in the sail and the mast combined can be improved from a practical point of view; whether the crew will be able to alter the camber of the rig more easily than at present seems to be so? Perhaps this could be achieved by a different method of control on battens and by a better method of control on steering the mast by the tiller. At the moment, the arrangements seem to be rather crude and lacking in fine adjustment.

The authors claim that the rig does away with twist. I am not very clever at these things but looking at the rig, and at the mast in particular, one sees that it has a straight leading edge wherever it is rotated and that the leech is bent when the wind is filling the sail. Surely there must be some twist in this sail from the leading edge to the trailing edge?

In the picture it looks nice because the leading edge of the sail, where attached to the mast, follows its own trailing edge, but it certainly does not follow the leading edge of the rig as a whole. Perhaps the authors could comment on whether a combination of the floppy rig and the present rig might be possible? I can see that it is difficult to make a mast with an 11 in width bend sideways but, if it is possible, would it in fact give better results that the present rig?

Could we also look at the wind sock arrangement of the latest *QUEST*, which used a pocket luff zipped on to the sail after the sail had been run up a conventional mast? This seems to have possibilities and the performance of the boat seemed to support this, part of the time.

May I comment a little on what Mr. Tanner said? I take all his graphs and mathematics as being words of wisdom because I do not understand these things well, but when sailing against 'Una' rig boats in sloop rig boats, the 'Una' go much faster and closer to the wind. I do not know the reason but perhaps it can be proved in the wind tunnel sometime?

With reference to Part II of the paper, I would welcome some comments on other aspects of hull form—the double-ender which the Australians use. This intrigues me and it goes faster than one could reasonably expect. When I first saw *QUEST*, I was convinced that it would have difficulty in getting out of its own way, but it went very fast indeed and I have always been surprised at the speed of these double-ended boats. One advantage they seem to have is the ease with which the crew can trim them. Moving the crew weight aft has much more effect than in the boats here. Could the authors comment on that?

As regards the problem of spray rails or knuckles, there seem to be two schools of thought: one where the knuckle is used to give lift at speed and the second which thinks that anything on the front of the boats stirs the water and should not be there. These people go in for slim bows which penetrate the sea and can sometimes become dangerous, but for practical purposes of racing these boats seem to be effective, the claim being that if nothing is stirring up the water, less power is used. Again, there are obvious problems here and the capsizing of both Australian *QUESTS* with fine bows goes some way to support the contention that we need some form of lift in the bows of our boats.

Going back to the double-ender, it seems that some waterline length is being given away by not using a transom stern, and the Australians have experimented on long rudder heads faired into the hull, so that the hull ends in a stern post 3-4 in wide, and the rudder is faired in above and below the water to give an extension to overall length.

Finally, would the authors comment on tacking a 'Una' rig boat? We saw in the film the lastest *QUEST* stuck in stays unable to bear away on to a new tack, and *LADY HELMSMAN* rushing through to leeward. It seems to me that one wants a little built-in weather helm for windward sailing and lee helm just after you have tacked, so that you can bear away on to a new tack. Perhaps some techniques can be developed for that.

Mr. D. C. Murdey, B.Sc., (Associate-Member) RINA: The performance of the catamaran among waves and its manoeuvring ability have rightly received a great deal of attention from the authors. These problems have also been the concern of the designers of high speed cargo liners and of super-tankers, and a great deal of research work has been carried out.

Although a high speed cargo liner and a catamaran have little in common, it is interesting that several of the authors' empirical observations and 'feelings' have been confirmed by a recent analysis of model experiments on hull forms of merchant ships*.

The reduction of the longitudinal radius of gyration has been found to result in a reduction of pitch, except when the peak of the wave spectrum occurs at a higher frequency than the peak in the pitch response curve. In the ship field, this corresponds to a long (800 to 1,000 ft LBP) ship in the seas associated (in the North Atlantic) with winds about Beaufort force 5. The corresponding case for a catamaran would be unusually short seas. If these were the circumstances in which it paid to separate helmsman and crew, then the authors' 'feelings' about an improvement would be substantiated.

The ship model results confirm the reduction of pitch as speed increases beyond some threshold value, although for ships this reduction is quite small, less than one degree. Unfortunately, the heaving motion is found to increase as speed increases, so the vertical motions are unlikely to be smoother at high speeds.

As far as hull form is concerned, indications are that the 'V' sections are best for reducing both pitch and heave motions. It is interesting that the authors have found an interaction between form of bow and form of stern, and further details of the 'deliberate mis-matching of pitching characteristics of the bow and stern' would be appreciated.

Mr. W. A. Crago, BSc. (Member of Council) RINA: I think it needs saying again, quite categorically, that the criterion which must be used to assess the ultimate efficiency of a sail is not its lift/drag ratio. Mr. Tanner has clearly pointed out in his discussion that the factors which are important in the functioning of a sail are the value of F_x and F_y to which I should like to add, as another important parameter, their centre of effort. It does not follow necessarily that the sail that has the highest lift/drag ratio will give the optimum value of F_x and F_y and therefore the best yacht performance. Of course, from an intuitive point of view, it seems highly probable that a high lift/drag ratio may very well result in a good performance, but it is certain that it does not necessarily provide the optimum.

I think it was Mr. Farrar who, in referring to fig. 5, said that although the lift/drag ratio was not high, the thing that appealed to him was the angle at which the maxima occurred. I may have misunderstood the point, but as far as I can see the angle is irrelevant. Thus, if one can conceive of a similar sail which had maxima at 90° and produced the same force as those in fig. 5, the yacht would sail in just the same way.

Turning now to fig. 13 in the second part of the paper. These hulls are

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* Moor, D. I. and Murdey, D. C.: *Propulsion and Motions of Single Screw Models in Head Seas*. Paper presented at Summer Meeting of the RINA, in the Hague, May, 1967.

very reminiscent of craft derived from an 'E' boat parent form that we tank tested immediately after the War. We tested a number of such forms and actually went to a higher length/beam ratio that even the 'E' boats had and, in every case, we found the curved buttock lines were bad in that they were always associated with increased hull resistance. It is interesting to note, therefore, that in fig. 13 the buttock lines run fairly straight, whereas in fig. 12 they are curved and one would like the authors' opinion as to whether this feature effected the performance at all.

I would like to ask the authors if they have speculated on the possibility of using hulls with chines and 'V' bottoms. The 30 knots they have mentioned is quite fast enough to justify this kind of hull with one or two steps.

Finally, may I say that Mr. Murdey's comments were interesting, but I doubt if any merchant ship data is relevant here because the $V\sqrt{L}$ achieved by the authors when running in waves is very much higher than that applicable to conventional merchant ship forms.

WRITTEN DISCUSSION

Mr. H. S. Wood (Associate-Member) RINA: I wish to thank not only the authors but also those who persuaded the authors to place on record this distinct advance in sailing technology. A considerable degree of the improvement in the rig is presumably due to (a) the reduction in parasitic windage resulting from the elimination of topmast stays and spreaders, (b) the tell-tale windows to warn of breakdown of laminar flow on the lee side of the sail, and (c) the means of adjusting the angle of the boom to the wing-mast. It would appear that the forward hand is even busier than on a conventional sloop rig. Does the boom angle require re-adjustment for changes in course or is the required curvature determined by the wind strength? Could the authors add a bibliography to the paper? Information on low-speed aerofoils seems hard to come by, presumably because it is now 'old hat' to those engaged in aeronautics.

Does Mr. Macalpine-Downie consider that even more speed could be attained from the hulls if the Class 'C' restrictions on crew number and sail area were ignored and a greater sail area supported by greater crew weight?

AUTHORS' REPLY

Reply by Major General Parham

With regard to the weight of the rig, I think that one may have to accept greater weight to get greater efficiency. Looking at fig. 1 showing gliding angles, one sees that the payload in all cases is the same, i.e., one man but the weight of the aircraft itself, which was around 50 lb in the case of Lilienthal's inefficient later glider has gone up to around 600 lb in the case of the very efficient sailplane of today. I do not think that extra weight is such a devasting penalty on the water with 'C' Class catamarans as people like to make out. After all, *LADY HELMSMAN* was heavier than her adversaries and it is an unquestionable fact that if you have weight you go round the corner better when you are tacking.

The other thing I would like to say is that we had it from John Fisk, who is probably the greatest expert on the actual sailing of these craft, that the

'Una' rig goes straightaway from the sloop rig to windward. However, the graphs and figures produced by Mr. Tanner seem to show that *LADY HELMSMAN* had a rig inferior in most respects to the more normal rigs with which he compared it, and yet she won. Is it a question of sending Mr. Tanner back to find some better figures, or what? I do not know. I am completely unrepentant about the sail being a wing up on end. I am convinced it is and I have no intention of changing my mind. Every single thing in my 30 or 40 years of aeronautical and sailing experience goes to prove to me that it is.

In reply to Mr. Fisk's question about the 'twist' on *LADY HELMSMAN*'s rig, he is, of course, quite right in saying that since the leading edge is straight and the leach curved, there must be some twist. What has happened is that, as the rigid leading portion of the wingsail is 'knuckled over' to leeward (to produce the desired camber on the sail as a whole) its curved rearward edge forms, when viewed from the eye of the wind, a curve similar to that of the curved spar rig in fig. 4. This curve, plus the effect of the fairly short stiff battens, has the effect of thrusting the leach to windward and thus reduces the twist of the sail as a whole.

Reply by Mr. A. Farrar

With reference to Mr. Tanner's remarks, fig. 5 was prepared directly from the raw wind tunnel data before the computer figures were plotted. I am now able to give the lift/drag curves properly corrected for wind tunnel effects and with the hull drag subtracted. These have been kindly worked out for me by Paul Spens whose help with the wind tunnel testing was invaluable but who was unable to attend the meeting. These curves, shown in fig. 15 may help to explain the wing sail's superiority over conventional rigs. Admittedly, on Mr. Tanner's figures, a 'C' Class catamaran would perform better with an X—boat rig but I feel there must be some practical reason why it would not work. Certainly, any soft sail catamaran was out of date many years ago when full battened sails were introduced and then the ordinary sloop rig was beaten so frequently by the 'Una'. There must be a practical reason for this and it is the practical effect that wins races.

Mr. Mackinnon asks if the rig is getting out of hand. I think it did get a little out of hand with *LADY HELMSMAN* because we had far more weight in the rig than we had hoped. The rig was so heavy that it broke two main beams on two successive days, due simply to the hammering of the boat through the Thames Estuary chop, with the rig supported on beams really designed for a sloop rig. We now think we can incorporate a much lighter rig which we hope will be more practicable.

The question of a height limit and a minimum weight limit for hull structure has been discussed by the rule-makers, who decided to leave it open for a time and see how things developed, and they are still watching. The fact that we have come down from a maximum of 40 ft to between 32 and 34 ft, I think indicates that it is self-limiting.

The minimal weight for the hull structure depends so much on the actual structural method—how they are built—but I do not think one can put on a minimum weight restriction. Mr. Macalpine-Downie will be able to say

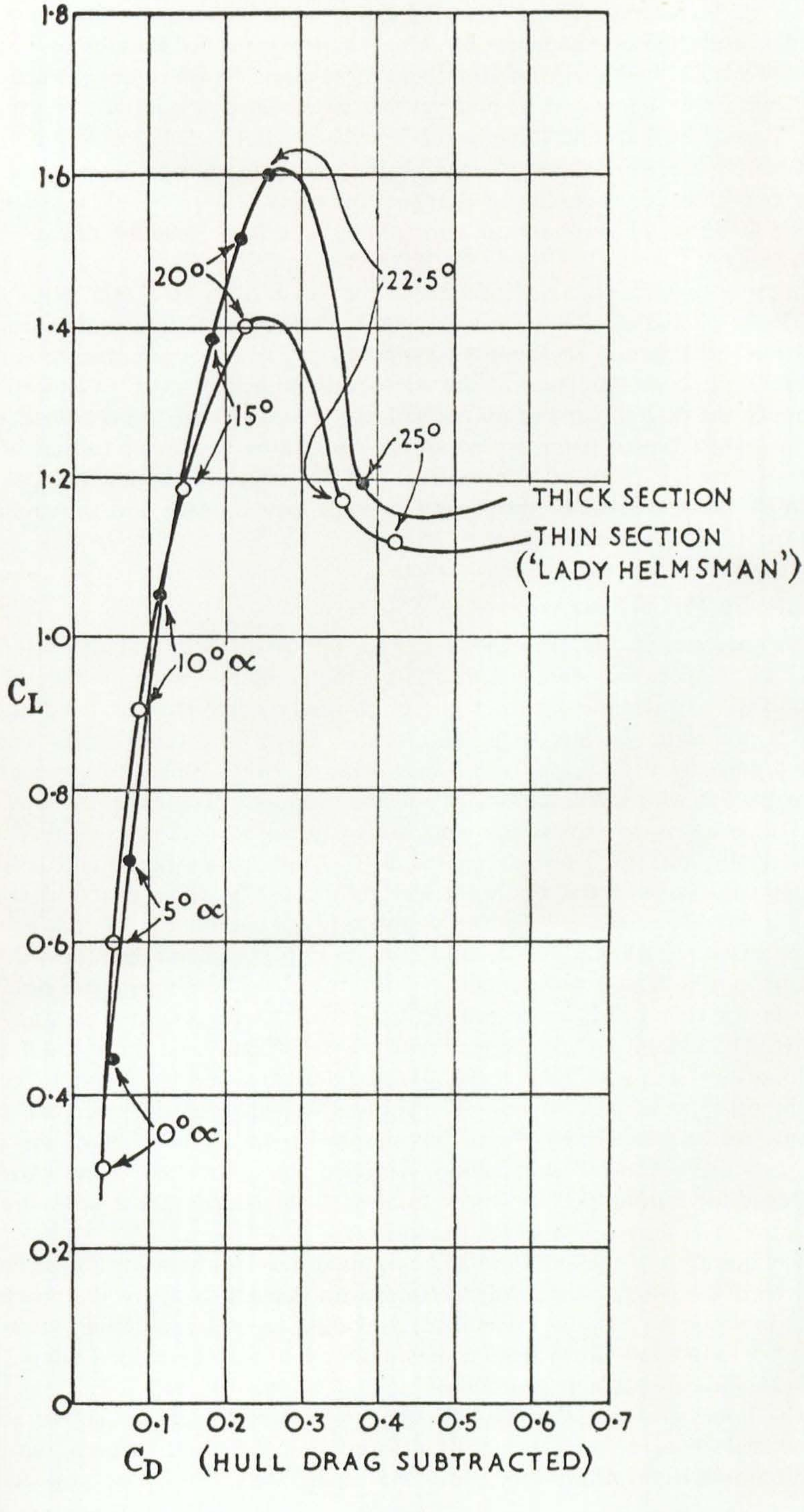


Figure 15 Corrected lift/drag curves

more about this than I can, but I happen to be on the committee which has to deal with some of these things, and while structural methods are still being developed, I think it would be a pity to insist on a hull limit and force people to build boats heavier than they may be able to construct them and still not break.

Some experiments have been carried out with the inflatable rig and these are still going on. I think it has enormous possibilities and I hope we shall get something out of it.

John Fisk asks if weight can be reduced. The answer is yes but, as with aircraft, less weight costs more money and we have not yet got the money to do it.

I think that flow control can be improved. We have a certain amount of control now and on *LADY HELSMAN*, it is certainly better than the Americans have. We want a micrometer on the spanner to get the smooth flow from one to the other. I think we can improve it.

Lack of twist. Certainly the straight leading edge on the spar does rather spoil the nice idea of no twist at all. The soft part of the sail is manifestly shown to be untwisted. The rigid part has a little, not much, twist and a good deal less than a conventional rig, but we have another design up our sleeve for a wing that I cannot show anybody just yet, which will go a long way towards getting rid of the straight leading edge effect.

The pocket luff on the mainsail is far from new. It was used on *SHAMROCK IV* in the America's Cup in 1914 and again in 1918. It gave rise to considerable complications, because whereas in *QUEST III* the crew had to roll the boat over on its side and took an hour lacing on the sleeve, in *SHAMROCK IV* it meant two men in bosun's chairs lacing the pockets through eyelets in the mainsail, which also took an hour. A round mast is helpful, although I am not sure if it really gives a true fairing from the mast on to the sail. It must improve things. Whether such an arrangement is ideal I do not know, but it might be very instructive to carry out some relevant wind tunnel testing.

The idea of fairing the rudder in with the hull to gain extra length has been stopped by the rule-makers, who have said that only a 3 in width is allowed without inclusion in the measured hull length.

Mr. Crago and I do not seem to talk the same language when it comes to sailing.

My reference to fig. 5 was to emphasise that with a fast moving hull the object was to get a good lift/drag ratio at a small apparent wind angle to achieve the best speed made good to windward. Whilst it was not practicable to instrument *LADY HELSMAN* fully, she did carry a compass, and the helmsman reported that the tacking angle (i.e., twice the course angle from the true wind) was 52° whereas 12 metres are considered to be doing well if they tack through less than 65°. A tacking angle of 52° corresponds to an apparent wind angle (β-λ in fig. 14) of about 10°, and it must be evident that a boat which can get its optimum driving force at 10° (not the maximum which is at about 20° and is only used for reaching) will go to windward better than one 20° to 30°.

Mr. Crago's example with maxima at 90° must surely be the Flying Dutchman of the legend doomed always to reach to and fro without ever getting to windward at all.

In reply to Mr. Wood, I should say that the greatest saving in parasitic drag is in having a smooth lee side to the mast/sail combination rather than the re-entrant where a conventional sail joins a conventional non-turning mast, whatever its section, with the wind shadow of the mast killing the lift on the lee side of the mainsail just where it is most important.

The forward hand has to work closely with the helmsman but does not have to make constant adjustments to the angle between boom and mast. This remains constant while the whole rig is rotated by the mainsheet to suit changes of course, the rig being maintained at its optimum angle to the apparent wind. For close reaching, the optimum angle is greater, so the rig still appears to be close-hauled. For broad reaching, the outhaul is eased to increase the camber and the boom angle re-adjusted to maintain a fair curve on the lee side of the mast and sail..

The data for the Göttingen low speed glider section comes from Latimer Needham, C. H.: *Aircraft Design* published by Chapman and Hall, 1939.

Reply by Mr. Macalpine-Downie

With regard to Mr. Tanner's remarks, we are not in fact concerned solely with side force. We often have an excess of stability and if we can get an increase of force in the line of motion we are often thankful for it at any price.

Mr. Mackinnon said, about pointing, that 26° is a very impressive figure. I was impressed originally when I heard that 12 metres would do 32°. I think one must distinguish between how high one can point without actually stalling (or going backwards) and how high it is, in fact, advantageous to point. My own guess would be more like 40° at best. I wonder what John Fisk thinks about this; he is probably the best qualified person to say. I have a friend in ice yachts who currently holds the world speed record and says that such craft also handle and point most effectively, very much like catamarans, a little closer than 45° at best.

As to space frames, perhaps through laziness I have failed to take much interest in them. Since we can hold boats together effectively with two cross beams weighing a total of 32 lb including fastenings; since we need a main sheet track across the boat and anchorage for the trampoline fore and aft; and since with crossbeams we can get all these simply and lightly, without unnecessary windage, complications and things to climb over—for practical considerations like these, the engineering virtues of space frames have always seemed less attractive to me overall.

Mr. Fisk mentions a double-ender. I do not really have any good answers to this but it seems apparent that with a double-ender one is, to some extent, losing effective waterline length in return for some reduction in wetted surface. I did say earlier on, and even now believe, that we are already at a very uncritical length in this class except principally in terms of steadiness in pitch. The main difference between longer and shorter boats lies in their performance in a seaway. I think this probably answers the question. I did not say that we needed knuckles. What I did say was that on balance they are probably, though not certainly, an improvement. This is a terribly mixed question.

Obviously they give better buoyancy above the waterline and they reduce wetted surface on the skin of the boat to some extent.

They have subsidiary effects in breaking up wave tops, which can affect the floor, though this is not normally important in this class. I really have no firm answer to this question.

The benefit of 3in wide spray rails in deriving dynamic lift by deflecting the racing bow wave is, however, quite marked. I think Mr. Fisk agrees with this from sailing on my first design some years ago both with and without them.

Tacking has been covered already. The weight of the boat obviously comes into it. The ability to trim down by the stern and get the relatively deep narrow chest out of the water, sail-handling techniques and the actual design of the hull form—all these things are very material.

Mr. Murdey talked about the motion in waves and obviously knows much more about it than I do. He asked if intuition led me to mismatch bow and stern. Yes, I suppose partly intuition (which is a derogatory word in this context) and partly empirical observation. I may very well be wrong. I think there are dangers in comparing these boats too closely with merchantmen. These seems to me to be a number of immediately relevant points of difference. One obvious one is that we may have rigs rising 40 ft or more above the waterline and weighing nearly as much as the remainder of the boat without crew—a mast with boom, rigging, sail, battens and the rest may weigh 250 lb. We then get such a high centre of gravity that this alone may invalidate comparison. It seems to me a very confused parallel.

Mr. Murdey also asks about moving the crew outwards in some conditions. This is also a very debatable point, and again I think I hedged my bets severely when writing about it. John Fisk and I first tried it a long time ago when sailing on the west coast of Scotland. We could not entirely make up our minds whether it paid or not.

Some people feel strongly that it can. If it does, it is obviously under critical conditions where the natural period of pitch is too closely matched to the period of incidence, and would be—and in my experience apparently is—of advantage in short waves, if at all.

Mr. Crago regards the buttock lines as being too curved. If one looks closely at the lines it seems to me that the opposite is true and that they are more, not less, curved in fig. 13. It would seem to me largely a question of drafting. If the plane is moved a little further towards the centre, the line becomes straighter and vice versa. Perhaps Mr. Crago's remarks refer more to a wider flatter section.

I have always approached the after body in this class from the point of view of taking the midship section and raising it up, so to speak, to make the transom, keeping the centreline as near straight as is compatible with what seems to me to be a reasonable curve of areas.

With regard to the planing hull, I do not pretend to know the answer but the price one would pay at low speeds for the advantage at high speeds would, I think, be unacceptable, particularly since the crucial phase in racing commonly occurs when the craft are moving relatively slowly.

The answer to the question put by Mr. Wood is in the affirmative. □

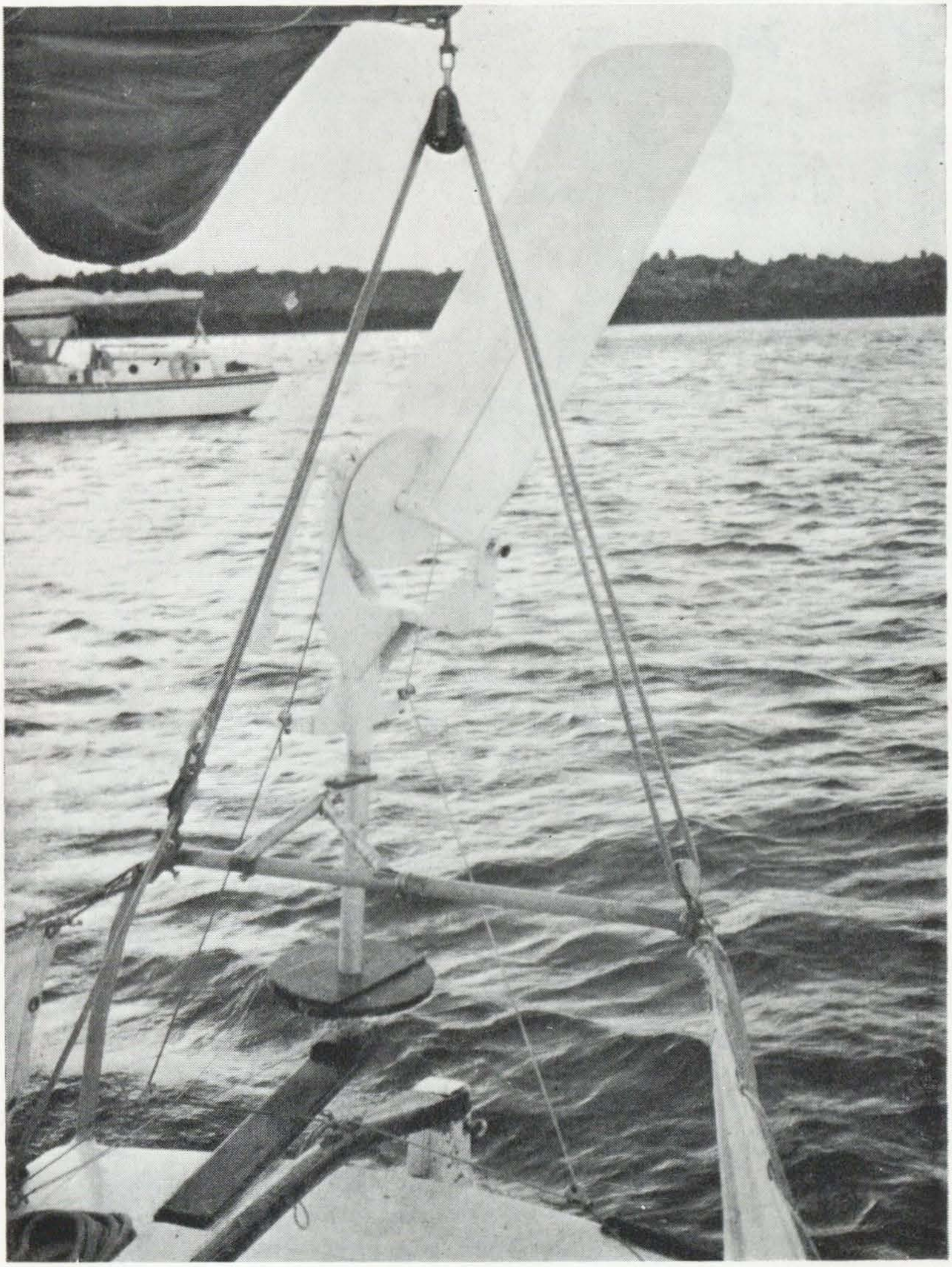
CORRESPONDENCE

Bernard U. Rhodes Yacht *KLIS* of Barrow, poste restante, Papeete, Tahiti
18th October 1968

Dear John,

Many thanks for your last letter.

I enclose a photo of 'FRED V', which I made in the workshops of the Charles Darwin Research Station in the Galapagos Islands. As you see, 'FRED' has a horizontal vane with the axis inclined 10° and he's much the best yet. With a French boy crewing, we made the 3,000 miles from Galapagos



to Marquesas in 20 days, 4 hours—on three occasions running 180 miles a day. The winds were never more than force 5, usually on the quarter. The usual rig was full mainsail and genoa set as a 'weather twin', tacked down by the forehatch and hanked to a jackstay for ease of handling. Thus, with the genoa eased forward of athwartships, when she broached on a wave it pulled harder than the main and helped 'FRED' to put her back on course.

Then we had some days of light beam winds, so we rigged the spare boom as a bowsprit and set the No. 2 jib flying from it, giving us a total of 450 sq ft. She averaged 6½ knots in a force 2 breeze and smooth sea—wonderful sailing. We were not pushing the boat unduly hard. We each slept 8-9 hours every night, occasionally going on deck to put a few rolls in the main if things got uncomfortable.

'FRED' was definitely the hero of the voyage. His design was dictated by facilities available, and it has the snag that for major alterations of course, the tiller-lines have to be re-rove through the blocks. Minimum friction is important and I found it best to have the lines slightly slack.

If I were re-designing *KLIS*, I would install an aft daggerboard through the cockpit floor, to counteract the broaching due to waves and take some of the strain off the rudder.

With reference to the 'drunken servo-pendulum' described in my last letter which I couldn't get to work, next door to me in Papeete now is the Belgium yacht *TIARE*, which has exactly the same idea—and it works fine! The secret is that the servo-blade is made very heavily, so that the whole conraption has a strong tendency to swing upright when deflected sideways—simple.

Congratulations on the publication *Multihull Capsizing*, which I have just received—in particular the poem *I'll get there*—very much to the point! I'll have to try and find a tune that fits it, and make a song out of it.

In debating the possibility of taking *KLIS* 'right around', the toughest spot would seem to be the Cape of Good Hope. Here the current can run strongly against the prevailing winds, building up a nasty sea, which could conceivably roll a Tri' as small as *KLIS*—even if she was lying a-hull.

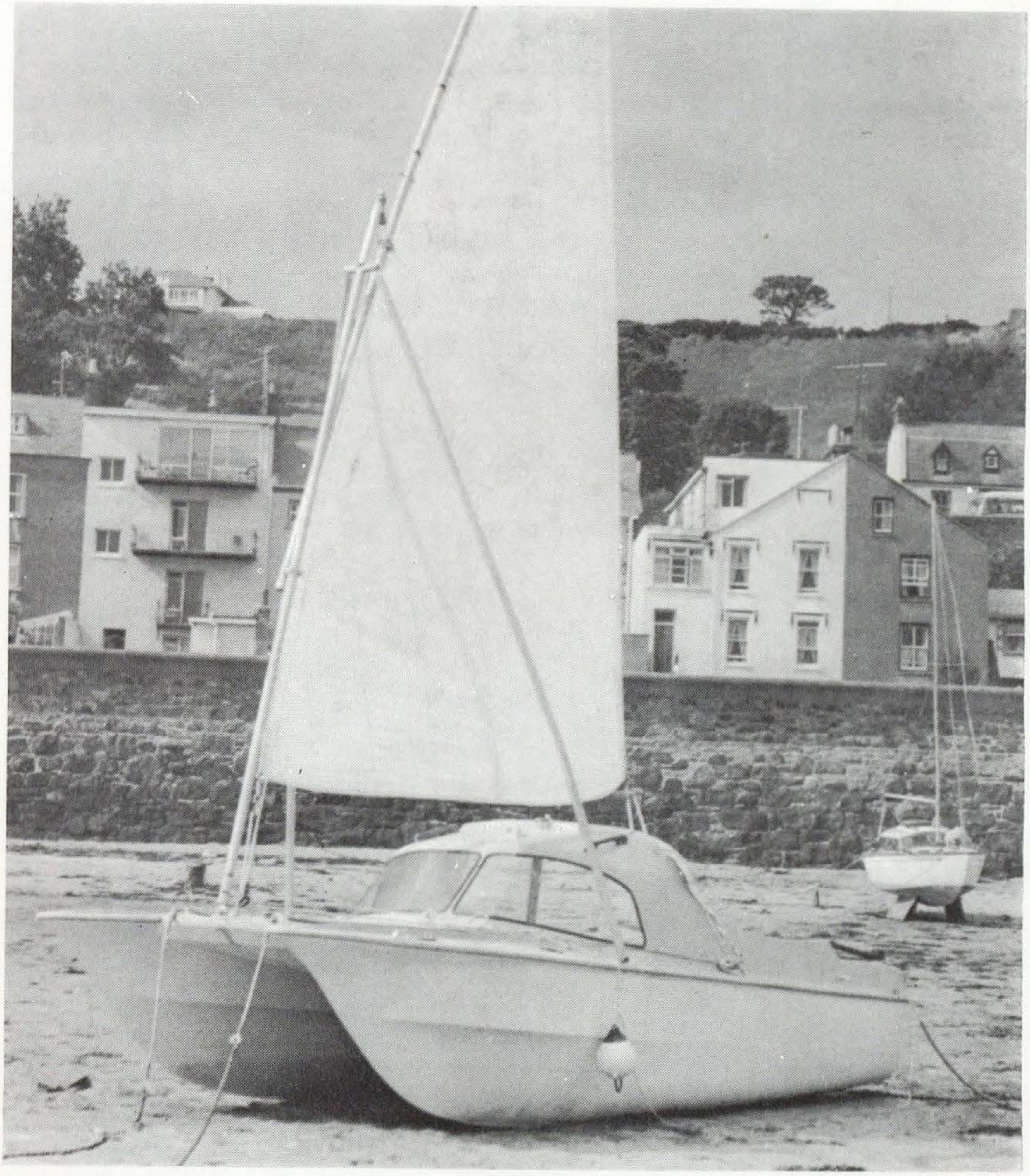
I heard that a Nicol *Clipper* 25 ft Tri' capsized off the Cape recently, running in 50 knots of wind. The skipper hung on for several hours and was finally picked up by a cargo boat and taken to India, losing everything.

I learnt after my bad fright in Biscay to be a-hull in anything over force 8, but this yarn, which I heard second-hand, gave me plenty of food for thought . . .

Before deciding to tackle the Cape in *KLIS*, I would want to turn her-over deliberately in sheltered waters, and try out some of the righting theories profounded in *Multihull Capsizing*. I think one could learn a lot, and I'll let you know if I ever get around to it.

Present plans are to stay in these waters at least 6 months, before island hopping on towards New Zealand.

Best wishes,
Bernard



T. L. E. Lowther Le Vieux Clos, Trinity, Jersey, Channel Islands

Dear John Morwood,
I have recently been experimenting with the twenty foot Daysailer Cat designed by Michael Henderson about five years ago.

Starting with a tripod standing Lug rig, I have modified and shortened the Luff spar in order to find the right balance. The result is very 'Arab Dhow' like indeed. As you say in your letter of Feb. 4th:—There is windage in the tripod, and the boat is obviously not as fast in light airs as the original sloop rig. The difference in sail area, two hundred as opposed to one hundred and seventy three, accounts for some of this, naturally.

However the yardarm is telescopic and no spar is more than fifteen and a half feet long. Useful for putting onto the roof rack of a car, and unrigging single handed.

The sail is loose footed, and can be brailled up, or stopped onto the yard and rehoisted out of the way while under power, or when drinking pink gins in the cockpit in harbour.

I am considering fitting twin bilge keels in lieu of the centre boards.

The tripod and yard are of light alloy, not much more expensive per foot than good stainless steel rigging. Alloy stockists keep thirteen foot lengths, but the fifteen foot six Luff spar has to be specially made, and I am using a crude steel cross piece and extension for the trials.

The sail can be dipped outside the tripod when running, (a bearing out spar is useful here), and the tack can be moved across to the weather bow when reaching.

I understand that Col. 'Blondie' Hasler experimented with a similar rig about ten years ago, previous to his 'Junk rigged *Folkboat*'. It would be interesting to know with what success.

I am not sure if Col. Haslar is a member of the AYRS but you may possibly know his address? I would like to ask him about his Dhow type rig.

Yours sincerely,

Tim Lowther

Robert G. G. Oliver 157 Laan van Nieuwe Oosteinde, Voorburg, z-Holland
6th August 1968

Greetings to our Patron, Presidents, Committee, Organisers and fellow members of AYRS.

Further to our Hon. Secretary, 'Bram Verkerk's correspondence and your welcome assistance, the first Dutch multihull club (Nederlandse Catamaran en Trimaran Club) was formed in January this year. We had three meetings before a 'sail-in' on the 15th and 16th June.

At a members' meeting 20.00 hrs 15th June, when our most active temporary chairman, Hr. P. de Wit, must resign in preparation for going abroad, nominations for the committee included myself. My first question to the members asked for their approval of suggesting to AYRS that we constitute the Nederlandse Catamaran en Trimaran Club as also the Netherlands Branch of AYRS. 100 per cent approval was given.

This letter officially submits the proposal to AYRS.

The AYRS overseas membership list shows some 24 in the Netherlands, not all are cTc members . . . . yet.

May we receive your comments and details of establishing process since my AYRS magazines are depleted by lendings.

Herewith two of the proposals for cTc on which I request your ideas and support, if you think they are good steps towards organizing the first multi-hull club of the Netherlands.

'Can we select a design of one hull as the cTc 'one design' for production of a series? The conjunction of a pair can be varied to plans of a private owner or varied to club-chosen experimental plans.

The 'mold' or 'former' being the property of the club, and being available at our clubhouse. Later it could be on loan/hire to a member or group of members. Sail plans could also be free to all variations with a maximum area well within the capabilities of the configuration.

Members could be invited to contribute to the scheme in 'man-hours' and other ways. The man-hours at £1.3.0 per hour would be cashed as sailing hours of hire of the club owned catamarans. All members would have the right to reserve a certain number of hours at a price-per-hour to be fixed . . . after passing an initial test in seamanship and precautions (compulsory).

Design to be chosen should have a thought for competition within the club and also inter-club, probably the 'A' Class'.

'Club headquarters can be on land or better still a rebuilt barge—or an elderly ship. These latter could be transferred from a summer berth to a winter position more convenient for interested members. It is suggested that two such should be the aim . . . one south and one north. Can a summer berthing at Bruggehof Haven be obtained at a reasonable cost? That water area, with tidal streams plus interesting sections (Biesbos) and a variety of cruising routes, seems to combine most of the desirable features. Just what facilities members would support must be discovered by trial and error, but the nearness to camping and supplies of food would make many weekends possible for a number of members.

For the northerners it has already been suggested that the Ijselmeer at Schardam, Scharwoude, Medenblik, Lemmer or Harderwijk have possibilities to be investigated . . .'

An article in the Nederlandse Waterkampioen (official watersports magazine) describes the capsizing of an *Iroquois*, off Medemblik on the 1st of May '68. After the translation is checked and certified correct I will send it on to the AYRS for comment. A second copy will go to Peter Steward, 63 Burke Rd., Ipswich, who I understand is collating reports of all multihull incidents.

Yours faithfully,

Robert G. G. Oliver

John Fisk 90 Undercliff Gardens, Leigh-on-Sea, Essex

5th June 1968

Dear John,

Following our few notes on your article which I return herewith, I hope my comments will be of some help to you.

Although *QUEST III* appeared to be of the usual Cunningham type I am sure that the underwater sections had been altered a bit. She seemed rather more 'V'd and finer forward, while aft of amidships she was quite close to a semi-circle. In fact she was a bit closer to the *Hell Cat* shape than the previous *Quests*.

I think *LADY H* was using the same masts as before, as I am pretty certain that no new ones were made. A 'Dolphin striker' was added to the main beam.

The net trampoline created more drag although it had the advantage of losing water.

The gear and fittings on *QUEST III* were rather more crude than in previous years and it seemed that the Cunninghams had become obsessed in sailing weight. They used a wire span traveller and a sort of kicking strap or boom vang arrangement in place of the circular 'Railway track' to control mainsail twist. The sole object of this was to save the twenty or thirty pounds of an extra beam. I feel with proper controls their rig would have been more effective but their sails were badly cut and the material appeared inferior.

The canoe stern must lose a little effective length against the transom, although *QUEST III* probably got some back with her straight stem. One advantage of a narrow ended canoe stern boat is that the crew weight can alter the trim much more than in a broad sterned boat. The extra power and weight of the *LADY H* rig requires a more powerful hull to support it and the whole thing seems to be a classical case of 'swings and roundabouts'.

I would have thought that the *Hell Cat* hull was a better high speed shape, whilst *Quest* might be more effective in lighter airs. I am not sure that I agree with you about pitching, as I think in some circumstances the broad stern of a *Hell Cat* hull is picked up by a sea whereas waves seem to pass the *Quest* hull very easily without much disturbance of trim. No doubt in some circumstances the wave frequency will be exactly wrong for each particular hull and will disturb it more than its competitor. Perhaps somewhere between these two hulls will be right.

I can confirm from my own observations that the *Venturer* hull is probably a little slower in very light airs, but as soon as there is a popple on the water or when the wind gets up a little she seems quicker than the previous *Hell Cat* hull. Although it might seem that she would be slower tacking, this is not noticeable in practise.

I would like to see a wing mast tried which would 'flop' into the same curve as the leach of the sail. Even with Austin Farrar rig the leading edge of the whole rig is straight, whilst the leach of the sail remains twisted. The bowed after edge of the mast smoothes out the transition, but there is still twist there.

One point I think you have missed about the centreboard which has been proved in dinghies. If the board angles forward from the vertical any twist or flexing which takes place will put on a positive angle of attack to give lift to windward rather than the opposite if the board slopes back. Experiments have been tried in the dinghy classes and angling the board forward has been shown to work.

I think the boards should be as thin as is possible consistent with strength and flexibility. The name of the Australian 'A' Class catamaran is now *Australis*.

Although *Lowcar* was built in fibre glass she was as light as most of the others (lighter than some) and was a very neat job of moulding. Bob Lostrom and Carcher will be building the *Australis* in America.

It was easy to trim the *Australis* fore and aft with the weight of one man. The fine ends of this boat seemed to penetrate seas easily without slowing down and she carried heavier weights better than most of the other boats.

I think it is fair to say that *TORNADO* was better than any of the other 'B' Class entries, but *MEHITABEL* and *ROTON POINTER* were closely matched. The former won in heavier airs and the latter in light going (*TORNADO* was almost always in front).

I cannot agree that the *Tornado* hull shape is near that of the *Shearwater* although I suppose all catamaran hulls are long and thin. As you know the

Shearwater hull carries semi-circles right through the hull and very close up into the bow. The *Tornado* is very fine and 'V'd forward and even carries a 'V' right to the transom of, I suppose, about 120 degrees.

These comments will come to you uncorrected and I hope they will-make sense.

Yours,
John

Hugo Myers 8011 Yorktown Avenue, Los Angeles, California
31st August 1968

Dear John,
It was a pleasure meeting you in person, and we're pleased you enjoyed your stay here. I just got off a copy of some of my papers to Mr. Richard A. Lee, whom you referred to me.

Enclosed are some articles on the TransPac race and a picture of *SEA BIRD*. I'm sorry we didn't get a chance to get to Costa Mesa to see the new 46 in the wood, but your schedule was too tight, of course.

We are all looking forward to more copies of AYRS publications and the always stimulating comments from Dr. John. You should now be the world's authority on multihull activity around the world.

Looking forward to our paths crossing again.

Best regards,
Hugo

Rudy Choy 2815 Newport Boulevard, Suite 'C', Newport Beach, California
11th September 1968

Extract from a letter to David Gaffyne

Dear David,
. . . I would like to offer some thoughts on the Single-Handed Trans-Atlantic Race.

A limitation should be placed on length overall at both ends of the scale. More waterline length means speed (with other things remaining equal). Otherwise only people with money have a fair chance of winning this race.

Higher design and safety standards, based upon present rules normal for ocean racing, should be imposed on contestants.

If stripped-down machines are to be included in future races, they should race in a separate (open) class. I also believe that there should be not less than three classes: monohull, multihull, and open, with the top prize going to first across (regardless of type) but smaller prizes awarded to the winner of each class. Otherwise the trend to over-specialized boats will lead to freakish development more than genuine advances. Though this is not wrong *per se*, most of the specialized features may offer little to the slower and essentially more conservative design trends that will be significant for normal cruising designs . . . .

Cordially,
Rudy Choy

M. Tennant

G.T.F. INTERNATIONAL CATAMARANS,
P.O. Box 52, Manurewa,
Auckland,
New Zealand
19th November 1968

Dear Mr. Gaffyne,

In Auckland we have twenty seven 'A' Class catamarans, most of which are G.T.F. boats of the Mk. II design. I will try and give you some idea of the type of boat that exists now. If further photographs are wanted I would be able to supply some of these.

Basically the MK II hulls are the same shape but are fuller with more buoyancy forward to cope with the vicious chop that occurs in our harbour. However most of the boats have moulded decks only on the forward section, as far back as the main beam. From there aft the decks are flat. This simplifies the attaching of beams which are rectangular in section, these having been found superior to the round beams of the earlier boats. There is no beam fitted right forward on most of the boats. Net trampoline decks and curved mainsheet tracks are almost universal. Both loose footed and conventional sails are in evidence as are parallel and canted booms. The kicker is taken down to the curved track and the main sheet is taken off a track, usually about 2 ft long, on the aft beam. The masts range from 26 to 30 ft in height, aerofoil masts have been tried, and also pocket luff sails.

Most of the boats are using some version of leeward bending of the mast. This has been found to produce a tremendous increase in performance. This consists of rigging the mast with a high set of shrouds with a set of intermediate left slack or tensioned to leeward with highfield levers. The result is a mast that curves to windward at the top and to leeward in the middle. The only reason for the increase in performance seems to be that the luff and leech of the sail now line up.

Trapezes have been tried on and off over the last three seasons with this season again finding them in favour.

The class seems to be retaining its development flavour here with very little evidence of a trend toward one design in the form of the *Australis*.

If I can be of any further assistance do let me know.

Yours sincerely,

M. TENNANT

SAILING 'YANKEE FLYER'

continued from page 61

side and how could you make the sail belly forward well and put a proper 15°-20° twist in the sail in anything less than a strong breeze? Maybe we'll see a slightly sloping compromise here.

Ice yacht experience helped me in getting to know how to handle *YANKEE* because the noticeable shifts in apparent wind and the radical idea of actually tacking downwind were old hat. It was great sport driving her at 20-25 mph on a reach in a 20 knot breeze with the spray coming back as if out of a firehose. But what can compare with a skeeter peeling off on a real downwind run? □

MULTIHULL TRANS-PACIFIC RACE 1968

J. Stanley

Eight official entries crossed the starting line on the 4th July, the fleet consisting of seven catamarans and one trimaran, all built as ocean racers. The boats, with their respective overall lengths, are listed below in order of corrected placing:

1 *POLYNESIAN CONCEPT* 35ft	5 *GLASS SLIPPER II* 49ft
2 *SEASMOKE* 58ft	6 *IMI LOA* 43ft
3 *LANI KAI* 46ft	7 *AURIGA* 37ft trimaran
4 *MANU IWA* 49ft	— *ILLUSION* 43ft (retired)

One additional catamaran, *SEA BIRD* (AYRS 64, p.57), sailed the course unofficially, she had been considered too unproven by the race committee and was refused official entry.

The start of the race in Los Angeles Harbour is organized by the Seal Beach Yacht Club, and the finish in Hawaii is taken care of by Waikiki Yacht Club. Most of the competitors average a sailing distance of 2,400 nautical miles from start to finish.

Winds averaging 8 knots lasted for three days and so removed any chance of breaking the Trans-Pac Record. The Tradewinds never blew stronger than 20 knots, and then only occasionally, except for a few squalls with 24-knot blasts which were all too brief. Sea conditions were always smooth.

The only true catastrophe of the race occurred shortly after the start when *ILLUSION* was dismasted approaching Catalina Island's West End. Her brand-new wooden mast was either defective or was poorly tuned. About this time the mainsail of *IMI LOA* parted at two low seams; the sail was quickly reefed as a temporary measure. During the night the sail was lowered, and repaired by hand-stitching and contact cement. The following night, both *IMI LOA* and *GLASS SLIPPER II* had their big spinnakers blow out in gusts of a minor squall. Later on, *SEASMOKE* blew out her large spinnaker, but with an electric sewing machine aboard it was repaired in a few hours. Finally, towards the end of the race, *MANU IWA* also blew her big chute.

First to finish, and second on corrected time, was the largest boat in the race, the 58ft *SEASMOKE*, while second to finish and first on corrected time was the smallest boat, 35ft *POLYNESIAN CONCEPT*. Third, on both elapsed and corrected time, was the oldest boat, *LANI KAI*. This unique group are all designs from the well known C/S/K partnership.

SEASMOKE and *POLYNESIAN CONCEPT*

SEASMOKE completed the race in 10 days 9 hours 0 minutes 23 seconds. This reduces by 52 minutes 52 seconds the Multihull Trans-Pacific Race Record of 10 days 9 hours 53 minutes 15 seconds set by *IMI LOA* in 1964. With the light winds of the 1968 race *SEASMOKE* had little chance to beat the official course record of 9 days 13 hours 51 minutes 2 seconds, made by the monohull ketch *TICONDEROGA* in 1965. However *SEASMOKE* has the potential to make an estimated 8 days 10 hours crossing as the following figures help to show. During one rare Tradewind squall, the needle on the speed indicator was pegged against the stop at 30 knots for one minute. For the final hour, to the finishing line, she averaged a steady 20-to-25 knots, with *IMI LOA* 500 miles (2 days) behind. When travelling at a speed of 20 knots, there is no spray on deck!

POLYNESIAN CONCEPT, known as *POLYCON*, finished 29 hours behind *SEASMOKE*. The usual C/S/K/ boats have asymmetrical hulls but *POLYCON*'s are symmetrical.

SEA BIRD

Designed by Hugo Myers, the 44ft *SEA BIRD* is a high-performance experimental catamaran. She crossed the starting line soon after the official fleet

SEASMOKE Photo: Beckner Photo Services

had cleared the area and maintained a second-place position behind *SEASMOKE.* Unofficially *SEA BIRD* finished second, 21 hours behind the new pace-maker *SEASMOKE.*

The first two nights were sailed with a reefed main and jib, because three of the crew of six, were not experienced catamaran helmsmen. Duties were rotated with two men on and four off.

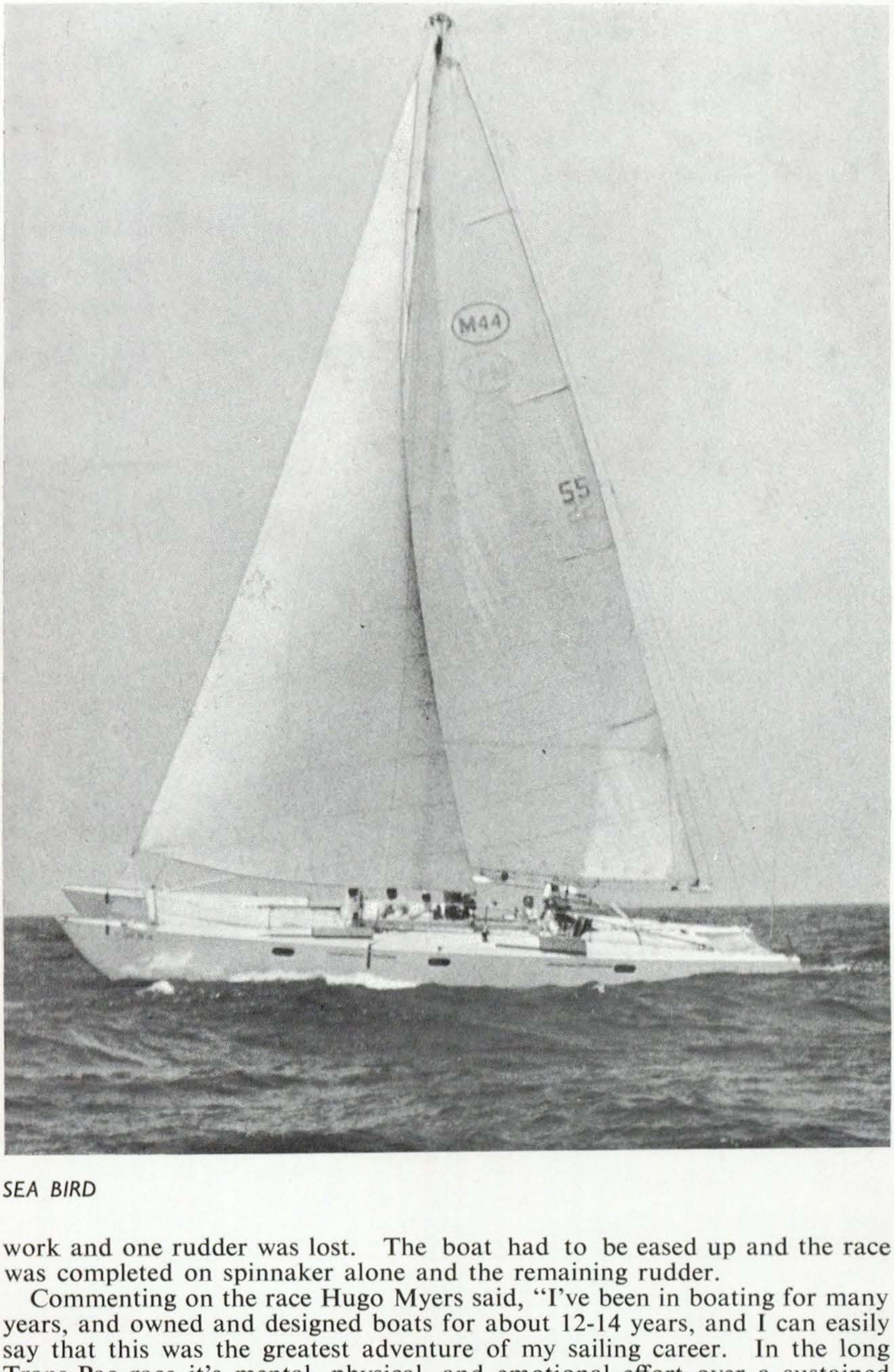
SEA BIRD has no between-hull cabin, the bunks, toilet and galley are all located in the hulls. Her design incorporates a rotating mast and double-luff mainsail to gain maximum windward performance.

During the race she logged two daily runs of 250 miles—good going for a new boat that was being 'de-bugged' as it raced along.

When about 800 miles from the finishing line the rudder posts began to

IMI LOA (left) sailing in company with *POLYCON*

Photo: Beckner Photo Services



SEA BIRD

work and one rudder was lost. The boat had to be eased up and the race was completed on spinnaker alone and the remaining rudder.

Commenting on the race Hugo Myers said, "I've been in boating for many years, and owned and designed boats for about 12-14 years, and I can easily say that this was the greatest adventure of my sailing career. In the long Trans-Pac race it's mental, physical, and emotional effort over a sustained period makes it such a great challenge. It's been many years since I had so many peaks of excitement and depths of depression in the months leading up to and during the race. I'd highly recommend it to anyone to experience the joys and disappointments people used to have when they lived a more physical sort of life." ☐

INTERNATIONAL CATAMARAN CHALLENGE TROPHY

by A. Smith 'Narragansett', Florence Ave., Whitstable

The eighth series of races for this trophy were held during September 1968 at Thorpe Bay, Essex. For the seventh consecutive year, Thorpe Bay Yacht Club, kindly provided the amenities, supporting craft, and organization so vital to this major racing event. Once again the USA were the challengers, this time represented by *YANKEE FLYER*, helmed by Greer Ellis (see page 59), with Bill Hooten of Danbury, Connecticut, as crew. Britain defended with what it probably the most proven 'C' Class boat-and-crew combination in the world—*LADY HELMSMAN* sailed by Reg White and crewed by John Osborne. Seven races were held with one race being declared null and void. Britain retained the trophy by winning four races, against two taken by the US.

Three wing-masted cats contested the US selection trials—*WEATHERCOCK* sailed by Jim Bonney, *SCIMITAR* sailed by Otto Scherer and *YANKEE FLYER* sailed by Greer Ellis. *SCIMITAR* appears to have been out of the running at an early stage leaving the other two boats to confuse the selectors. *WEATHERCOCK* was designed by George Patterson who pioneered the use of wingmasts on 'C' Class cats with his earlier boat *SPRINTER*. Initially *WEATHERCOCK* showed great potential, especially in heavy weather, but unfortunately it soon began to show signs of structural weakness. Built of stressed ply, canoe-bowed and with wide transoms, she was probably the lightest contender. With a very clean rig and able to move through the water without undue disturbance, she was full of promise, but her teething troubles were not going to be solved quickly.

After being beaten several times in light weather, by the obviously light weather boat *YANKEE FLYER*, the selection committee chose the latter for the challenge.

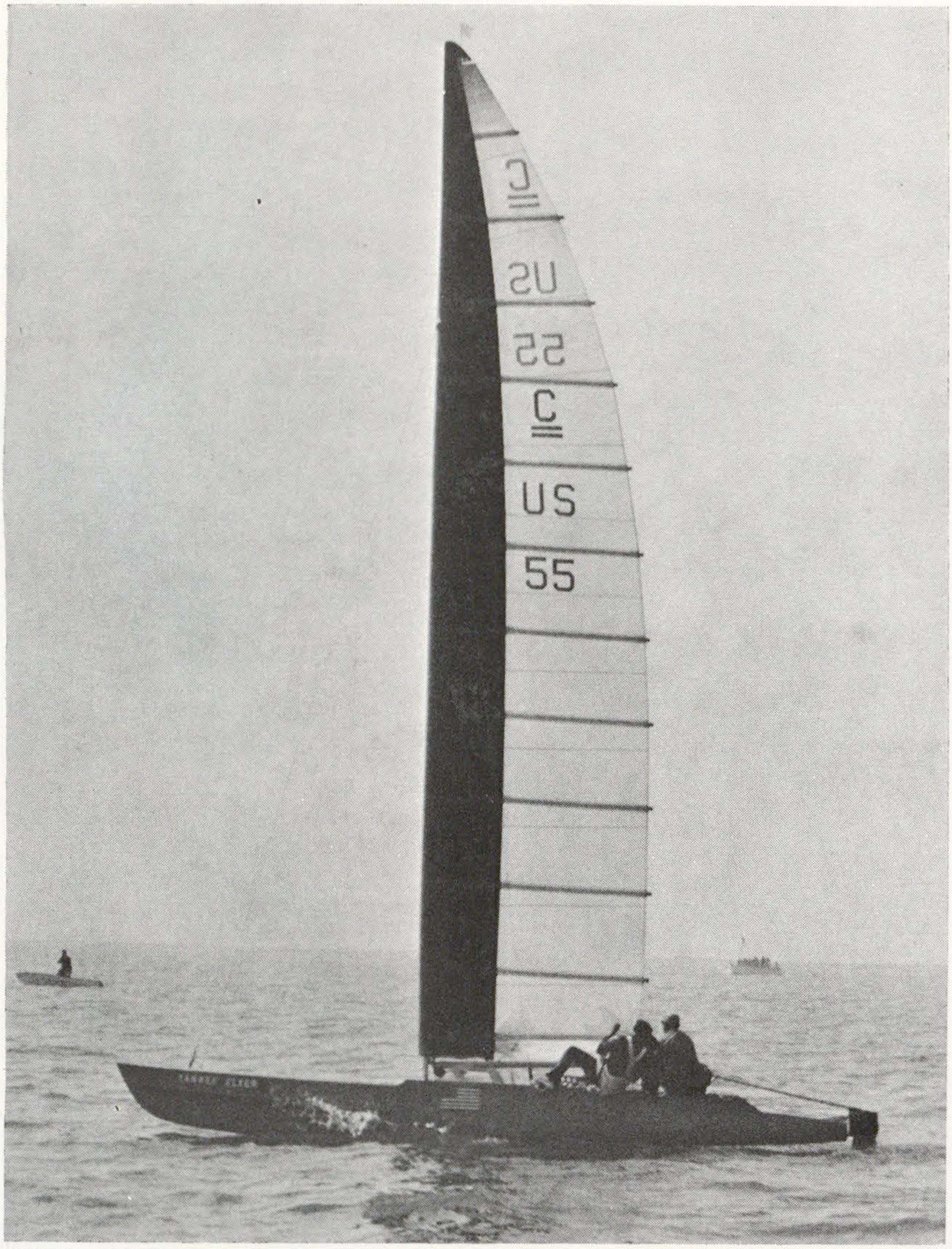
YANKEE FLYER was built from three-year-old GRP *Beverly* hulls, by her owner Edme Deschamps of Stone Harbor, New Jersey. She has a very high aspect ratio rig with the wing mast accounting for some 43 per cent of the 300 sq ft sail area. A 6in aluminium tube runs the full length of the mast, forming both the main support and the leading edge. Attached to this, making the symmetrical aerofoil section, are ribs of expanded polyvinyl chloride. The trailing edge is made of mahogany and the aluminium alloy luff groove is set into it. Top grade mahogany veneer (1/16in thick) was used to skin the mast; its maximum chord measures 41in. The heel of the mast pivots on a jack which is in the form of a tube. This tube slides inside the mast and enables it to be raised or lowered about 3ft to match the weather conditions. To reduce wetted area only one daggerboard was fitted, in the port hull.

The British selection trials were contested by three boats, all with wing masts, *LADY HELMSMAN* sailed by Reg White, *WILLS VENTURER III* sailed by Roy Bacon, and *EARLY BIRD* sailed by her builder and owner Derek Nunn. During part of the trials *WILLS VENTURER III* used one of *LADY HELMSMAN*'s old wing masts, while *LADY HELMSMAN* carried a new and much larger wing mast designed by Austin Farrar. The design and wind tunnel testing of the new mast had been completed by July 1967 but the means to build it were not available until July 1968. This meant a rush job for the firm who built it with the result that it was not able to meet its designed performance. After *LADY HELMSMAN* had been selected to be the defending boat it was decided to abandon the new mast and use the old one.

EARLY BIRD's wing mast was built by Derek Nunn to the same new Austin Farrar design, it was a most beautiful job and much more efficient.

LADY HELMSMAN Photo: Joyce Doughty

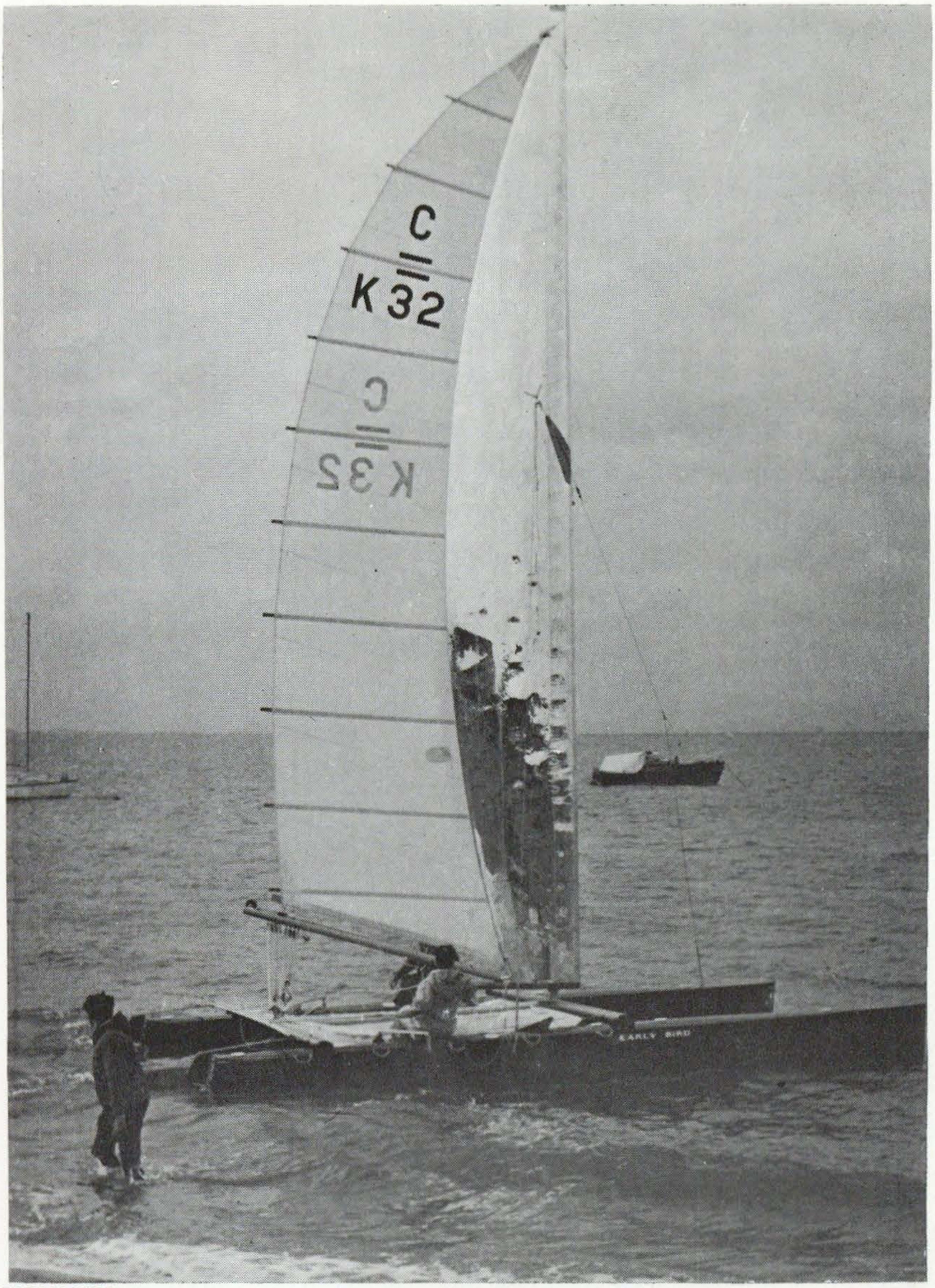
The method of construction used by Derek Nunn differed from that used for *LADY HELMSMAN*'s mast. Basically the mast consisted of a plywood tubular 'main spar' with expanded polyurethane ribs which were then covered with foamed-plastic sheet. An outer skin was then added of very thin heat-reflecting aluminium-faced 'Melanex' plastic. Her hulls were straight stemmed with a semi-circular underwater section amidships. They were constructed by the developed ply method. *EARLY BIRD* never completed a race during the trials due to gear failures, obviously more development time was needed, so for the third year running the honour of defending the trophy went to the now veteran *LADY HELMSMAN*.



YANKEE FLYER

Photo: Joyce Doughty

The results of the challenge races were precisely what could be intelligently anticipated if one leaves out helmsmanship and possible gear failure. With light winds and a calm sea, *YANKEE FLYER* could take full advantage of her high rig and one centreboard, but in anything of a breeze combined with the usual estuary slop, the powerful low rig and clean lines of *LADY HELMSMAN* would prove superior. The latter conditions prevailed and *YANKEE FLYER* suffered from loss of lateral plane when flying a hull on the port tack while the tall heavy mast caused excessive depression of the lee bow. In the fourth race *YANKEE FLYER*'s main beam bent and the rig collapsed. This could have been caused by the impact load of the mast exceeding the compression strength of the beam or by the



EARLY BIRD Photo: Austin Farrar

dolphin striker being knocked out of line by a floating object. An aperture or window in the front of the trampoline would enable the crew to keep a check on this vital support.

Perhaps the time has arrived to assess this 'C' Class event. For the spectator it is useless and participation is severely restricted, only three nations have so far been able to compete. Surely the real value lies in the fact that the 'C' Class cat is the largest, and most sophisticated high-speed sailing boat, economically, that can be used for development and research. If the rules could be amended to allow three nations to challenge at a time, the feedback must be, more interest shown and increased knowledge. □

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