RETIREMENT YACHTS AND POLARS

A.Y.R.S. PUBLICATION No. 70

KINNEGOE on Lough Erne—Note bent mast

CONTENTS

THE AMATEUR YACHT RESEARCH SOCIETY

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

Editor and publisher:

John Morwood, Woodacres, Hythe, Kent, England.

EDITORIAL

November, 1969

The Annual Subscription is now due

The subscription is £2 or $5.00 American or Australian. It should be sent to Woodacres, Hythe, Kent, England. However, French and New Zealand members can either subscribe to their 'National Organisers' or to us, as they wish. If subscriptions are not paid by January, 1970, No. 71 will not be sent out.

Bankers Orders are enclosed for the convenience of members.

If anyone has had a misbound or faulty copy of a publication, will he please let us know. Publication No. 69 has been delayed but will be sent shortly.

Editorial help

I regret that I no longer find that I can assemble and edit all four publications each year. I have, however, brought all the articles which I have accumulated into some sort of a classification and can now give maximum help to anyone who is willing to edit them. If anyone feels that he would like to edit a publication on one of our subjects, would he please write in. Alternatively, he can pick any subject he likes.

I suggest that all people who would like to do this interesting but rather difficult job might like to meet in London and we would work out a method of operation between us.

The 'AYRSFOIL' flying hydrofoil class

Seven sets of plans for Don Nigg's flying hydrofoil boat have now been received by members. When one or more of these have been built and seen to work, we expect that others will want to build them, too. Remembering back to the days when the Prouts and the AYRS were trying to get the catamaran going, we don't expect the flying hydrofoil to take on very quickly. If we can get a racing fleet going by 1975, we will be well pleased.

Winter meetings 1969-70

Local sections will be circulated separately about these.

AYRS ties and windsocks

AYRS ties with a single device cost $3.00 or £1-1-0 each. Dinghy sized windsocks are 5½ in long and cost $2.00 or 14/-. The Cruiser sized windsocks are 16 in long and cost $4.00 or 28/-. The windsocks are lettered with AYRS on each side.

Our book on self steering

The hard backed edition costs $4.00 or 22/6.

Advertisements

A full page advertisement in our publications costs £12 or $40.00 for an inside page and £20 or $60.00 for a back page (only for regular advertisers). These low prices only just cover the cost and matter for them is only accepted at the discretion of the Editor and must be in our hands at least two months before publication is due.

Near complete sets of publications

The following members are missing the publications noted.

No. 21 *Ocean Cruising*. Oran L. Marksbury, 2273 Colgate Drive, Costa Mesa, California 92626. Willing to trade a year's AYRS membership in return.

No. 39 *Trimarans* 1961. Juan Baader, 14 Lydia Ave., Birkenhead, Auckland 10, New Zealand.

Nos. 00, 00, 00, 00, 00. Sam Catt, Maxstoke, The Oval, Dymchurch, Kent. The loss of these was my fault. My own set is not complete, and I suggested to a wanderer that he borrow the missing ones from Sam to copy, photographically. Alas, he didn't return them.

Nos. 21, 22, 23, 28, 29, 39. John Leach, 104 Montgomery Rd., Ipswich, Suffolk.

Publications being prepared

Ruth Evans is still working on the *Constructional Methods* publication. Anyone with relevant information on this subject can send it to her at: 82 Campden Hill Towers, Nottinghill Gate, London, W.11.

Dudley Soulsby is working on the next *Catamarans* publication. His address is 24 Lambourne Gardens, Furace Green, Crawley, Sussex.

Paper of interest

1 Lennart Apelstrand suggests: *The Aerodynamics of Sails* by Prof. J. H. Milgram, 7th Symposium of Naval Hydrodynamics, Rome, August 25-30, 1968.

2 University of Southampton *The Induced Drag of a Yacht's Hull* available on loan from Woodacres. Members thinking about keel and centreboard shapes will find this paper of interest.

RETIREMENTS YACHTS AND POLAR

Edited by John Morwood Woodacres, Hythe, Kent

This publication has given me enormous fun to assemble, both for personal and for AYRS reasons. Personally, I had quite forgotten the great pleasure which owning a boat and working on it gives one. I had also forgotten the sense of accomplishment which a cruise to unfamiliar waters produces and the feeling of intimacy with the countryside, people and historical buildings which only this kind of voyage produces. I hope that the account of our trip in *KINNEGOE*, has captured the pleasure we got from it.

The Retirement Yacht

I feel rather a cheat in heading this article 'by John Morwood'. Of course, very few of the ideas are, in fact, my own. I have been sitting here for 14 years getting all kinds of ideas in from members and have been storing up a file of those which apply to the kind of boat I want in my own mind. I have merely stated the accumulation of ideas in this article. Even if the resulting boat does not suit anyone else's wants, the method of selection will be of value.

Perhaps one idea in the retirement yacht article is my own. That is, the *warming* of a boat by a refrigerator. As Gerald Holtom points out: "Only an Irishman would think of that one."

Polars

Apart from the 'fun' articles, the main interest in this issue is the polar curve of yacht performance. Our figure-taking sheet for members will, we hope, spark off our members, who have that kind of personality, to take the sailing performance of their boats. It is not a difficult matter once the figures wanted are known. The figures can all be taken if one has a compass, a speedometer and an anomometer.

Yacht calculations

By thinking over the yachting theory, both Harry Morss and Edmond Bruce have produced ideas which will increase our understanding of sailing. Perhaps there are even more 'discoveries' to be made arising from 'The Course Theorem'. Perhaps the most fruitful line of thought would be to divide the sailing performance into hull and sail polars and then work out methods of re-combining them into the total boat performance.

Centreboards and keels

The article by Leonard Tiemann seems very useful in the understanding of centreboard and keel shapes. By using supersonic aircraft theory, which we think may be more analagous to hydrodynamics than is aerodynamics, he indicates that centreboards and keels make surface waves *even if they have no thickness*. This probably explains Edmond Bruce's finding of the value of aspect ratio of 1 : 1 for a hydrofoil being the best. Higher aspect ratios make more 'Surface fuss'. I once made a balsa wood model 2 ft long by 3 in wide and ballasted it with the blade of a *Chopper* which was 8 in long, $\frac{1}{4}$ in thick and $2\frac{1}{2}$ in across and of a rectangular shape. When set vertically, this blade produced a wave amidships about 1 in high, when the model was towed fast.

Other articles

There are lots of other articles which members will find of interest. One never can tell when a fact from one of these will take root and become vital to some future proposition.

Dave Keiper's hydrofoil

Dave continues to fly his hydrofoil in San Francisco Bay. Apparently, it can 'fly' with as many as nine people aboard and can cope with steep waves and rough conditions. *WILLIWAW* can sail faster than the wind and also, Dave claims, faster than a 'C' Class catamaran. He has had the experience of having the sail flapping to windward while 'gybing' because he was exceeding the windspeed. When one remembers that *WILLIWAW* has bunks and cruising accommodation, Dave really has something. Surely, *WILLIWAW* should be the yacht of the future and other people should be making boats along the same principles. We exhort them to do this.

Actually, Dave's letters have quite upset me in my thoughts about hydrofoils and my 'Retirement Yacht'. I feel that she should be built very light in weight and 'Fly', rather than be merely stabilised by her foils.

ANTILLES RACE

This is a preliminary announcement of a proposed two-man multi-stage race to be run in May 1970 under rules similar to the two-man round Britain race, which will take place later the same year.

The St. Croix Yacht Club will sponsor the event and handle starting and finishing arrangements off Christiansted, St. Croix, U.S. Virgin Islands. Other clubs at other stops along the way will handle local arrangements.

Any seaworthy craft manned by two persons will be eligible. There will be a small entrance fee and prizes will be given for first and second place, as well as a small prize for each leg of the course.

The entrant's time will be taken for each leg of the course and added to determine the overall winner.

Course: The First leg; Christiansted, St. Croix to Gustavia, St. Barths.—105 miles.

Second leg; Gustavia, St. Barths. to Ft. de France, Martinique—225 miles.

Third leg; Ft. de France, Martinique to Bridgetown, Barbados—128 miles.

Fourth leg; Bridgetown, Barbados to Christiansted, St. Croix—445 miles.

Each start will be 72 hours after the first start to allow time for a party and visit ashore at each island.

The lesser Antilles have some of the world's finest sailing waters. We hope to share them with competitors from all over the world in the area's first major ocean race.

Dick Newick, Race Committee Chairman,
Box 159,
Christiansted, St. Croix,
U.S. Virgin Islands 00820.

CORRESPONDENCE COURSE IN YACHT DESIGN

A correspondence course in yacht design, a monthly newsletter and an annual design seminar are three of the programmes announced by the newly-formed Yacht Design Institute. Founders of YDI are Edward S. Brewer, Naval Architect, and Jim Betts, founder and president of International Amateur Boat Building Society.

The home-study design course will consist of 24 lessons covering a wide range of subjects from development of basic yacht lines to racing measurements. Modern design and materials will be emphasized with coverage of fibreglass, metal, wood and ferro-cement and multihulls as well as conventional designs for sail and power boats.

A unique aspect of the school will be a programme of special studies in multihull design headed by Norman A. Cross, Naval Architect. Every student will receive one lesson in catamaran and trimaran design and those who wish to go further into this area will take a 'minor' course of four additional lessons.

Among the exclusive features of the YDI course are the furnishing of over $50 worth of text books plus the 24 printed lessons, discounts on drawing tools, 12 sets of boat blueprints for student study, a fibreglass experimentation kit to teach the student to work and design in this material, an 'internship' programme allowing a student to study with Ted Brewer at his design studio, school blueprint service, tank testing of student designs, a post-graduate programme of study available to graduates and a programme of promotion of student plans for sale to commercial and amateur boat builders.

Students pay and study at their own pace. As each lesson is completed, a test paper is returned to the school with payment for the next lesson. There is no set schedule, but the school says the course consists of about 2,000 hours of study and work and should take from nine months to two years for completion. Each graduate receives a certificate. The student will actually design six boats during the course.

For the yachtsman who wants to learn more about design and performance, but who has no desire to enter the design profession, there is an 'audit' programme where the student receives the study material, but does not return test papers and does not receive a certificate.

YDI also publishes a monthly newsletter called *Yacht Design News* which is sent free to design students and is available to non-students for $10 a year.

A three-day yacht design seminar will be sponsored by YDI January 23-25, 1970 in New York during the boat show. One day will consist of guided tours of the show with special presentations for YDI students at various exhibits and a critique by the school staff. Another day will be devoted to student work on actual designs under supervision and the third day, open to the public, will consist of presentations by designers and suppliers.

Brewer and Betts are co-authors of the recently published book *Understanding Boat Design*, which will serve as an introductory test for the school.

Ted Brewer has been designing for 12 years and is well known for his successful racing and cruising sailboats and comfortable motor cruisers. He has worked on 5.5 Metre Olympic winners, America's Cup defenders and his designs have won many cruising prizes. His excellent record and his universal style make him uniquely suited to be the academic 'dean' of the YDI school. He will personally grade each test paper and give necessary comments on the work of each student.

Jim Betts has been sailing and racing for years and is founder and president of the International Amateur Boat Building Society and editor of its magazine, *Amateur Boat Building*. He is also something of an amateur designer and recently completed a 16-ft fibreglass sloop for the Society. He is presently working on a 37 ft ketch for his own building and use. Betts is a public relations consultant and is author of *The Restaurant Casebook of Public Relations*. He will function as the school's administrator, handling day to day details and will edit *Yacht Design News*.

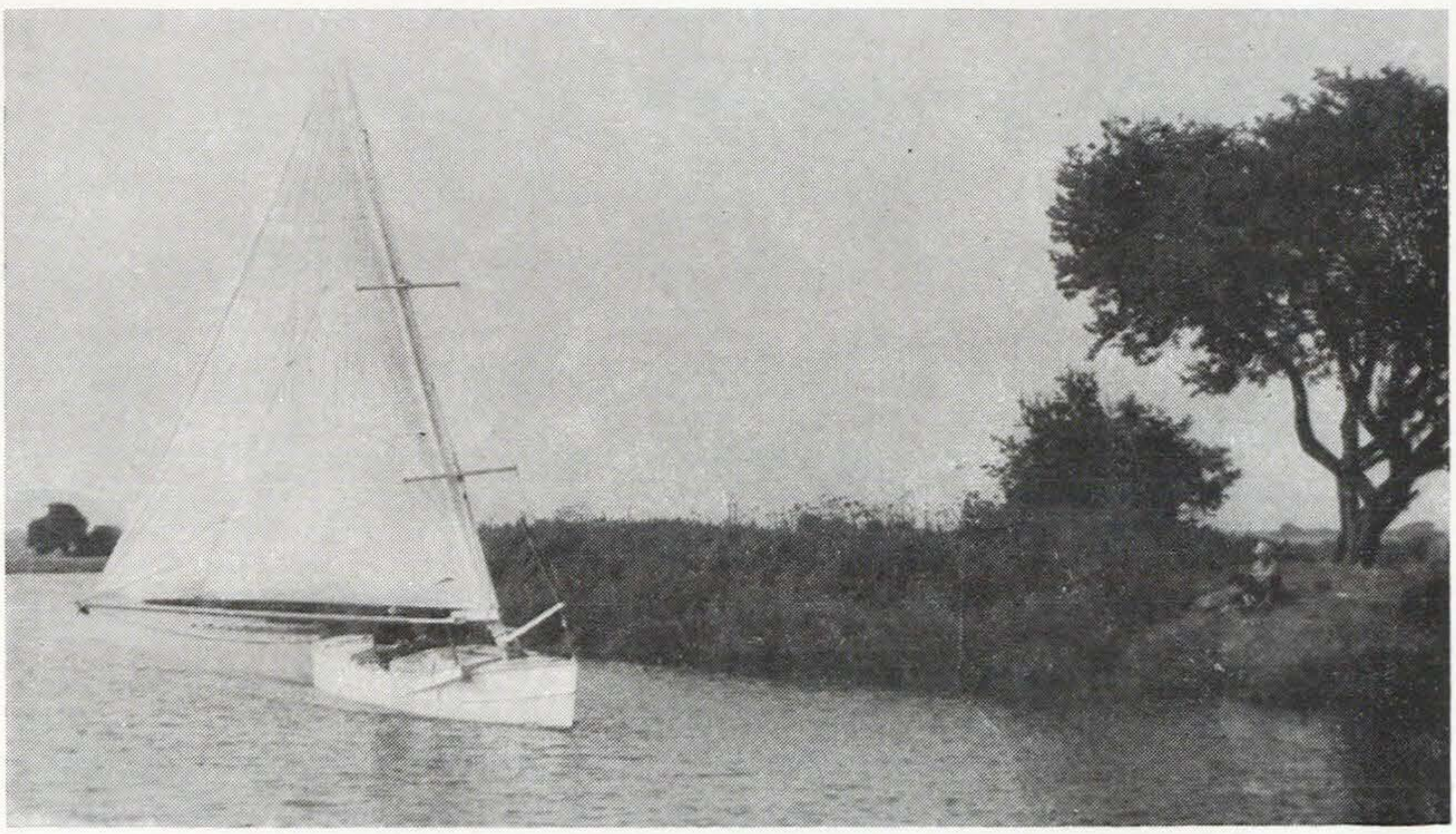
YDI has an attractive eight-page booklet which outlines the school's programme in detail. The complete course is being offered at a special introductory price of $325, payable in small installments with each lesson.

For further information write Yacht Design Institute, 111 Woodcrest Ave., White Plains, N.Y. 10604.

KINNEGOE IN IRELAND
or
A Holiday with a "GREMLIN" (or LEPRECHAUN)

by John Morwood

When I was 16, I designed *JEHU*, a cruising-sailing canoe, 21 ft overall with 4 ft beam. I then built her at a cost of £8—but that was a long time ago. She gave us lots of fun and we cruised many miles in her, sleeping aboard.



KINNEGOE running

KINNEGOE running towards Plucks Gutter

Based on *JEHU*'s design and 36 years of yachting study and experience, I designed *KINNEGOE* in 1967 as an 'Inland Waterways Cruiser'. Derek Kelsall built her for me in plywood, though I often felt that neither he, nor his foreman, thought she would be much good. The materials used in her cost some £120.

KINNEGOE's dimensions are as follows:—

LOA	25 ft	Sail area	150 sq ft
LWL	22 ft	Mast length	22 ft
Beam	4 ft	Weight	300 lb
Beam (WL)	3 ft 6 in	Designed displacement	800 lb
Draft (hull)	3 in	Water ballast (9 Jerrycans)	180 lb
Total draft	9 in	Keel: 8 ft fore and aft, 6 in deep	

Design principles

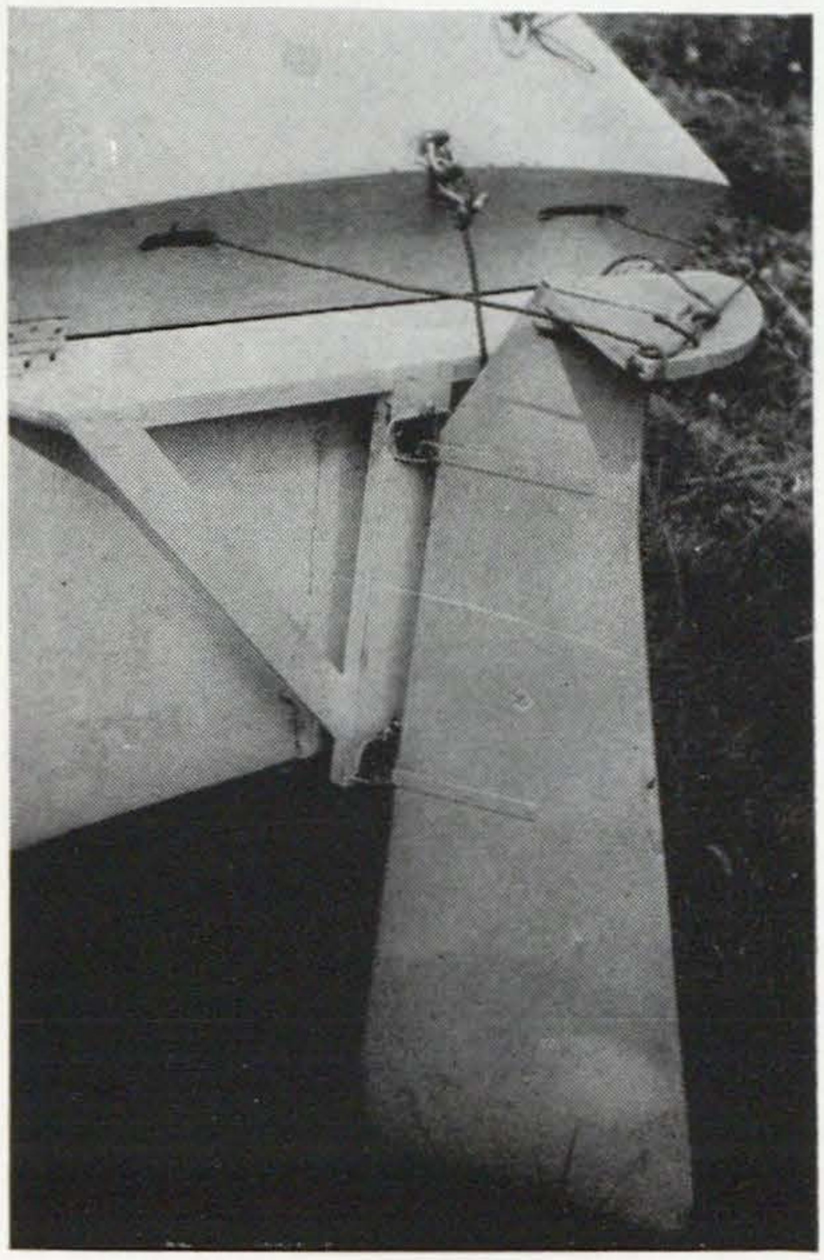
KINNEGOE is designed strictly for the accommodation. She has a central cockpit 5 ft long. Just aft of this, but under the aft deck, one foot of length has the food store, stove etc. Fore and aft of the cockpit and store are two 6 ft 6 in berths (on the floor). All this adds up to 19 ft and the remaining 6 ft are where the boat is contracted to the bow, giving a fore cuddy where we stowed a folding bicycle.

The boat when sailing has only 2 ft of depth. But, when drawn up for the night, the fore and aft decks can be raised to give 5 ft of headroom, plywood panels being put in at the sides. Three wooden bars bridge the raised decks above the cockpit, giving 6 ft of headroom there and, when canvas is put over them (actually we used balloon fabric) there is amazingly roomy accommodation.

The 'Master section' has a flat floor 3 ft wide. Double chines on each side increase the beam to 4 ft, the piece between the chines being angled at 45°. The topsides are vertical. The wetted edge of this section is of about the same length as that of the two hulls of a *SHEARWATER* catamaran.

There are no frames as such. Five watertight bulkheads and the transom fulfil this function and longitudinal stringers (and rubbing strakes) give the strength and shape to the boat.

I had wanted a lifting rudder but somehow the boat was built with a fixed one. When the inevitable happened and the transom was half torn out, I



The rudder and "gallows"

built a 'gallows' affair attached to the top of the transom by two hinges and held down with shockcord. The rudder was then hung on this and it has worked well.

Summary of *KINNEGOE's* design

Though the main emphasis in the design is accommodation and low cost, the result is a 'Rowing-sailing boat', rather like the 'Deal Galley' of 150 years ago which was celebrated for its ability to withstand rough weather. She rows easily and sails in the lightest of winds. People are amazed by her lack of beam but, with her flat floor, she is immensely stable when the top chine is immersed, though the first 5° of heel occur quickly.

The rig

The trouble in belonging to the AYRS is that one is continually being bombarded with new ideas which one wants to try. My original plans of *KINNEGOE* included hydrofoil stabilisers which would only have been suited to open water. Having decided to sail in inland waters, these could not be used. In their place, I decided to have the best rig theoretically possible by avoiding the known faults of the conventional rig. These are as follows:—

1 Sail twist.
2 Mast interference at the luff.
3 Triangular plan form.
4 Straight or concave luffs to the sail or sails.
5 'Sweepforward' of the mainsail. 'Sweepback' of the jib.
6 The boom eddy.

Using a 'pocket luff' sail and a revolving plank mast, bending with the concavity to windward, as suggested by General Parham, the mast interference, sail twist and straight leading edge were abolished. Sloping the mast aft gives a vertical 'aerodynamic axis' with no 'Sweepforward'. The sail thus did away with all the usual faults except the boom eddy which I plan to conquer in future by building up the cabin top in a curve to meet the foot of the close-hauled sail. This sail might be loose footed or have a 'wishbone boom'.

The mast

This is a pine plank 22 ft long and 6 in by $1\frac{1}{4}$ in in section. At the fore edge of the lower end is a rudder pintle which fits into a hole in a steel bar which

KINNEGOE's vital parts

can revolve on a side to side axis. This allows the mast to be raised and lowered, and to revolve. In fact, the pin was not seated strongly enough and the whole fitting had to be strengthened, while the hole in the steel bar had to be widened to let the mast bend.

The boom

We use a 12 ft length of plastic drainpipe of 3 in in diameter for the boom. It is, of course, far too bendy but a 3 in by $\frac{1}{2}$ in plank and two $1\frac{1}{4}$ by $\frac{1}{2}$ in strips inside it, make it stable.

In order to get the best airflow on the lee side of the sail, the mast must be turned more than the boom. The boom is therefore in two pieces, the main length and a short piece at the mast, which it embraces. Ten inches aft of the mast, the two parts are joined by a vertical bolt which allows them to be angled to each other. Aft of the bolt, I left a length of wood on the fore piece and a line from its end to the boom stopped the angle from becoming too great. It was this bit of wood which caught on the stay on our trip and brought the mast down.

Preparations for the trip

We had been sailing the boat from Plucks Gutter on the Kentish river Stour all winter. We sailed her to Grove Ferry and pulled her out with my Reliant three wheeled car (598 cc) and towed her home for repainting and general tidying up. We also had to move the keel 2 ft forward.

Gerald and I working on *KINNEGOE* at Woodacres

Moving the keel proved a difficult job but my friend and AYRS member, Gerald Holtom most kindly came to our rescue and spent hours doing jobs which would have been quite beyond me. It was this timely help which made our Irish trip possible.

THE IRISH TRIP

The original reason for taking *KINNEGOE* to Ireland was the Guiness award of a silver harp and a case of Harp Lager beer for any non-Irish boat which sailed through the Grand Canal from Dublin to the river Shannon.

Never having won a cup or prize of any sort in my life, I though it would be nice to have the harp on the mantlepiece.

The trip, too, appealed to me. I am not built like Chichester, Rose or Knox-Johnson, willing to sail around the world. If I sail West of England,

Slipping *KINNEGOE* at Grove Ferry

I prefer to be carefully surrounded by land. The Grand Canal suited the bill excellently. However, I had asked my friend Roger McElligott to come with me and, as he was going over to a 'Hooley' at his ancestral home in Ballymacelligot in Co. Kerry, he agreed to look at the Grand Canal on his way.

The trouble with the Irish is that they never forget. Roger McElligott commanded the Irish garrison when Cork was besieged by the English in 1690 and has suffered from Claustrophobia ever since. The narrow ribbon of the Grand Canal seemed far too restricted for Roger and he said that, if we wanted to sail it, we would have to have an outboard engine. He was not keen either to row or tow the boat, if the wind was not favourable.

Now, I detest outboards. They are noisy, smelly things which won't work for me and have a strong liking for vertical travel to the bottom. We had thus come to an impasse but solved it by agreeing to sail down the river Shannon, starting from its tributary, the Boyle, near the town of the same name.

The road trip to Boyle

Pat, my wife, and I have been married for nearly 30 years. In this time, I had noticed that she had a bit of a devil in her at times, but I had no idea that she had such supernatural powers over her demons. It now appears that she is an accomplished sorceress because she put a nasty little 'Gremlin' in our frying pan. Mind you, though unpleasant and causing us a lot of trouble, this Gremlin was typically from my wife, mischievous and annoying but not actually doing us any harm.

KINNEGOE and my "Motorised Trimaran"

The story of the Gremlin started last Christmas when my daughter Maureen gave me a kettle and frying pan for the boat. These were put in a room which had accumulated so much junk that we couldn't get to the back of it. Suddenly finding that we had some rodents in the room, Pat got the local 'Rodent Operator' to put down some stuff and soon, from the smell, we we realised that it had 'operated'. Massive clearing of furniture then revealed a dead rat in the frying pan. The exact nature of the spell used must remain secret because Pat denies any knowledge of the matter (as all good witches must) but the end result of it all was that we were landed with a Gremlin, though we didn't know it at the time.

We had booked a passage to Dublin from Liverpool on a boat leaving at 11.45 p.m. so, on the appointed day, we loaded up the car with all our gear, including the frying pan (and Gremlin) and set off down the drive. We had only got to the main road when our 'friend' got to work and destroyed the car's clutch. We had decided to use Roger's car because we thought my little three wheeler was a bit weak for such a long tow. I naturally assumed that it was one of Roger's private Gremlins and thought no more about it.

We sadly got the boat towed back up the drive and took the car to a garage for a new clutch. Then, we changed the booking for two days later and consoled ourselves as best we could.

Two days later, we started out again for Liverpool. The car ran well, the boat towed like a dream, its beam of 4 ft and shallow keel being mainly responsible. We slowly increased our speed to 50 miles per hour and were all set for a pleasant drive of some 275 miles.

Taking *KINNEGOE* home from Grove Ferry

But we reckoned without our Gremlin who, on the outskirts of London, struck again. This time, the welding of the bottom of the towing bracket broke. We towed carefully to a garage where the towing bar was altered to make it possible to tow, even though it didn't look too strong—an Irish mechanic later said "It looks a bit delicate." This job took four hours and once more we set off.

But our Gremlin was not going to let us off yet. He suddenly materialised about a dozen policemen alongside us. They waved us into the curb. A great big red-haired sergeant, with the face of a prizefighter, came up. Perhaps the Gremlin had slipped into him at that moment because he looked extremely formidable. Our hearts sank.

"What weight is your trailer?" he said.

"I don't know" said I, acting the 'innocent'.

"It hasn't got brakes" said he, "Do you know at what weight a trailer has to have brakes?"

"Six hundredweight". It seemed a good figure to say. I had no idea, of course.

"Two hundredweight" said he, sticking out his lower jaw, complete with ginger stubble.

"Oh dear me" said I, "I knew there was a certain weight but the chap who sold me the trailer said it was all right."

"It's a pity you didn't go to the 'fountain head' of the local police. They would have told you." He then opened a little book where it clearly said ". . . 2 cwt . . ."

"Of course, I know that ignorance is no defence in law." I felt that waving a flag of some legal knowledge might have a good effect. It seemed to work for he said:

"I'm not going to summon you but you must realise that you are breaking the law."

"Thank you very much indeed" said I, trying to look humble in the midst of my delight. His final shot was:

"It's a wonder my Kent colleagues didn't pick you up."

I suppose, by this time, the Gremlin was fed up with his game and retired to the frying pan. All the police got into their van and onto their motor cycles and disappeared into space. Roger and I sighed heavily and wondered if we would ever get to Liverpool, let alone Ireland. But we had to put on 'The Act' and we set off again to drive through London.

London was not too bad. Stopping and starting, diversions and traffic were all accomplished until at last we came to the M1 motorway. A quick inspection showed that our 43 ft of car and boat appeared intact and well secured and off we set at 50, then 60 miles per hour.

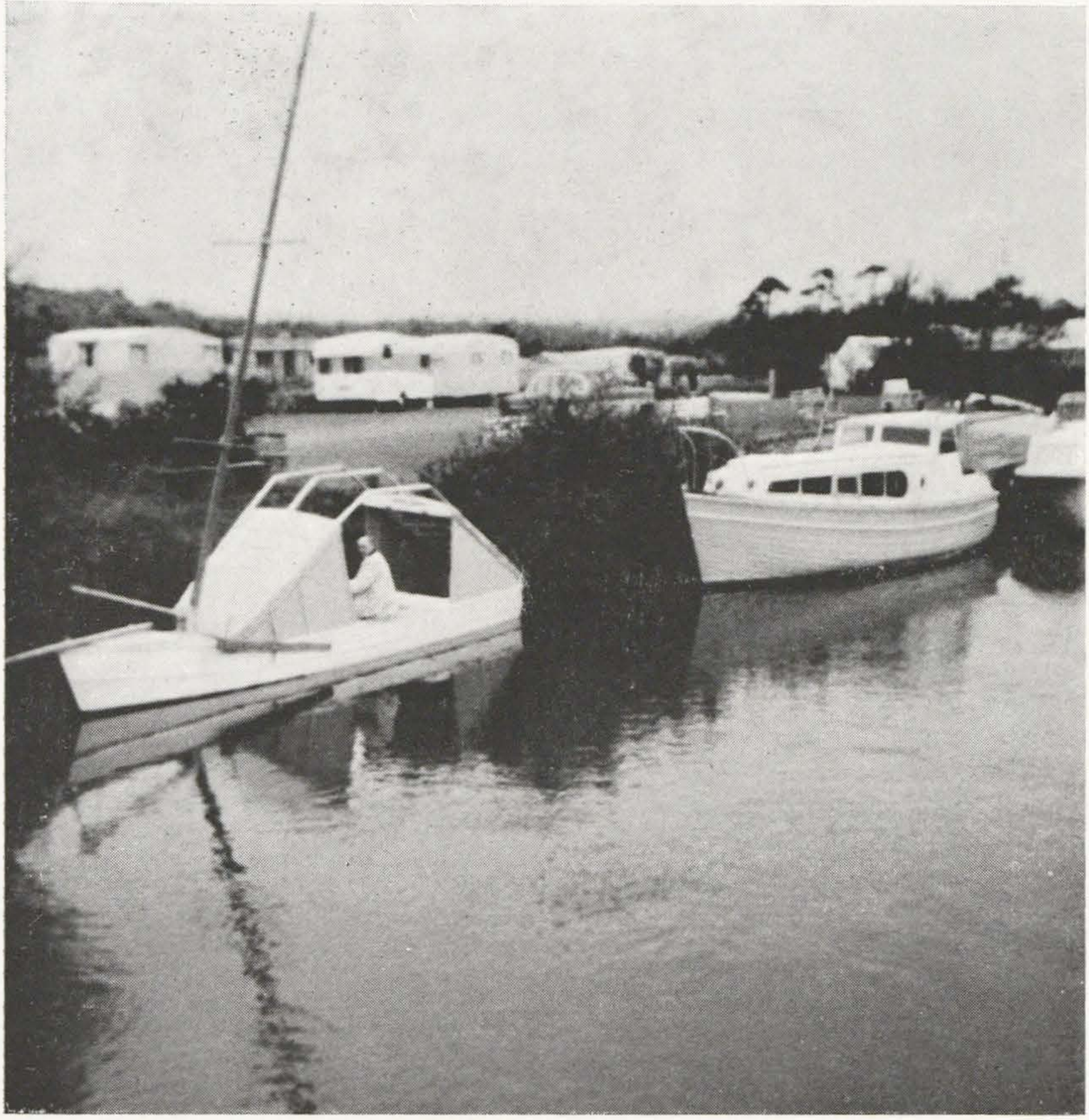
We wrapped up the M 1; slipped across to the M 6 by the A 5; wrapped up the M 6 and got to the Liverpool Docks with a whole 15 minutes to spare.

The Irish Sea crossing caused no bother; nor did the trip to Boyle from Dublin of about 100 miles along the Sligo road. There are so few people in Ireland these days that the roads are almost empty of cars, and while traffic police may exist, we certainly didn't see any.

Boyle

We launched *KINNEGOE* about 400 yards from where the Boyle river runs into Lough Key and tied her up to a grass bank, near a quay. We erected the mast, put up the cabins and tent and got all our gear aboard, including the frying pan. We were tired by this time and did not stow things properly, merely putting them in the cockpit. Nor did we fill the water cans. Roger had decided to spend the night in an hotel in Boyle for general convenience but I blew up my inflatable mattress and got my sleeping bag ready for bed.

Roger and I then went to his hotel and learned a bit of the local history and geography from a rather pleasant chap in the bar. Apparently, he was a McDermott and the ruins of the McDermott castle are on one of the islands in Lough Key. In Boyle itself, there are some excellently preserved remains of a Cistercian Abbey with an underground tunnel down to the Lough, about a mile away.

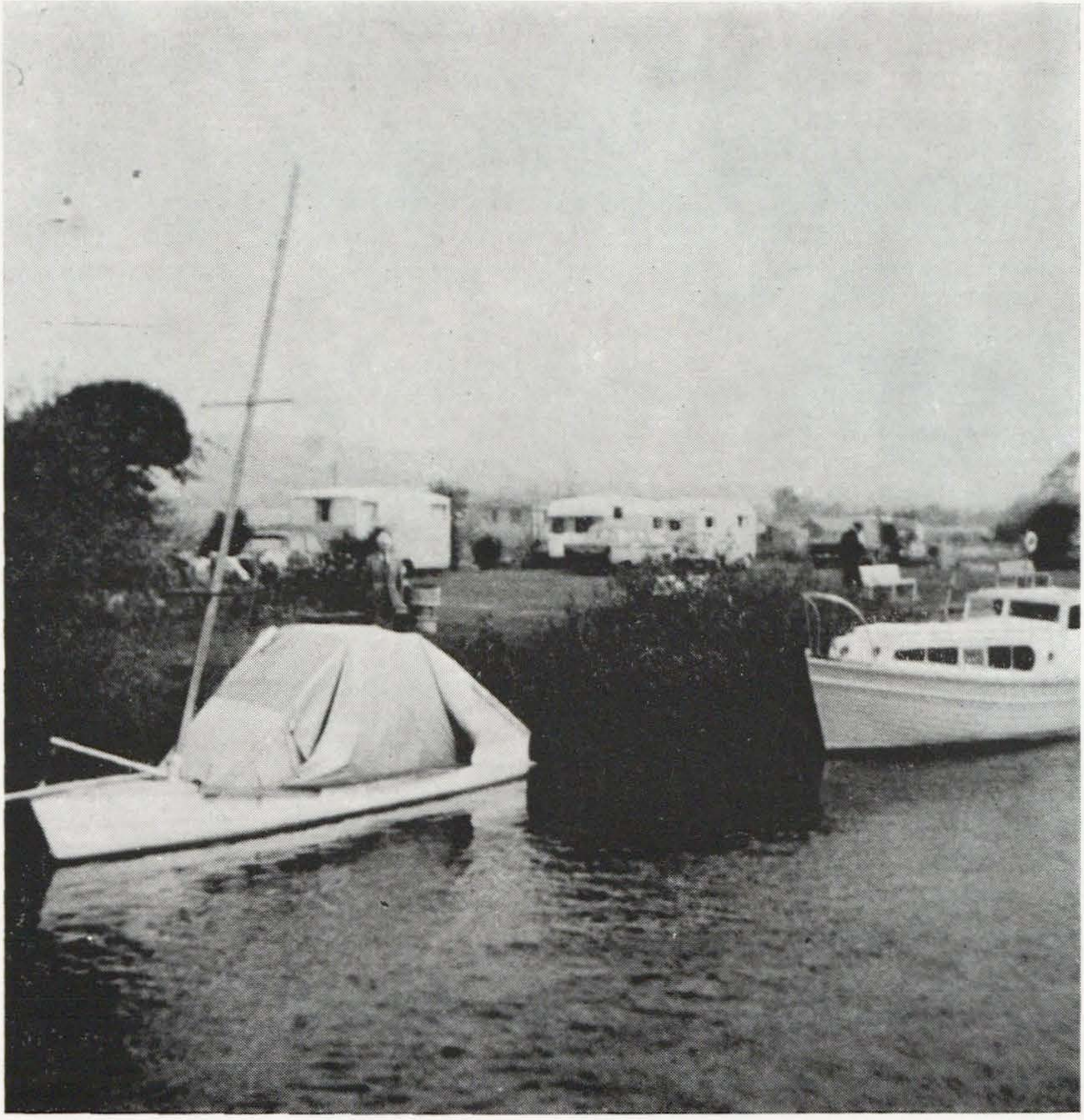


KINNEGOE with decks raised at Boyle

After closing time, Roger ran me back to the boat. The Gremlin, by this time, had recovered from his temporary transformation into the ginger-haired police sergeant and, of course, was now in *KINNEGOE.* He caused me to slip as I was getting aboard and my feet and legs went into the water below the boat. I grabbed one of the side plywood panels and the boat capsized on top of me. I pulled myself out of the water and still the boat did not right herself, the mast resting on the bank. I pushed up the mast just a little, however, and she came up. I had seen some things fall in the water when she fell over but I was now cold and wet and decided to leave them. Fortunately, the side decks did not submerge so no water was taken aboard.

I got on the boat more carefully this time, took off my wet clothes and was soon snug and warm in my sleeping bag. On thinking the matter over, we thought that the high stowage of weights and the absence of water ballast was the cause of the capsize.

The next day, we fished out a biscuit tin lid, the red plastic bucket and my hat from the bottom of the river.



KINNEGOE at Boyle. Balloon fabric in place

Three days on the Boyle

One supposes that the Gremlin had exceeded his function by making a personal attack on me on the night of our arrival. However, he was still active because he produced either rain or strong winds for the next three days. By this time, we realised that fortune was rather against us and we decided to wait for better days before sailing.

We slept comfortably in our sleeping bags, cooked, ate, read and made expeditions by car, first to Carrick on Shannon where the landlord of the 'Shannon View Hotel' talked to us for three hours. Next, we toured Lough Key and studied our route down the Shannon. Finally, we did a massive tour to Sligo, where we saw the Isle of Innisfree of Yeats' poem. From there, we went to Bundoran in Co. Donegal, to Ballyshannon and over the border to Co. Fermanagh, in Northern Ireland. We then skirted the south shore of lovely Lough Erne to Enniskillin where we called on my sister Mary. Her husband, Val, is the headmaster of Portora, a public school in the English tradition, founded by James the first. Val wanted to sail with us a couple of days later and we agreed to ring him up and tell him where we had got to.

Roger on *KINNEGOE* at Boyle

Lough Key

We had now committed ourselves to sail the following day and, in a really nice force 2 wind, we sailed down the river to Lough Key. We had long and short legs across the route through the Lough. *KINNEGOE*, under full sail, went fast and close to the wind, tacking inside a right angle and making little leeway. We were very pleased with her.

Lough Key is only about three miles long but, as we went, our wretched Gremlin increased the wind to force four, with gusts of five blackening the water surface. Moreover, the wind direction would chop around through some 60°, due to islands and woods, which made sailing rather a strain.

We had nearly crossed the Lough and were just beating up the last bit of the outlet bay to the exit when Roger suddenly noticed that the boom swivel had caught on the lee shroud and was being held there as we put about. This kept the mast from turning and it bent enough to keep the stays from holding it up. It went over the side. We pulled it aboard and one of the many hire cruisers now to be met on the Shannon towed us to Clarendon lock, which we went down in company with a couple of other boats.

A very pleasant Dutchman, who had emigrated to Ireland, then took us in tow for about a mile and a half through Knockvicar and Oakport Lough to Cootehall, where we tied up. Crossing Oakport Lough, which is about half a mile long and half a mile wide, the waves were about 2 ft high, each with a whitecap. The wind must have been a good force five.

Roger on the quay at Boyle

At Cootehall, we looked for damage and found none. We thought that it was simply a matter of the mast bending which had brought it down. Gerald Holtom had warned us that the boom swivel might catch on the stay but, with all the multitude of jobs to be done before we started, it was not touched. We cut off some six inches of the offending wood and hoped that our Gremlin would now leave us alone. I rang up Val at Portora and told him where we were for our sail the next day.

Our last day on the Boyle

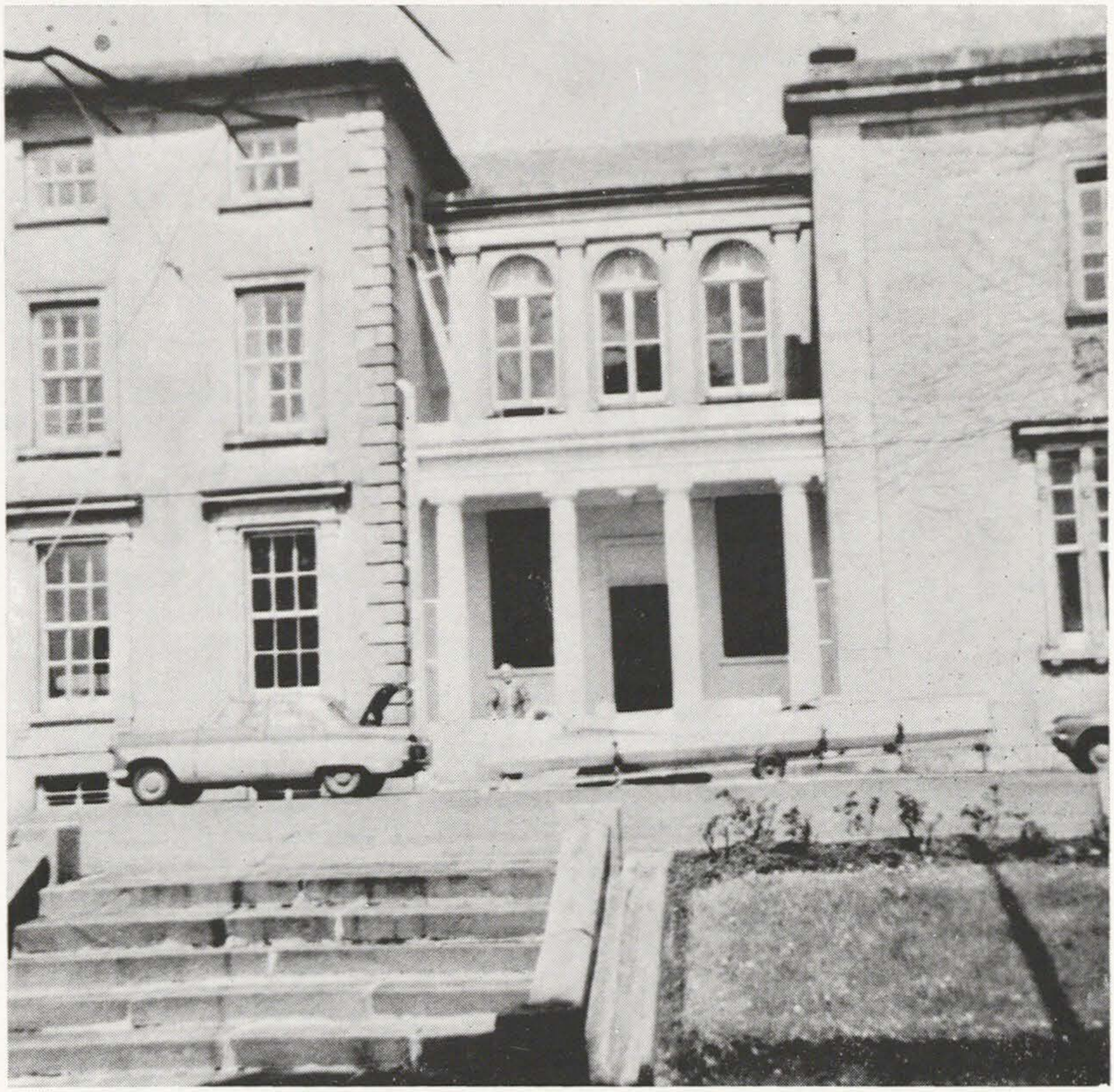
When Val arrived, we set off in a calm. Soon, a light head wind appeared and *KINNEGOE* beat beautifully against it. A high tension cable is marked on the chart but with no height given. However, it was some 30 ft up and we cleared it easily.

We were just entering the last piece of river before it opened into Lough Drumharlow when the wind suddenly increased to force four and, with no trouble at all, the mast again fell over the side. This time, the outrigger struts which took the stays actually crumpled up and the screws of the chain-plates pulled out. Apparently, the outriggers had been badly strained on Lough Key and we had failed to notice it.

Once more, we pulled the mast aboard and rowed back the mile or so to Cootehall quay. Val now kindly suggested that we pull out the boat and take her to Portora where they have a boatbuilder and boatbuilding shed.

We collected the car and trailer from Boyle, taking the opportunity to look over the Cistercian Abbey with its lovely stone carvings in a good state of preservation. To our amusement, one of these was a female pagan figure of an indecent type called a 'Sheela-na-gig' which had been built in. One supposes that the Abbot used this figure to estimate the strength of vocation of his monks.

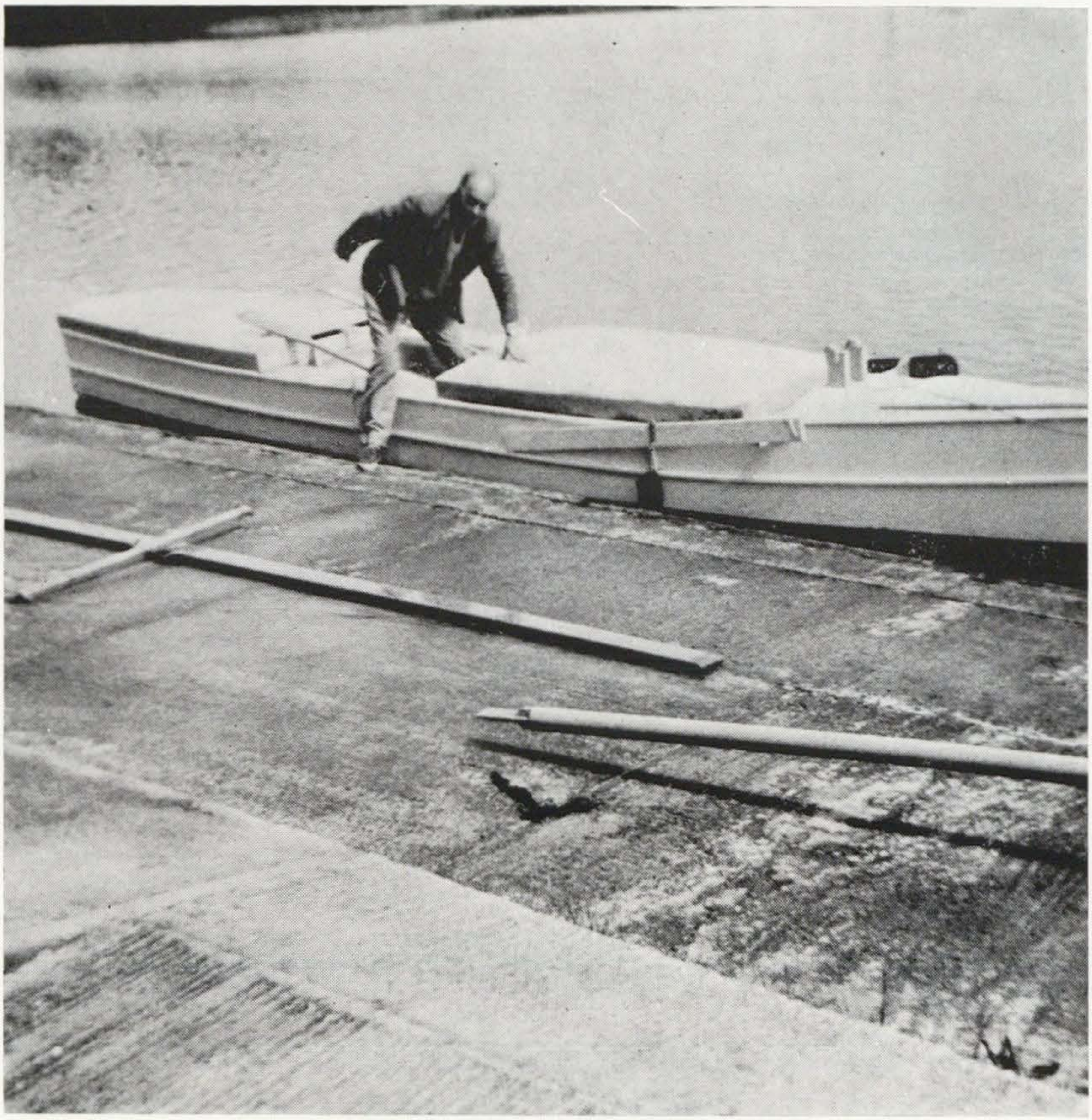
We plucked out the boat and took it the 40 or so miles to Portora by road. Arriving at the school, we left the car and boat outside and took in our clothes and bedding while my sister went to prepare some food. She had



KINNEGOE (and Gremlin) arriving at Portora only started when the stove refused to work. Obviously, our Gremlin, which we had brought to their door, had tired of our boat. It was probably not mechanically sophisticated enough for him. Or, Portora being an old school, it is possible that our 'friend' had found some companions to whom to show off his expertise.

Next day, Walter Vaughan replaced our outrigger with a nice piece of pine and bolted it onto its mounting. He also bolted on the chain plates so that it will take a pretty strong Gremlin to make it fail again.

I imposed myself on Billy Dougan in the boat-building shed and made a handsome cross for the boom swivel and coated it with 'Formica' for easy movement. I also made a 'Yoke' to fit the mast so that it can now be turned by pulling a string. The cross on the boom was neat and tidy and I felt that this Christian symbol would turn our fortunes, which it did.



KINNEGOE at Billy Dougan's Boatshed

Another view at Billy Dougan's shed

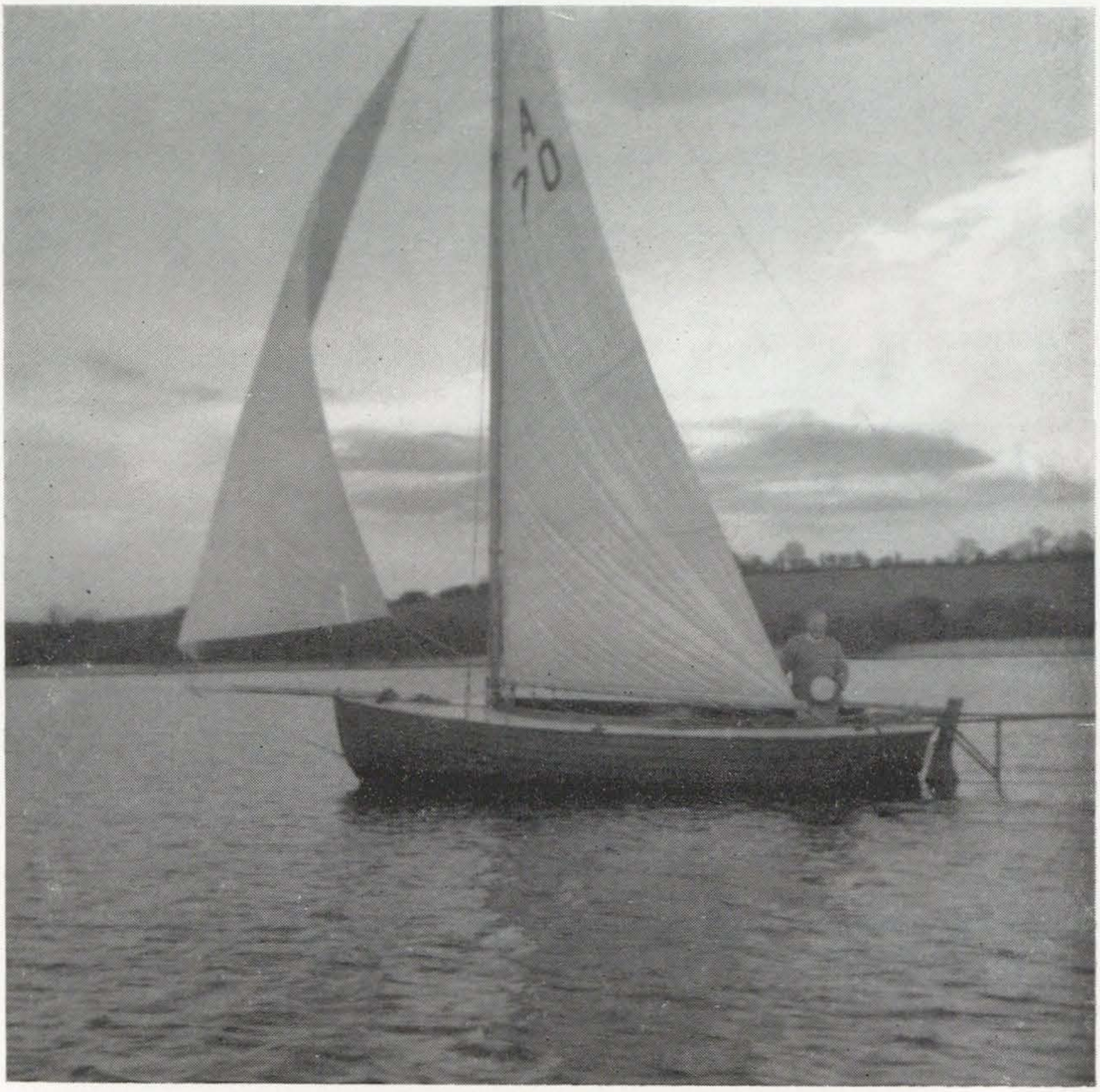
Sailing on Lough Erne

We had now three days of our holiday left. The boat was in good condition. Our Gremlin had left us for the mechanisms of Portora school. The weather was superb with sunshine and light winds.

We sailed one day in company with Val's 18 ft yacht *BALLYSHANNON* around Devenish Island on which there is a perfect 'Round Tower'. There are also the remains of an Augustinian Abbey and, right beside it, the foundations of the priory church of the Culdees, an Irish religious order. The Round Tower is 81 ft high and was an anti-Viking device of the monks. The abbeys were of considerable importance in Medieval times.

The Vikings apparently portaged boats from the coast to Lough Erne and ravaged the shore where there was anything of value. However, as there were only a few religious houses on Lough Erne and no towns of the natives, their overall objective is a little hard to see. There are, for example, no traces of Viking settlements.

Devenish Island was the place from where St. Colomba went to Iona, in Scotland (then inhabited by Picts). The Scots were, of course, Celts and pre-Celts from Northern Ireland who followed him. The story is that St. Colomba was alleged to have put up a bit of a 'black' causing the battle of Cooldreveny in 560 A.D. He was then censured by the clergy and his Abbot, St. Molaise sent him in penitential exile to Iona. I must here disclaim any expert knowledge of history and hope that I haven't offended



Val's *BALLYSHANNON*

any Irish or Scottish susceptibilities by the above disclosures. They would appear to be the facts as known to my sister Mary and the Encyclopaedia Britannica (1910 Edition). Roger, who had been to Iona, pointed out the considerable resemblance between Devenish and Iona in appearance without knowing the history and Val told us that these two have a common tradition of a basic Celtic religion with Glastonbury Abbey, in England.

In sailing, we were happy to note that *KINNEGOE* was as fast as Val's *BALLYSHANNON* both to windward and leeward, though his mainsail was not setting very well. We sailed seven times in the three days, tried out the brailing reefing gear (which was not satisfactory) and generally enjoyed the almost perfect weather.

Devenish island, showing Round Tower and helicopters

The return trip

Finally, we had to get home. We pulled out the boat, loaded up the car and drove the 100 miles to Dublin, crossed the Irish Sea and drove home—all without trouble because we had left our Gremlin behind us. It is true that the nuts on the trailer wheel half unscrewed and the dreaded Kentish Police appeared just as we were negotiating the entrance to my drive but we got in before they could get out of their car. If this was our Gremlin working, his influence must have been weak, owing to the distance from Ireland.

Enniskillin and Lough Erne

The 43 feet of car and boat at Dublin docks

Summary of *KINNEGOE*

1 The living accommodation is extremely roomy for two people. We were very comfortable. Our alcohol stove (Turm 36) was a grand cooker. The storage was just the right amount for us.

2 *KINNEGOE* sails well to windward, tacking within a right angle. She is fast with no water ballast but feels weight noticeably. The modest sail area of 150 sq ft is about right, but she needs to be reefed for force four. She could do with just a little more wooden keel. I will first try an extension of the present keel to the bow and, if this is not enough, I will increase the total draft to 1 ft.

3 The boat's light weight and shallow draft make her tow well on the roads and are very useful for lake sailing. They also make slipping and launching very easy indeed.

4 The brailing reefing method was not a success. This will have to be studied further and, if it cannot be made to work, the pocket luff will be replaced by a mast track.

5 The 'gallows' method for a lifting rudder works well.

Summary of our trip

We had a grand time, despite our Gremlin. I know of no other 25 ft boat with sleeping accommodation which could be trailed 500 miles and shipped across a narrow sea so easily, though the cost of this was £26 each way, due to her length. In all, *KINNEGOE* seems to be an excellent 'Inland Waterways Cruiser' and 'Sailing-rowing boat'. We certainly did not feel that we ever wanted an engine. She is also excellent value for what she cost me (about £400, in all).

Our 'Gremlin'

It was only when we got home and I had time to think about him that I realised his full nature. While on our trip, I put down our misfortunes to 'Accident' or my own bad judgement.

Our Gremlin did us no harm and, in fact, pointed out our faults of design and workmanship most astutely. I now feel most grateful to him.

Of course, if he was put there by my wife's sorcery, I do wish she would sail with me again. She could then order the winds and weather a bit better for us.

Now I come to think of it, when Pat *did* sail with me, we had far better weather than we have now (unless she wanted to go on a shore expedition).

Finale

On our day of departure from Portora, my sister Mary came to Val and me. "Come and look at the 'Fridge. I think there is something wrong with it."

Val and I went to it. A distinct 'Hiss' was issuing from inside. Not a bad hiss, I thought. Indeed, it was a benevolent, almost a happy hiss. Obviously, it was our Gremlin who had found a new and comfortable home for himself. Perhaps, the modern trend is for Gremlins to be 'Cool'.

Roger suggests that our Gremlin was, in fact, a 'Leprechaun' who had been 'working' in England, as so many of the Irish do. One can most certainly think of many Government departments where he could have been active. Then, wishing to return home, he had chosen us to get back to his native land. I have my own ideas but we never can tell.

If he is a benevolent Gremlin (or Leprechaun), we wish him well and thank him for his treatment of us. If not, or he turns too difficult at Portora, Val is a cleric and I believe the 'religious' have methods of removing unwanted demons.

I still have no silverware on my mantelpiece. We didn't get *KINNEGOE* even as far as the river Shannon. But we did have a lot of pleasant sailing and no one could call the trip dull. It is seldom that people have the 'privilege' of cramming into two weeks so much experience of Forces, both natural and supernatural.

Future plans for *KINNEGOE*

1 It is highly satisfying to have such a theoretically perfect sail on a boat. If I can abolish the boom eddy, I shall be even more pleased.

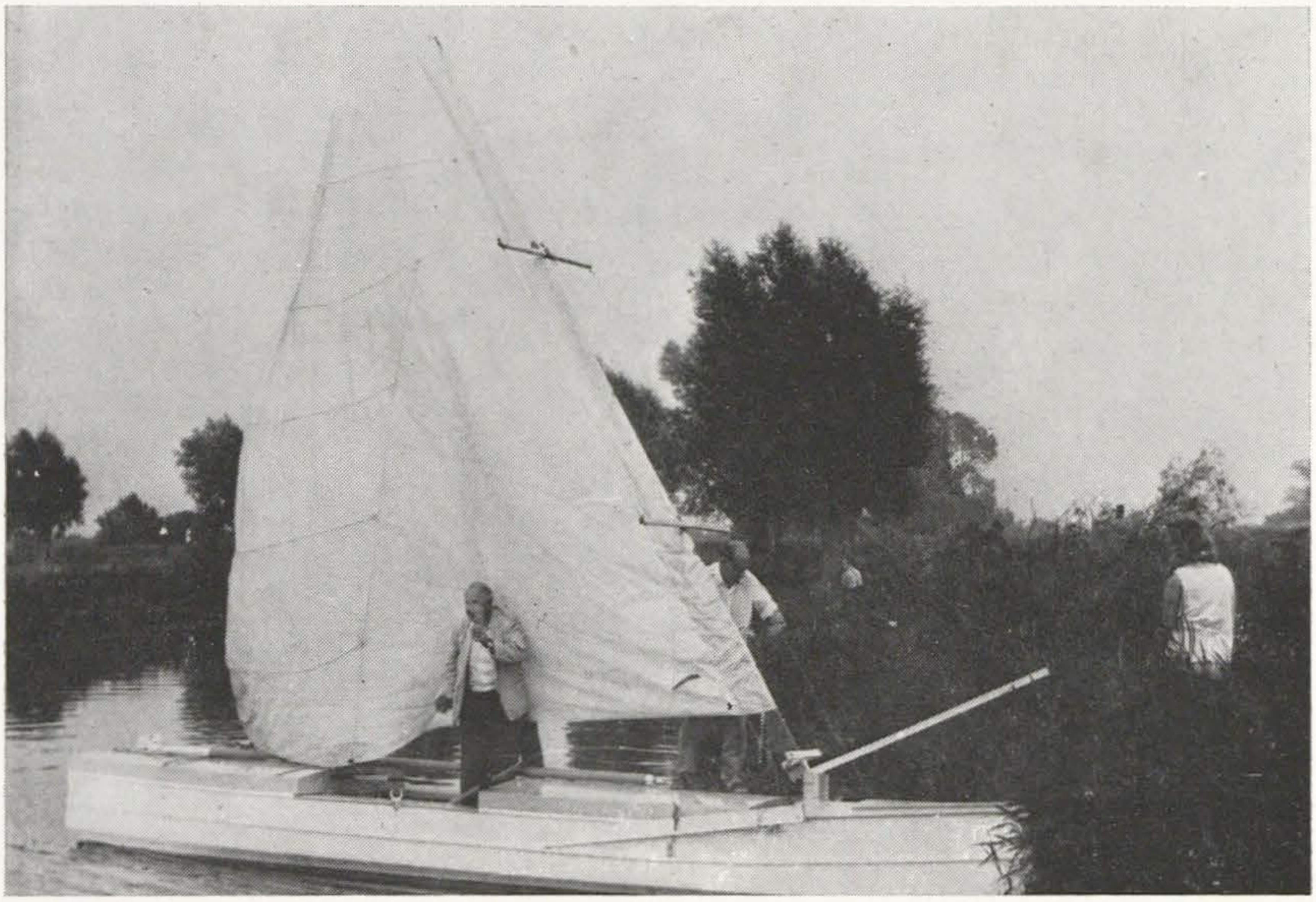
2 If a jib can be devised with a similar 'geometry' to the mainsail, not only extra speed in light airs would be achieved but the efficiency of the rig might be increased.

Erecting the mast

3 The hull efficiency is obviously good, despite the 'unconventionality' of the design. I now feel that I must build myself a test tank to see what round bilge shape would improve this to the utmost possible. I want a re-circulation tank for the testing of models in what is called 'Laminar flow'. The objective would be to get as low a 'Hull drag angle' as possible.

4 I still intend to design and fit hydrofoils for upright sailing.

5 Having discovered that the best of the 'Tea Clippers' with three masts and the square rig could sail at 28° from the apparent wind, as compared with 30° for a dinghy or ordinary keel boat and 20° to 25° for a 12 meter, I have a strong urge to try this rig on my boat. With curved yards and revolving plank masts, it might be the best rig possible.



The mast is newly up

Technical details

I guess that the β angle (the course to the apparent wind) is about 25°, made up of 10° as δ_S, the 'Sail drag angle' and 15°, as δ_H, the 'Hull drag angle'.

A very efficient jib should reduce δ_S to 7°. Hull research would, I hope, reduce the δ_H angle to the region of 10° (the minimum known for this angle is 9°).

The result would be a boat pointing at 17° from the apparent wind and about 25° from the true wind direction. Such a result is far better than any yacht now known with the possible exception of a 'pinched' 12 meter.

Postscript

Three weeks after returning home, there was the following exchange of letters with my sister:

Dear John,

There were, comparatively speaking, quite a number of religious houses on the islands and shores of Lough Erne. The Vikings' visits are frequently recorded in the 'Annals' (records of contemporaneous events, kept by the monks) so they must have thought the journey worth while. The Culdees are, for example, one such house and they are hard to place exactly.

Even St. Colomba is a bit tricky. The latin life of St. Molaise of Devenish gives him the full credit of the penitential sentence. But it is also claimed for St. Molaise, of Inishmurray, Co. Sligo.

My 'fridge was restored for use 2 days ago—but my watch won't be ready for another week and the kitchen alarm clock is declared unfit for further use.

PLEASE take your Gremlin back.

Love,
Mary

Dear Mary,

Many thanks for your help with the historical side of my article.

I am, as you well know, only the weakest of 'Gremlinologists' but I think I have a deep insight into the one we took to Ireland.

I feel sure that HE was responsible for your 'fridge going wrong. But, I will not agree that OUR Gremlin would bother himself with watches and clocks. This was undoubtedly the work of some minor fellow aping the 'Maestro'. OUR Gremlin was obviously a great expert, specialising in the 'spectacular'.

After a great deal of thought, I feel that OUR Gremlin has at last accomplished his ambition and will now be prepared to lie dormant in a successfully working 'fridge for many years. However, I think you should always treat the 'fridge with the greatest respect, bowing down whenever you open the door (as you do now). It is probably this obeisance which HE needs to keep HIM content.

Love,
John

Definitions

1 'Lough' is the Irish for lake.

2 'Gremlin'. Gremlins were discovered by the Royal Air Force during the 1939-45 war. They appear always to have been connected with aeroplanes and machinery but, though I have questioned many pilots, their exact nature remains a bit indefinite. I believe that one was actually drawn in 'Tee Emm', a magazine produced for R.A.F. pilots, beside his arch 'activator', a certain (mythical) Pilot Officer Prune.

Some pilots say that the Gremlin is never seen. Others say that he stands on the wingtip with a smile on his face and 'messes things up'. Apparently, however, his commonest activity was to switch the undercarriage lights to green, while the wheels were up, this resulting in a 'belly landing'.

Before Gremlins were discovered, one used to say that there was 'a spanner in the works'. However, my attempts to define a Gremlin as 'The spirit of human error' was met with great resistance, all pilots affirming a supernatural being, quite unconnected with 'pilot error', a term which could not be applied to them.

3 'Leprechauns', synonyms: 'The Little People', 'The Wee Folk' belong to Irish folk lore. By tradition, a leprechaun is a little chap, dressed in green with a red cap, who rises from the ground and, when he has spoken,

Sailing at Pluck's Gutter. The mast is too straight sinks into it again. It seems logical to suppose that the tradition takes origin from the Irish aborigines whom the Celts found when they entered the country about 500 B.C. These could well have been small folk with 'ginger' hair, living in winter and when there was danger, in 'Souterrains', or underground passages with a stone 'chamber'. This type of person still exists in the British Isles, the two examples which spring to my mind being the late Sir Winston Churchill and the Police Sergeant who stopped us in London.

The Celts attributed great manual dexterity and supernatural power to the leprechauns. This was doubtless due to the large numbers of stone monuments, the best known of which is Stonehenge, which were present when they arrived.

SAILING NEAR INNISFREE—May 1969

by Roger McElligott

We did arise and go then
Sailing on Lough Key
With a long boat, and a tall sail
Across that inland sea.

We hoped to find some peace there
After months of nothing but go
But on t'other side of the lough, behold
The mast came dropping slow.

"All hands on deck", the Skipper cried,
"Fish mast and sail from the drink",
We pulled and heaved, and the task achieved,
Nor boat nor hearts did sink.

A cruising Dutchman took us in tow
With many an encouraging cry,
And brought us to port at little Cootehall,
And left us there to get dry.

Next day we set sail in the teeth of a gale
Which sprang up near Drumharlow Lough,
The helmsman was Val, who proved such a pal,
With skilled handling the boat ne'er did rock
Till we rounded a bend, and that was the end,
As down came mast and sail en bloc.

We all arose and went then,
Went up to beautiful Erne,
With gracious hosts we stayed
And much we there did learn.
And found fine sailing there,
There peace came dropping slow,
And every moment we enjoyed,
Till it was time to go.

A "RETIREMENT YACHT"

by John Morwood

The design of my yacht *KINNEGOE*, though suiting my present needs for a boat, has an ulterior motive. Though I didn't realise it at the time I designed her, she is a prototype of the yacht I ultimately want to build for my retirement—but smaller, of course. She is also the test bed for hydrofoils, rigs and keels about which I want to know. This work will occupy me for the rest of my life.

The retirement period of life

One hopes to retire from work when reasonably active but inhabiting a body which will slowly lose its powers. I will spare my readers the lurid medical details of it all. But the needs of the environment for an old person can be summed up by two factors only, as follows:—

1 Warm, dry air to breathe.
2 Living in interesting surroundings, with mental work to do.

The advantages of a Retirement Yacht'

1 The air in a yacht can be almost rigidly controlled in temperature and humidity.
2 There is always activity where there are boats. Boating people are friendly and helpful. One can never be bored in such an atmosphere.
3 There is no garden to dig. If one has a creative botanical bent, one can grow potted plants. Or, one can just enjoy the scenery provided by the Almighty, or man.
4 In England, Ireland and Europe generally, there is an extensive canal system. If my yacht could pass through any canal, I could visit friends and relations in any part of the country while I am still active enough to do so.
5 Marinas and yacht moorings generally, whether at sea or inland, seldom involve walking up hills. If they do, the yacht can be moved elsewhere.
6 Rowing a dinghy is almost perfect exercise for the arms, legs and chest. This keeps the calcium in the bones and the fresh air tones up the arteries.

Summary

If one can have an appropriate yacht designed and built, one can avoid many of the disability of old age, especially loneliness and boredom.

The selection of a yacht

Most members who write to me on this subject have already picked a trimaran and generally add ". . . for extensive cruising, possibly around the world . . ." Most such letters come from California and the choice may well be right for them. My own choice is based on the following requirements:—

1 She must sleep 8 adults and some children—I have a wife and 3 married daughters.
2 She must be able to pass through any English canal. This means a maximum beam of 6 ft 10 in because that is the limitation of certain canals.

3 She must be able to cross to France or Ireland. She must therefore be a proper sea-going yacht, and capable of sailing around the World, if I felt like it.
4 She must have a shallow draft.
5 The hull must be thermally insulated so that she will be cool in summer and warm in winter.
6 The internal 'climate' must be capable of control by efficient air-conditioning. This means, in effect, temperature and moisture control.
7 She must have a small, *very quiet*, auxiliary engine and fully retractable propellor.
8 She must be as efficient in both sails and hull as is possible i.e. have low 'drag angles' for both.
9 There must be no ballast, or only enough to right her after a capsize.
10 She must be safe, in all her equipment so that an old and 'doddery' man will not cause an accident. This means that there should be neither Butane gas nor petrol and preferable neither kerosene (paraffin) nor diesel oil. Alcohol is, of course, the safest fuel because fires with it can be put out by water.

THE HULL

Materials

The obvious material for the hull is PVC foam and glass fibre, as used by Derek Kelsall as it is thermally insulating and weighs only 3 lb per sq ft. However, I hesitate to trap bubbles of air below the waterline because I feel that, in time, they will become water-logged. Also, the fibreglass skin can be punctured or abraded by rubbing. A solution to this drawback of the PVC 'sandwich' has been suggested by Jock Burrough. This is to have the bottom of the boat made from Ferro-cement (which weighs about 15 lb per sq ft), with the 'sandwich' only above the waterline.

The 'Master Section'

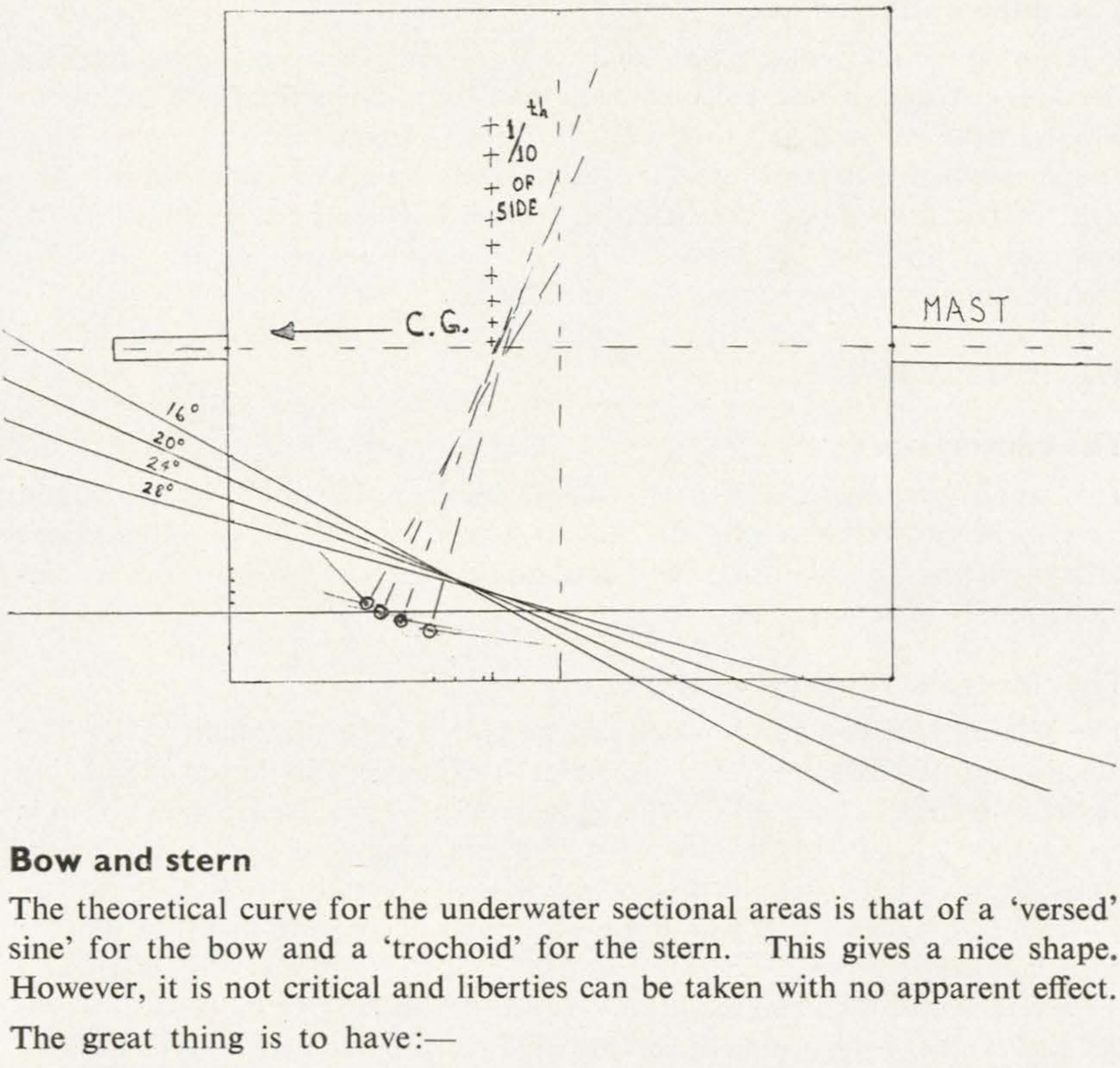
If this were a complete circle with all the weights stowed below the 'Metacentre' i.e., the centre of the circle, there would be a good deal of stability without any ballast whatever. The headroom would also be over 6 ft. In drawing the 'Master section', therefore, one should start with a complete circle and modify it to one's needs. For instance, flattening the floor increases the initial stability. If one does this, however, the displacemeet removed could be put as ballast on the bottom of a shallow keel.

Vertical topsides and adequate rubbing strakes are necessary for inland waterways and it is also desirable to have a parallel sided piece of boat midships. Side decks should be about 1 ft 6 in for comfort. The coachroof not only gives headroom but should give righting moment in the event of a more than 90° capsize.

The box section

In contrast to the circular section, the 'Box' section has the greatest amount of 'Form Stability' for a given beam. However, when the displacement is light, the stability curve is not very much different from that of a circular section. The diagram shows a box sectioned yacht lying on her side, with the mast horizontal. The centres of the immersed triangles are shown with lines drawn from them vertical to the LWL's. The stability is maximum when the section is heeled from 20° to 24°, but the line of buoyant lift has only moved 10 per cent of the beam. With the amount of displacement shown, placing the Centre of Gravity to the left of the vertical line shown by crosses will result in the yacht righting herself.

In practice, few yachts will have an absolutely square maximum section. Rounding the bottom corners will improve the waterflow and will make the stability curve even more like that of a circular section. Having side decks and a high coachroof will lower the centre of gravity.



Bow and stern

The theoretical curve for the underwater sectional areas is that of a 'versed' sine' for the bow and a 'trochoid' for the stern. This gives a nice shape. However, it is not critical and liberties can be taken with no apparent effect.

The great thing is to have:—

1 Small wetted surface.

2 Flat surfaces to dampen rolling and pitching.

3 'Form stability', which roughly means that the underwater sections should be more than twice as wide as they are deep.

It would appear from Chapelle's book *American Small Sailing Craft* that the *NEW HAVEN SHARPIE* is the fastest single hulled boat possible. The 'box' sections, with a wide, flat floor, make ballast unnecessary and give immense stability. However, this shape will slap and pound forward and some V to the forward sections is needed for comfort.

Summary of hull shape

The end result of this reasoning is a *Narrow Boat*, such as is used on the English canals, but resembling a drawn-out *Flying Dutchman*, which has the flattest floors of any dinghy I know.

THE KEEL

The choice of a lateral resistance appendage is between three alternatives:—

1 Deep ballasted keel of the modern pattern.

2 Centreboard.

3 Shallow, low aspect ratio keel of the *Kinnegoe* or *Norfolk Wherry* type.

The deep ballasted keel

It is not generally realised how much of a yacht's heeling is produced by the keel. When sailing close-hauled, there is a powerful force acting to windward on the keel and this heels the boat. At one of the London Boat Shows, we had a re-circulation test tank, made by Owen Dumpleton. The sight of our little model heeled down to the gunwale by the leeway alone, was most impressive. A good deal of the ballast on such a keel is therefore used to counteract the heeling force on the keel itself.

The deep draft of a full keel would make the boat's use on the Inland Waterways impossible.

The centerboard

This would probably be the most efficient choice. But more ballast would have to be carried than with the *Kinnegoe* type of keel, many seldom used canals are too shallow to use the board and the interference with the accommodation is annoying.

The 'Norfolk Wherry' keel

The Wherry keel is a plank which can be bolted on to the main keel. The functioning part is some 7 ft long and 1 ft 6 in deep, its lower edge being an arc of a circle. (See *AYRS No.* 62, *page* 69). The effective area added is only about 7 sq ft but its use must improve windward performance very considerably. Otherwise, it would not have been used.

KINNEGOE uses a keel 6 in deep very similar in shape to that of a Wherry on a hull draft of only 3 in. When first used, the keel was too far aft and there was neutral or slight lee helm. However, on moving the keel forward, definite weather helm appeared and the windward ability increased remarkably We had in effect added the rudder area to the lateral resistance of the boat.

The advantages of the Wherry type keel are as follows:—

1 Shallow draft.

2 Small heeling moment.

3 The ability to take some ballast.

The only doubts about this kind of keel lie in its possible inefficiency as compared with other types. We found that *KINNEGOE* sailed well to windward and tacked within a right angle but this might have been due to the sail. It would only be by finding out the hull 'drag angle' that its value could be found. This can be tried at full scale or in a test tank.

The 'hoped for' hull drag angle

The minimum known hull drag angle is 9° (Edmund Bruce, for a trimaran). Widening the hull should increase the drag by some 10 per cent and this would surely increase the drag angle to 10°. If, however, the drag angle of a 5.5 meter is 22°, we must be very ignorant of such matters and this problem should be looked into very keenly by all tank workers.

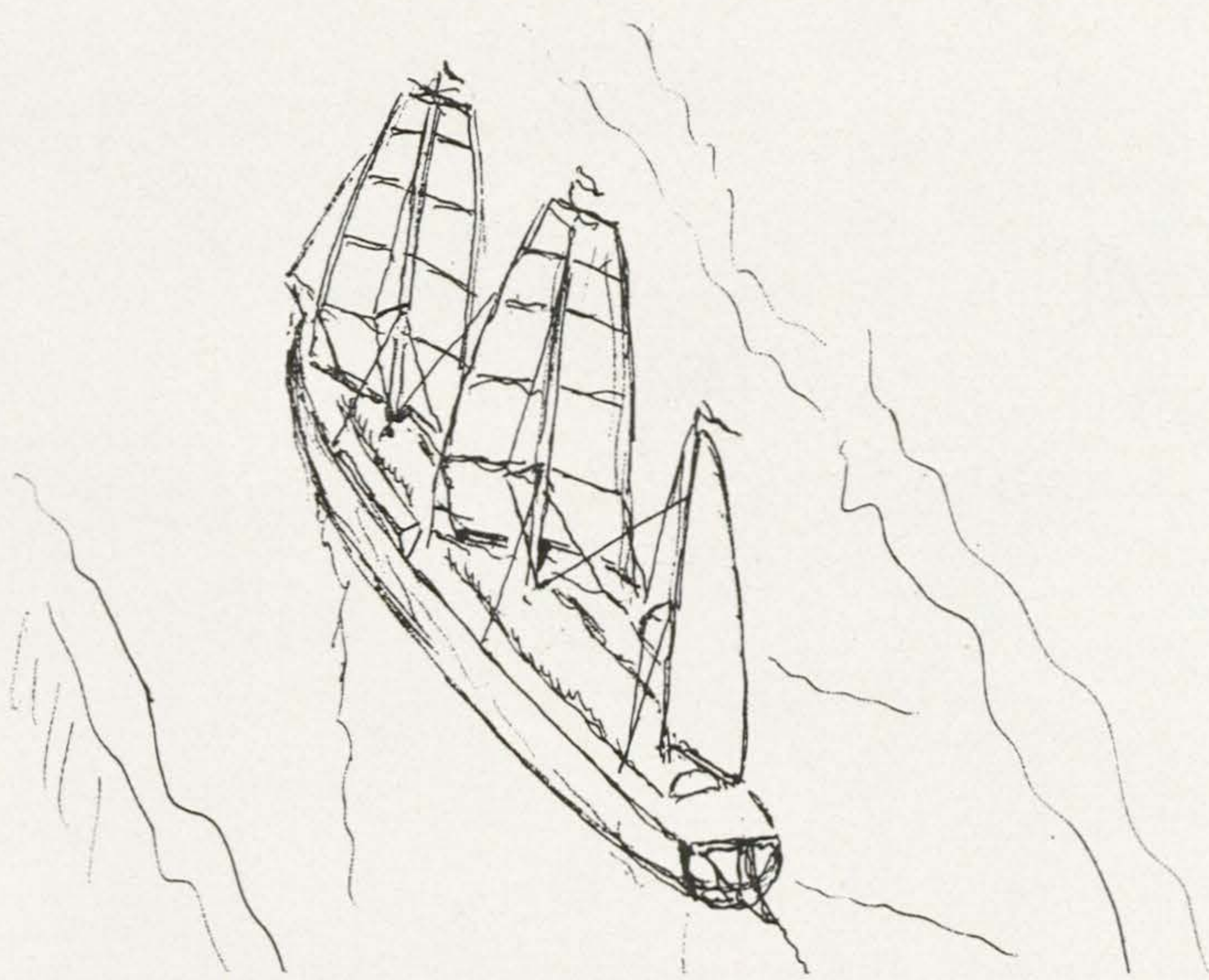
The rig

Our rig on *KINNEGOE* is an attempt to make the orthodox sloop rig as efficient as possible. It is a good line for experiment and I will continue with it. The addition of a jib on a bendy mast might be a great help in efficiency and sail area and this will be tried. However, I cannot keep myself from thinking of the full square 'ship' rig on three masts whenever I think of sail efficiency.

The arguments for the 'ship' rig

At the height of their development, the clipper ships could sail 'within 5 points from the wind'. This means a course to the true wind (γ angle) of 56°. Now, everyone who has sailed in company with the large square riggers agrees that, when they put on sail, they are much faster than any yacht. Let us suppose, therefore, that they can usually sail at the same speed as the wind, i.e., $Vs = Vt$. If anyone cares to get out a pencil and their rusty geometry, they will find that, if $Vs = Vt$, $\gamma = 2\beta$ (β being the course made good to the apparent wind).

All this means that, if the square riggers could sail as fast as the true wind, close hauled, they sailed at a β angle of 28°, even though, at that time, they had masses of hemp rigging, thick masts and straight yards. On many



Retirement Yacht with squaresails. Note retracted hydrofoil. The foot of each squaresail has a boom which is held outside the lower stays by a strut. The masts rotate so only a single stay is needed for the upper mast. This is a simpler system than that described for the "Cutty Sark Yacht" in this publication.

occasions, the *CUTTY SARK* was recorded as ". . . doing 14 knots, on a bowline", i.e. $\sqrt{L}$, close hauled.

John Hogg gives the minimum β angle for an 'X' One Design as 25°, only 3° better than the possible course of the square riggers. Surely, with modern rigging, revolving plank masts and curved yards, one could retrieve this 3° and far more?

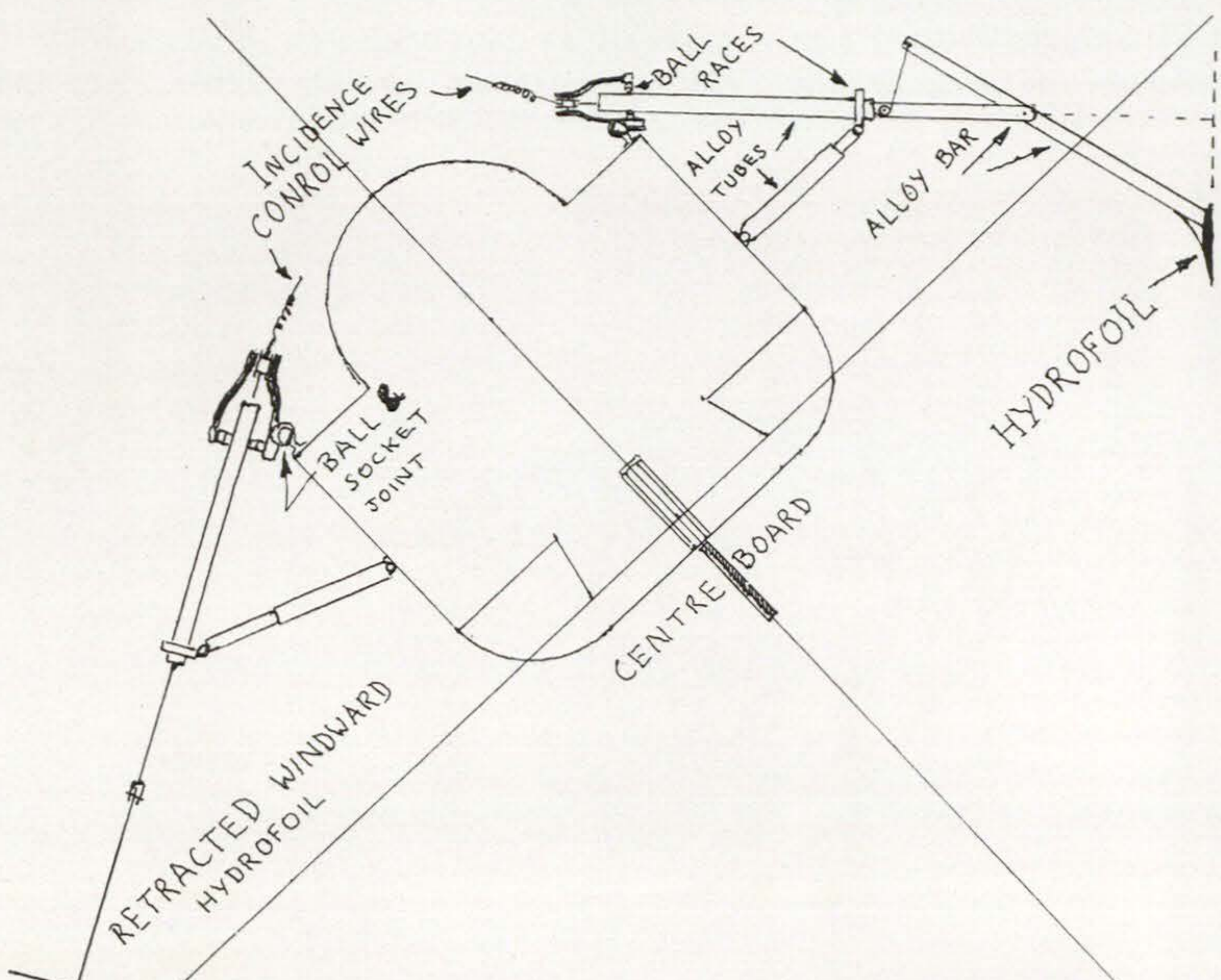
The rig for a retirement yacht

The choice obviously lies between a 'cleaned up' sloop rig and a 'cleaned up' square rig. One would most certainly choose the more efficient of these, but the smaller size of items and the easier reefing of the square rig would make it more easily worked by an older man.

When I have completed my hull and sail experiments on *KINNEGOE*, I would most certainly like to try out the square rig on her.

The ocean-going requirements

Our yacht has already been designed to be stable enough to sail the narrow seas and oceans but it will be a tender ship and will heel easily. Eric Tabarley, on *PEN DUICK V*, used shifting water ballast to deal with this and it worked well. Indeed, he saved quite a bit of weight on the keel because of it and this must surely have contributed greatly to his amazingly quick passage in the Pacific Single-handed Race from America to Japan. However, shifting ballast of any kind is cumbersome, slightly hazardous and far less effective than hydrofoils.



Section of "Retirement Yacht" showing hydrofoils. The overall beam is about 21 feet. Each foil rotates through 360°. The left hand foil shows the "working position", though lifted above the L.W.L. The right hand foil is rotated 90° and gives the view which would ordinarily be seen from abeam. These foils are stabilisers but the same system could be used for the main lifting foils of a "Flying hydrofoil".

Hydrofoils for a retirement yacht

In the AYRS, we have been 'Mulling over' hydrofoils for 14 years. The main problem has always been the height control, or relation of the foil to the water surface. This is very necessary in all forms of 'Flying hydrofoil' and for a hydrofoil stabiliser for a boat with little stability of any kind. However, if a boat has a lot of stability on its own such as the yacht which we have conjectured up to now, it seems more than likely that no relation to the surface is needed.

The hydrofoils which I think would suit my retirement yacht are inverted T foils, one on either side, both retractable along the sides of the boat and also capable of easy removal.

The problem of foils

This is simply sternway. If a foil is set to give positive angle of attack when going forwards, it will have negative angle of attack, going backwards. It can be solved by having the foil revolving through 360° on an axle at the top.

There are two main ways of using inverted T foils:—

1 Both foils can be attached to the ends of a cross beam which can rock from side to side so that only the lee foil would be in the water. Both foils would rotate through 360° and have positive angle of attack, put on through a spring. In a seaway, such a foil system would have the angle of attack vary due to pitching but, in the main, it would function in a very similar way to water ballast, giving a roughly constant righting moment.

2 Both foils can be in the water at the same time. A kind of 'joy stick' in the cross bar would then set one at a different angle of attack to the other and the resulting moment used to counteract heeling. The whole cross beam would be allowed to revolve so that pitching would not affect the foil incidence. The 360° rotation for this system needs some thought but should not be insuperable.

Care would have to be taken with the second system that the weather foil did not break the surface. If it did, the positive incidence would come off the lee foil.

Experiments

Again, *KINNEGOE* is a grand test bed for foil systems.

VENTILATION

General

If a yacht is watertight, it will be airtight or almost so. We have therefore to plan for both air intake and air extraction. Every part of the yacht must be adequately ventilated, especially the 'forgotten ends'. The ideal method is to take air in at both ends of the yacht and extract it over:—

1 The saloon.

2 The Galley.

3 The W.C.

However, the ends of a yacht can be covered with water. It might therefore be better to take the air in over the coachroof and pipe it to the ends. This means that one would have a single apparatus on the coachroof both to take in and discharge the air.

Air warming and drying

The most economical method of space heating is the 'Heat pump'. The domestic refrigerator produces quite a profit in heat, too, by its facility of condensing the water vapour in the air.

This line of thought leads us to the conclusion that the intake air should be passed through the 'cooling' side of a domestic refrigerator, where it will be at least partially dried. From there, it would circulate over the 'warm' side of the same 'fridge to be warmed and passed to the ends of the boat. The 'fridge could be run by paraffin (kerosene) or alcohol and the chimney of this could run outside the boat, if the driest air were wanted.

The water condensed from the intake air is unlikely to freeze, though it will be cool. It could be used for drinking and to produce a 'Cold store' for perishable foods.

In very hot weather, a by-pass for the air should be arranged to let it avoid the 'warm" side of the 'fridge, the air from which would be sent outside.

Heating

In company with Insurance Companies, I do not like bottled gas and am not fond of paraffin (kerosene). Alcohol and solid fuel seem to be safer because fires caused by both can be put out with water. For heating, therefore, I would either use the cooker for temporary heat or, for really cold weather, a solid fuel stove. However, if the yacht is made from PVC foam sandwich at least from the waterline up, so little heat will escape through the hull that heating will be relatively easy. I have been told that the human body produces as much heat as a half kilowatt electric fire. This is unlikely to be true but, if the port lights are double glazed, a great deal of heat will come from the people inside. The 'fridge system of air drying will produce more.

COOKING

We liked our 'Turm 36' alcohol stove on *KINNEGOE*.It might have been slow compared with gas or electricity but we didn't seem to notice this. We didn't have an oven but I once saw a metal box oven which could have been put over any burning cooker. It consisted of two metal boxes, one inside the other. Large round holes in the outer box at the top and bottom let the stove fumes circulate between the boxes and heat them up. There was a door on the front which opened into the inner box but it was hollow and as thick as the gap between the boxes. Holes in its top and bottom allowed the hot air to circulate through it.

LIGHTING

Here, I favour a dual system of oil lamps in gimbals and fluorescent strips worked from a zinc-alkaline battery, through a converter. Even though one foot of fluorescent lamp only uses 10 watts of electricity and a converter is about 80 per cent efficient, electrical generation is likely to be a problem. I know nothing of 'Solar Cells' and such-like and confine myself to the ancient windmill or to its modern equivalent, the Flettner Rotor, as seen spinning on top of motor vans for ventilation. If the electricity fails, I will use oil lamps or candles. I hope I never descend to that evil thing, a 'Chore horse'.

AUXILIARY POWER

I always feel that it is 'cheating' in the yachting game to have any auxiliary power at all. One should surely have a yacht which will sail at great speed in the lightest of airs and, if there is no wind at all, one should just sit and wait for it—or row, use a 'Uloh' or other method of man-power.

This attitude cannot be kept up for a 'Retirement yacht'. One will eventually become too old and weak to drive a yacht by man-power. One must have an engine.

I have three requirements of an auxiliary:—

1 It must be quiet.
2 It must do as many miles to the gallon as possible.
3 The propellor must be fully retractable.

The quiet engine

Ideally for this, the engine should be run by steam, which is the quietest engine of all. With a 'Flash boiler', heated (one hopes) by alcohol, one can have steam pressure in a minute or so. One would like to see an account of the 'Stanley Steamer' motor car of the early years of this century which had a remarkable performance. Unfortunately, even the best steam engines have not the economy of fuel of the internal combustion engine. But, as I would be content with low power, this might not matter.

Fuel economy

Undoubtedly, the best fuel economy can be got from a small 3 h.p. diesel engine, which should also be reasonably quiet. I rather hesitate to take on the job of getting a steam engine working and will probably go for this right away. We have been told that the Yanmar diesel is the lightest one on the market and, with proper rubber mounting on the concrete part of the hull and general soundproofing methods, it should be satisfactory.

The retractable propellor

At some period in the life of every yacht, the propellor gets foul of rope or weed. This makes me feel both exasperated and stupid. It is also good seamanship to have every working part of a yacht capable of easy inspection. Also, I am a member of the 'No holes below the waterline' school and lastly, I want nothing dragging in the water while I am under sail.

The best way that I see to deal with all these problems is to have the propellor shaft coming out of the side of the transom and sloping down into the water at an angle of 30°. It would be fitted with a universal gear to allow it to be pulled up to the transom when not wanted but some form of hinged support would be needed to steady the prop in the water. This solution is not quite perfect, however, and an 'Inboard-outboard' type of propellor might be better.

THE W.C.

It may soon be a requirement in every marina and Inland Waterway not to empty sewage into the water. This might not come for 20 years but it will soon be necessary on the Norfolk Broads and will doubtless be extended. Provision for conventional disposal should therefore be thought of, but I see no reason why a small 'Septic tank' should not be possible.

The septic tank

This is a tank where 'anaerobic bacteria' can quickly destroy organic matter in either sea water or fresh water. The tank has baffle plates to hold up the 'sludge' until it is destroyed, and its only requirement is that air shall be kept out of it. The W.C. effluent is not likely to be more than half a gallon per day per person and a 2 to 5 gallon septic tank should cope with this. Provision would have to be made for cleaning out the tank every few years (about 7).

In accordance with my belief in 'No holes in the hull', I would have neither the W.C. intake nor septic tank effluent below the waterline. I would take the W.C. water from a tank holding, say, 5 gallons which would be filled from outside as needed. The effluent from the W.C. would be pumped into the septic tank and would displace an equal amount of fluid through a hole well above the waterline.

Ablutions

As I intend to live aboard, an adequate basin, shower and bath tub would be needed. There would also be the galley sink to be serviced with hot water. Therefore, some kind of water heater would be needed and methods of taking the hot and cold water to the service points would have to be worked out.

FUEL AND WATER STORAGE TANKS

Water tanks

These would, in general, be built into the ferro-cement part of the hull. There would be a need for about 100 gallons and the tanks would have to be arranged so that the water would not run to leeward when the hull heeled. The water would, of course, act as ballast. All the tanks would be as near the middle of the yacht as possible to keel the 'ends lively'.

Fuel tanks

The alcohol, paraffin (kerosene) and diesel tanks should ideally be placed well away from the engine, galley and saloon to reduce a possible fire risk but, as they will also be made in ferro-cement, this is not absolutely essential.

Summary

The writer's ideas on a 'Retirement yacht' are given. Few people will have the same ideas. The 'requirements' are far too stringent for most. However, the method of selection and some of the solutions may be of help to anyone projecting such a yacht.

For myself, I now have some interesting research to do. I also feel that such a yacht as I have conjectured would make a comfortable place to live in right away. I am sorely tempted to have it built at once and put it on a trailer in my wood. I might even grow rambling roses up the stays until I reach the stage of being a 'senior citizen'.

Finale

Gerald Holtom, to whom I subjected this article on a 'Retirement Yacht' points out that I have been vague about it all. I haven't drawn any lines or produced any plans. My attitude has been fairly deliberate. I felt that I only needed to put down what I needed in the hope that other people would 'twist' these requirements to their own needs and produce various forms of yachts quite different to the one which I will finally produce. I feel sure that we all would like to see the yacht that the 'other fellow' has in mind.

It would never do if we all had the same kind of yacht and we would like to publish members' ideas of their own 'Retirement Yachts'.

LETTERS

Gerald Holtom 55 Hillside Street, Hythe, Kent

Dear John,

Many of the features of your 'Retirement Yacht' seem to have been hovering undefined somewhere in the vague recesses of the mind, but when described by you in this way they jump out of the page as obvious necessities. You touch upon so many constructional problems and details worthy of co-ordination that I hope you will build this craft at once.

Your design opens up the possibility of sophisticated and adventurous cruising to both remote and populated places beyond the reach of keel boats and multihulls; the capital cities of Europe and the wild beaches. Techniques of the bargee and longshore man would be yours to practice.

One or two questions come to mind:—

1 Why build one hull when two at least would be more effective for testing one against the other. Modification of one hull from a three masted square rig to a single 'bendy mast' sloop would be costly. Even the cabin layout and roof shape would have to be changed. Good design demands that components should be complementary and properly integrated. For example, mast, sails and cabin top are effective as one co-ordinated unit. As three units, conflicts arise such as boom eddies etc. Since GRP and ferro-cement are materials which are not readily modified, I suggest that it would be wasteful to try and design one hull and upperworks which could be changed to accommodate either a sloop or 3-masted square rig.

Although it is fairly easy to design one hull upon which to test the advantages of water ballast in side deck extensions (as in *PEN DUICK V*) against foil stabilisers. I suggest that this too would be simplified by building two hulls, one for movable water ballast and one for foil stabilisers.

2 When your refrigerator is used for reducing humidity in the cabin, how much drinking water can be condensed from it?

3 Surely there must be a solar heat device on the market fit to build into the cabin roof for activating the 'frig'?.

4 Can the hot side of the 'frig be used for heating water in an insulated storage tank?

5 I prefer push button for plumbing for shower and galley. This could be done by pressurising the water tanks in the hold, which I would pump up by a foot pump and also by a 'wave motion' pendulum.

The only serious threat to health of body and mind in your Retirement Yacht concept is the rampaging polution of the deep seas, coasts and inland waterways of the world. This will probably see us all off unles you can design a survival suit for use in the cockpit and on deck. In the meantime I am trying to find some method by which the polutionists can be persuaded to poison themselves.

Gerald Holtom

John Morwood to Gerald Holtom

Dear Gerald,

I am glad you find the article of interest. I don't suppose that I myself actually thought up many of the ideas and mechanisms. It has been the flow of letters which I have had to think about from the AYRS members which have produced most of the features. I am merely the person who has assembled them.

It is possible that the inference could be derived from my description that I have merely devised a 'Ditch-crawling yacht', only suitable for inland waterways. This is, of course, far from the fact. The hull is very like that of Hedley Nicol's trimarans—I have merely suggested that the floats be replaced by hydrofoils. As you so rightly say, the yacht could go *anywhere*. And, it would be a fast deep sea cruiser (or racer if lightly enough made).

I would dearly love to have the yacht built immediately. However, many practical snags would undoubtedly appear in the design of both the hydrofoils and square rig and it would be safer to try these out on *KINNEGOE* as an economy measure.

As regards your questions:—

1. It would, of course, be grand to have two hulls, one designed for the square rig and one for the avoidance of the boom eddy with a 'bendy mast' sloop rig. Unfortunately, finances would hardly run to this unless several people take to the basic idea of the boat. The trial of water ballast against hydrofoils is so simple on the other hand, that the building of boats to test it is just not necessary.
2. When I was in America, Jack Stoddart told me that, when he started his 'Air conditioning' in his house, he got some 50 gallons of water the first day, 35 gallons the second day and thereafter about 25 gallons. A rough calculation shows that my yacht, if some 40 ft long, would only have about 1/16th of the volume of my house. It therefore looks as if the water condensed would only be about a gallon per day. However, I am at this moment setting out to try the effect of such an air drying system and I may have an answer with more exactness soon.
3. 'Solar Cells' are, I believe, readily available. A motor car has been driven in America with a battery of them on the roof so the current output must be good. I have never seen one.
4. Obviously, the 'hot side' of the 'fridge could be immersed in an insulated tank and would then produce warm water. The result of this would, however, be an overall cooling of the air of the boat. However, owing to the 'cold side' being not shut in a 'box', more heat would be produced than in a domestic 'fridge. The insulation might be removable from the tank,

however, so as to adjust the relative temperatures of the hot water and air of the yacht.

5 What a good idea to have pressurising the water tanks by a foot pump! This yacht will really be comfortable and easy to live in (if it is ever built). The 'wave motion' pendulum might well work on an ocean voyage or in an exposed mooring but would hardly be likely to serve me in the Inland Waterways.

Your final point about pollution is a sad one. However, I will raise no banners about it. My yachting interests (and those of very many other yachtsmen) take origin from a revulsion against 20th Century artifacts and culture. We object to the pollution of mind, air and body by 'soap operas', internal combustion engines' exhaust fumes and detergents. Our solution is the 'coward's way out'. We escape the juggernaut, not try to tame it.

John Morwood

R. Herbert Victor Navigation Co., 11 Hawthorn Drive, Salford 6, Lancs.

Dear John,

So, you are going to have a bash at the steamer. I don't see why not, because, with all the know-how of the past 150 years of Steam, we still haven't touched more than just inside the knowledge of the Steam engine.

But, having got an efficient watertube or flash boiler, why not step into line and use a turbine for propulsion?

Personally, I'm all for bringing the Steam engine back. It could include the high speed ball bearing and the inside, rotary steam valve. For a start, why not make a discreet enquiry or use some 'fluence' among the right folk to bring to light a naval steam pinnace (or an Admiral's barge—the same thing with a bit more brass around the funnel). These had Babcox & Wilcock's Water Tube Boilers working at around 240 lb per sq in and, when the stoker 'turned on the gas', by heck, you could feel the collossal effective power underneath. The boats fairly ploughed through the water.

Some comparisons with the modern equivalent would be odious; for instance, the space required for the stokehold, engine room, fuel, and water; also the flues and other things. But, in a hull built for these items, steam has a whale of a lot to recommend its re-entry into industry.

If you are lucky enough to get a suitable engine going, I'll be around (I hope) to pass on a little of my experience. I'll set the valves and take cards for maximum ihp and, unless a big end bolt comes adrift, you won't hear it moving.

On the other hand, how about making enquiries among the former Steam Wagon manufacturers? Sentinel, Foden, the Basingstoke firm who made the boiler with a side door, and another firm who mounted the engine (twin hp) right behind the driver.

Years ago, I worked for both the Stanley and White Steam Car companies. They used the then 'flash type' boilers and could be got ready for action in $1\frac{1}{2}$ minutes. The principles of the 'flash boiler' was that, at each stroke, enough water was pushed back into the boiler to compensate for the amount required to move the engine, perhaps a tablespoonful. There was no residual supply.

R. Herbert

Dr. James Morwood, M.B., F.R.C.S., D.P.H.
'Tyworth', White Beam Way, Tadworth, Surrey

Dear John,

You mention insulation in connection with PVC foam construction. Good insulation is essential to install with other forms of construction, as well.

I like the idea of a 'Retirement Yacht' and I think your design of a septic tank is good, if unusual, but the effluent, although fairly clear, will smell a bit.

James

Reply by John Morwood

Dear James,

Thank you for reminding me of the smell of the septic tank effluent. I should have thought of this myself.

The answer might lie in 'building in' a pipe in the hull which could open below the waterline. The septic tank effluent and other discharge waters could be emptied into its top, well above the waterline.

John

THE ECONOMIC POSSIBILITIES OF WIND PROPELLED CARGO SHIPS

by W. Prölss

From the German magazine *Schiff und Hafen*

The writer has, with the aid of work carried out by the Institute of Shipbuilding at the University of Hamburg, and especially by von Wagner, instituted a study for use of windpower for the propulsion of cargo vessels.

The study was based upon a mixed cargo vessel of 17,000 tons because:—

a The draught of vessel permits the use of all normal harbours.

b This size lies in the field of keenest competition.

c There is a demand for vessels of this size as shown by the project studies (In chronological order "Freedom" (Japan) S D 14 (Britain,) "German Liberty" and "Pioneer" in Germany).

The study was therefore based upon an existing type of ship.

Economic considerations of various power sources

1 *Fossilized fuels* (coal and oil) are universally used. Oil has outpaced coal for shipboard use, being a more concentrated source of heat. The conversion of heat to mechanical energy requires extensive investment in science and manpower. A great increase in thermal efficiency can not be envisaged with the conventional prime movers (steam cycle, diesel or gas turbine). The development of the fuel cell for ship propulsion could change the picture. Even if the thermal efficiency is improved, oil has still to be paid for.

2 *Nuclear Power*. A very concentrated source of energy. Technically feasible for cargo ship propulsion but at present not economically competitve with oil.

3 *Wind*. A source of energy derived from the sun. It is also the oldest form of propulsive power for large vessels. The usable portion of energy is

variable, the distribution is geographical and seasonal, in trade wind zones reliable, and for many routes predictably adequate.

It has not been utilised very efficiently in the past, and the main purpose of this paper is to examine it in the light of modern aerodynamics and technology.

Further small increase of efficiency in utilisation can be expected in the future, as with oil fuel, but the wind is free of cost.

Since oil fuel is the only practical source of energy for merchant vessels at present, any alternative energy source has to bear comparison with it.

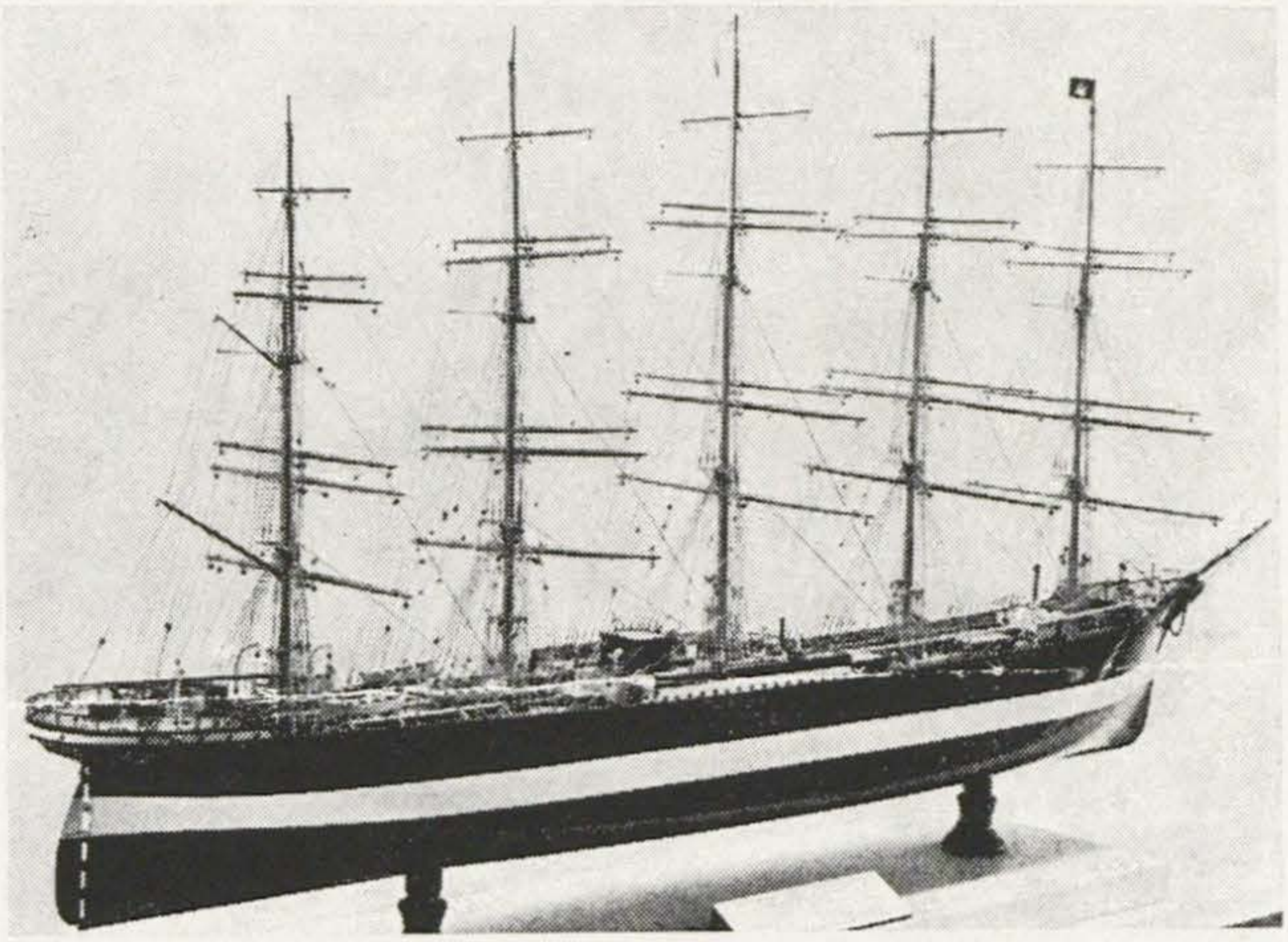


Fig. 1 Five-masted ship *PREUSSEN*

Operation of a sailing ship

Picture 1 shows the famous ship *PREUSSEN*, which up to now represented the ultimate in development. The rigging was so complicated that nowadays it would require a crew of 70 men. The employment of such manpower is expensive. Since 70 men cannot simultaneously handle 300 sheets, the manoeuvreability is also affected. The amount of rigging also interferes with quick handling of cargo.

The sail area of these big ships was broken up into a large number of sails, so as to permit their handling by muscle power. This resulted in sails, which were aerodynamically far from ideal.

To over come these four basic drawbacks of the existing rigging, an unsupported 3-legged mast was developed (Illustration 3 and 4) and fitted with curved spars, carrying sails that could be set or gathered by remotely operated motorised winches. This concept became the foundation for further research, resulting in a design of an unsupported elliptical mast with spars, supporting correctly shaped sails. Illustration 5 pictures a set sail and No. 6 the mast with sail stowed away inside the mast. The winches and sail manipulating devices are also housed inside the mast.

The sails are set relative to the wind by rotating the mast. Illustration 7 shows the 3-legged mast (with the rotating device on deck) set parallel to each other. Illustration 8 shows unsupported masts with sails set for maximum propulsive effect. (Mast bearings below deck).

Illustration No. 9 shows the general layout of a sailing bulk carrier for grain or coal cargo. Cargo, work and living spaces are shown—no engine room below deck. The mast bearings are above the bulk-heads and good access is available to the hatches. A ship of this type requires a small crew and is sailed by bridge control. It is readily manoeuvrable and has good propulsion by means of effective sails.

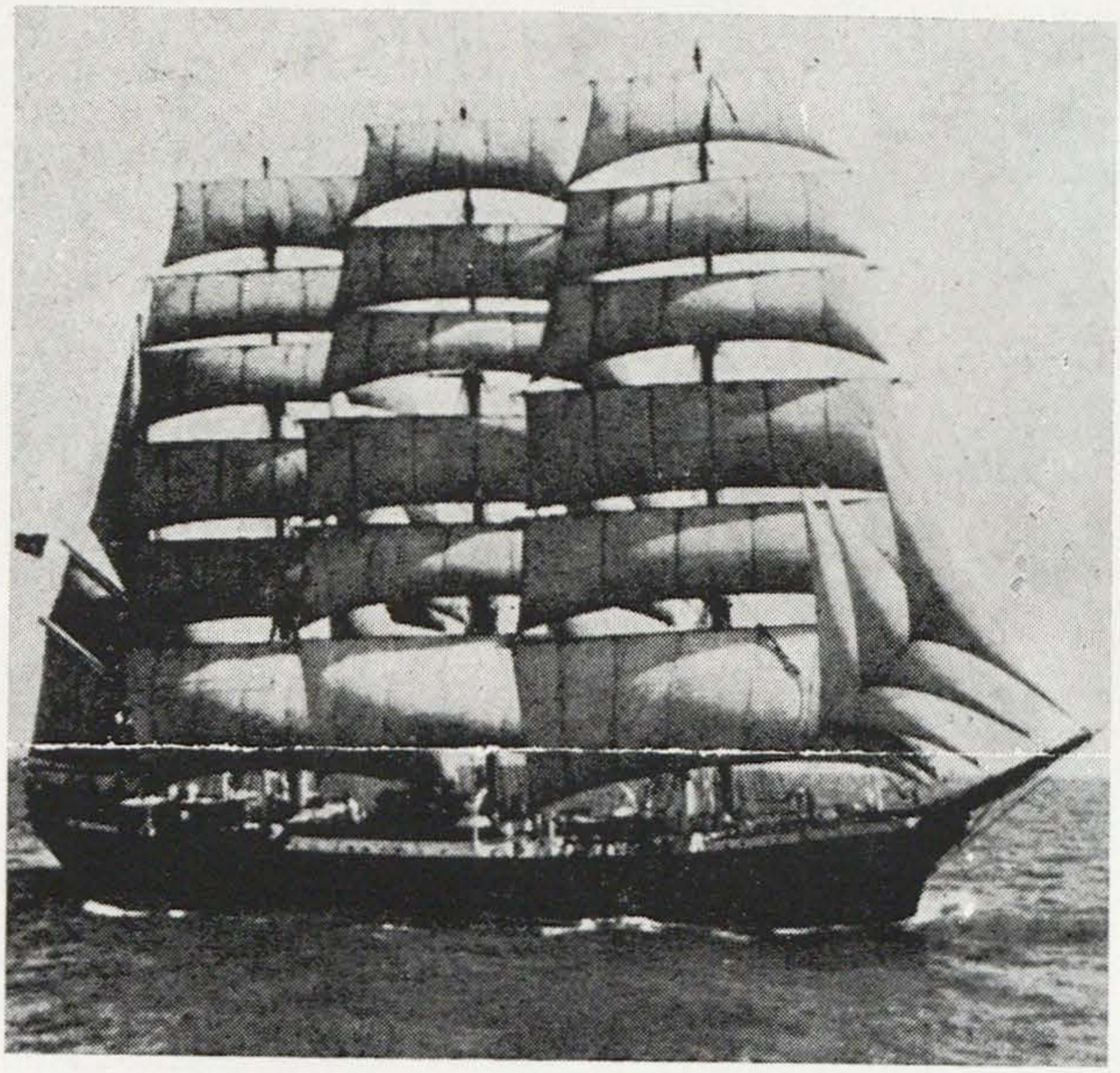


Fig. 2 Four-master barque 5200 — d.w.

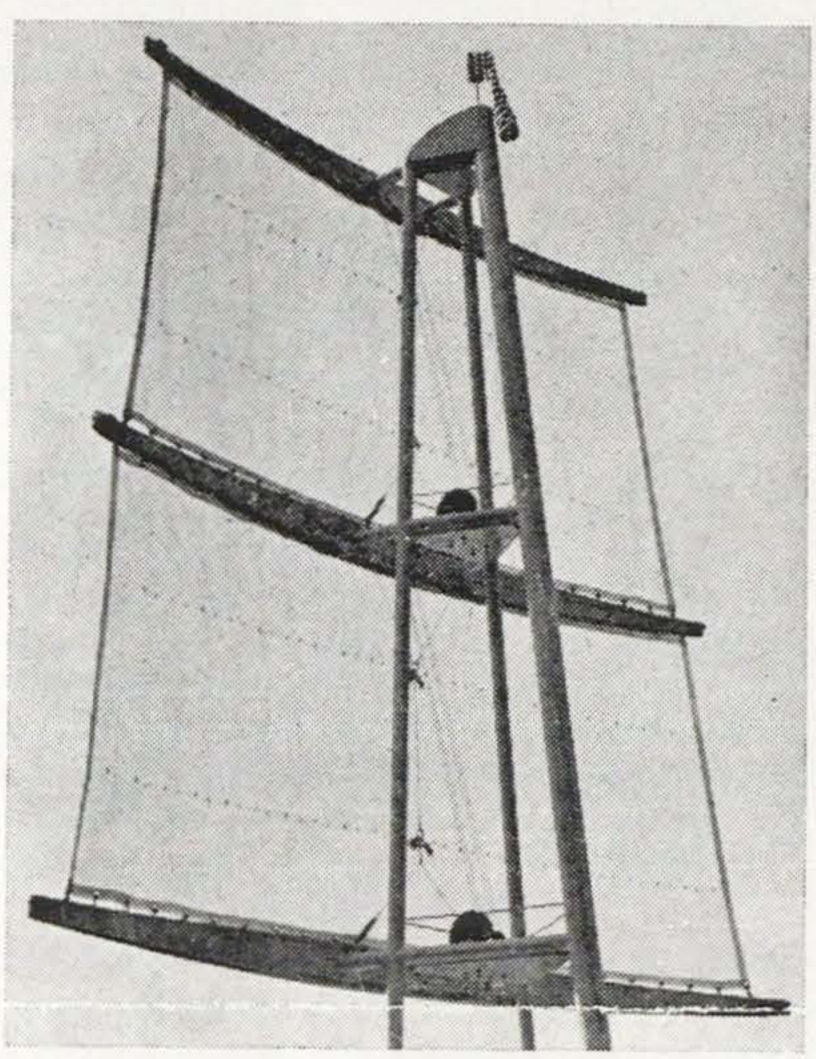


Fig. 3. Tripod mast with sail set and furled

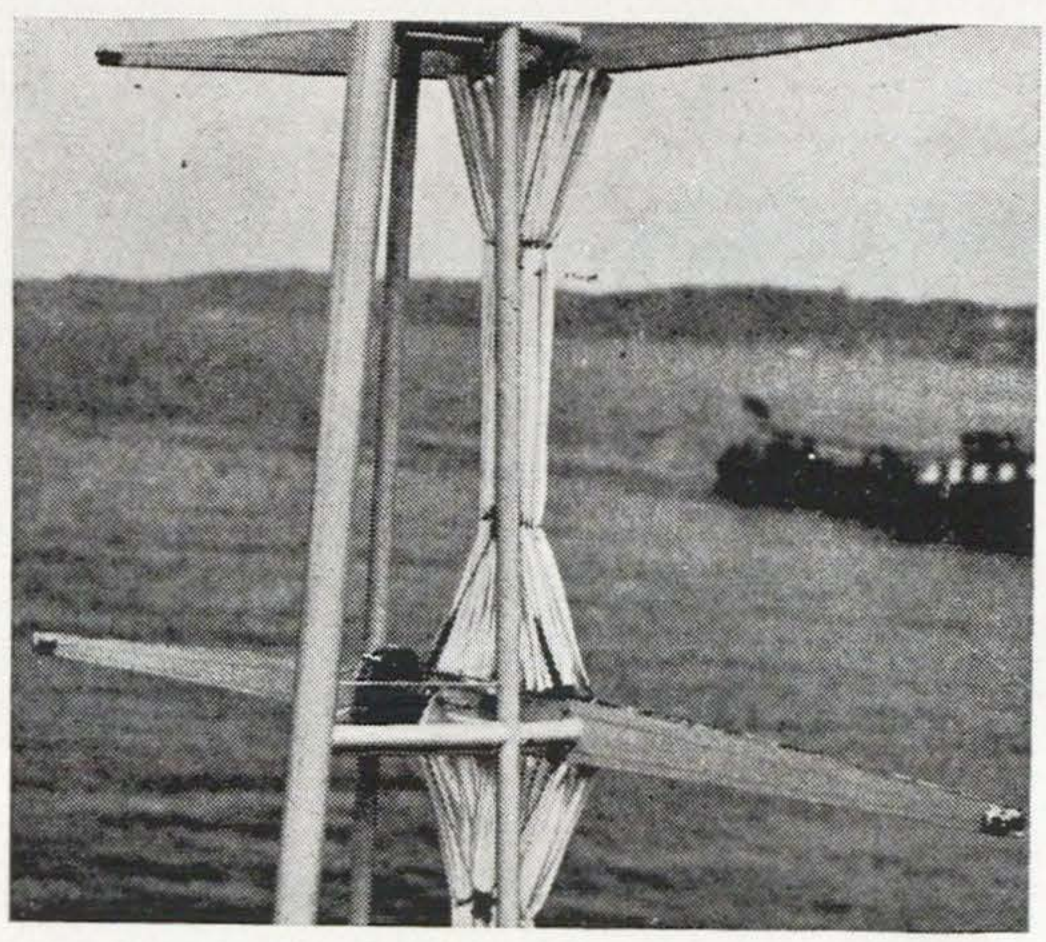


Fig. 4

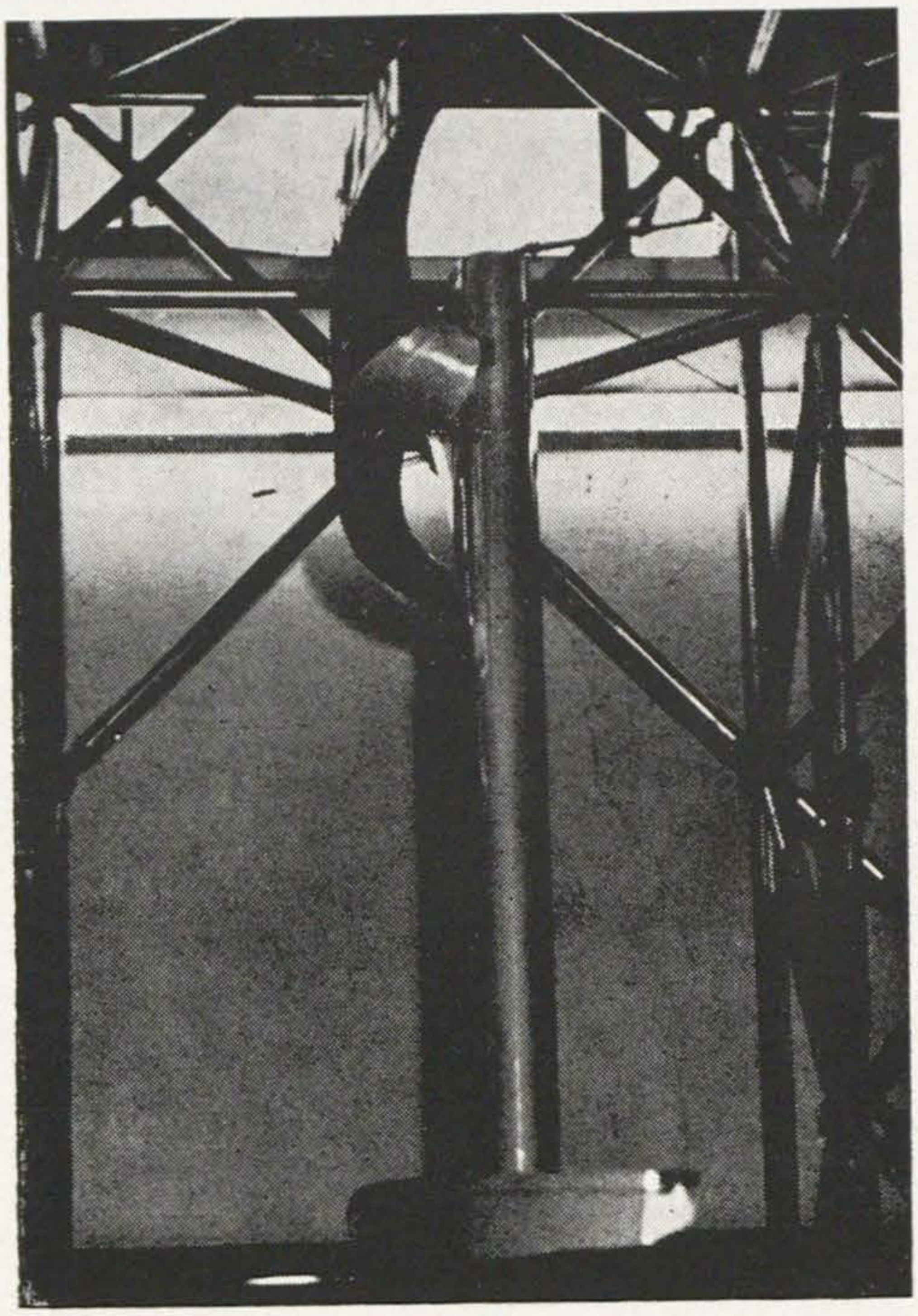


Fig. 5

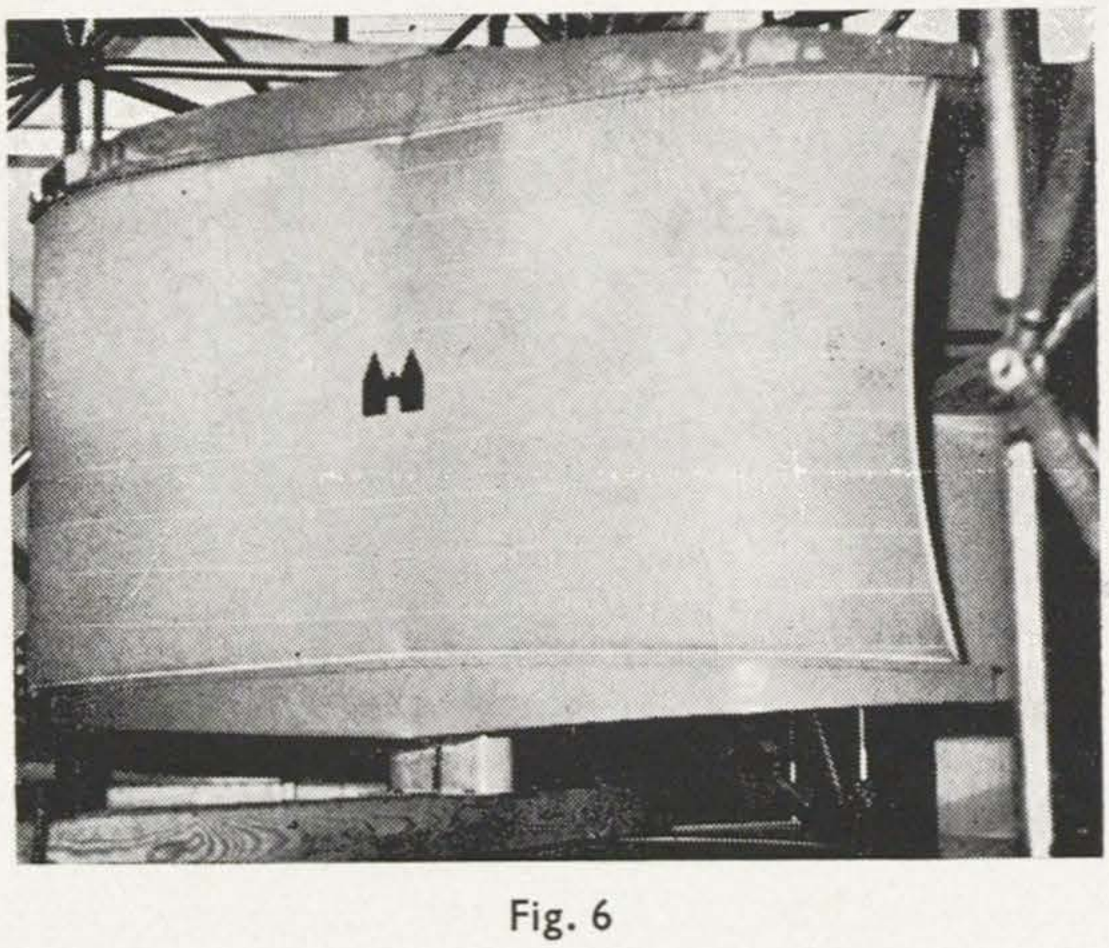


Fig. 6

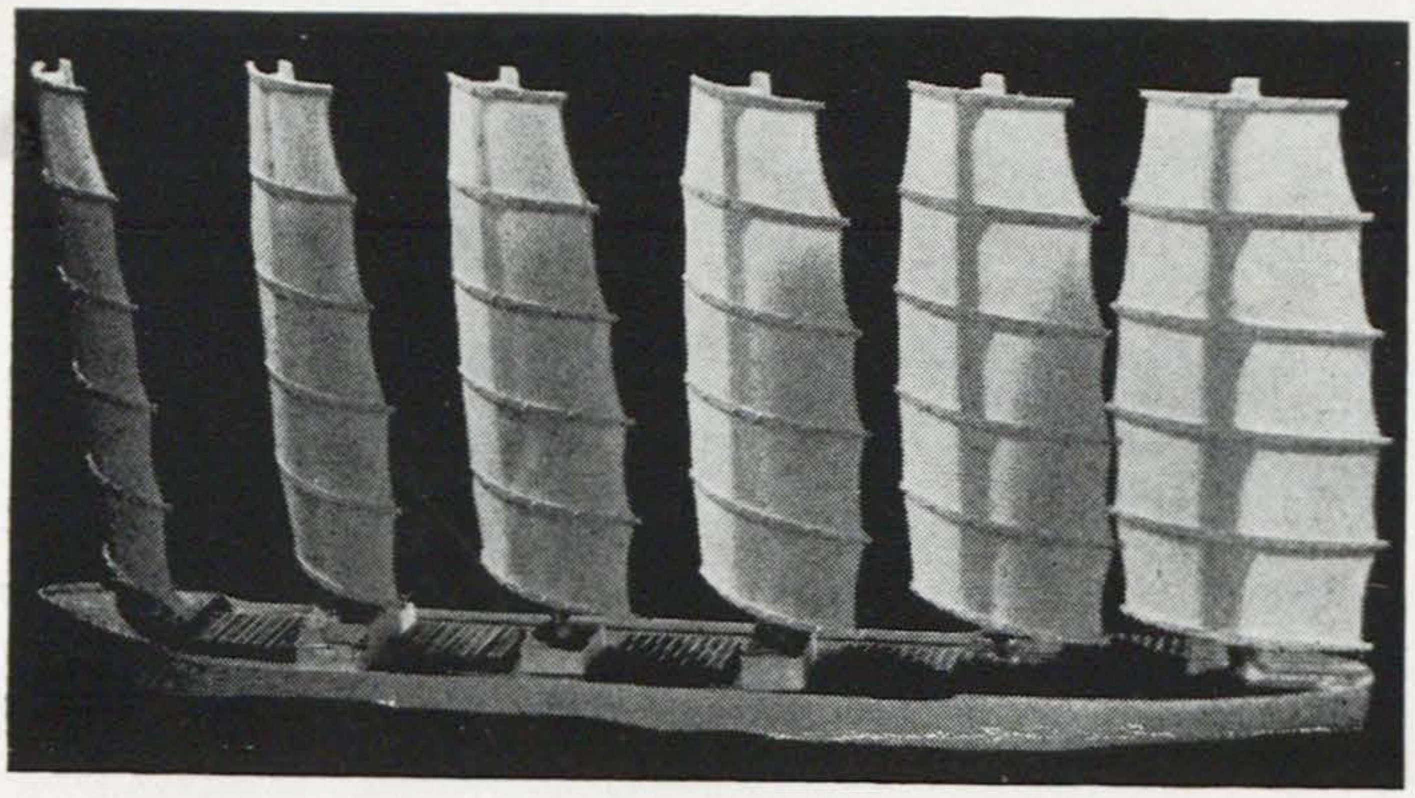


Fig. 7 Cantilever mast rigged model

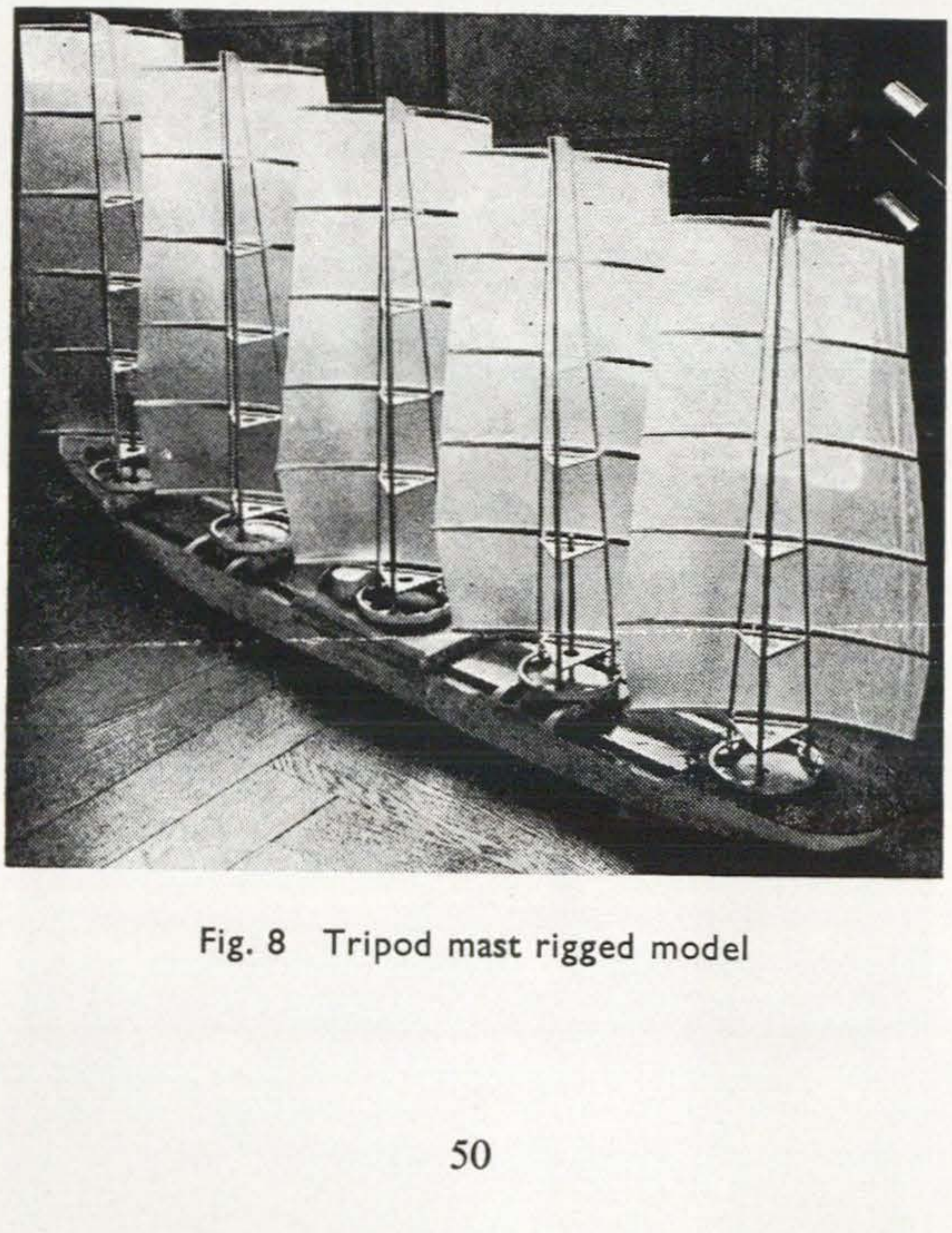


Fig. 8 Tripod mast rigged model

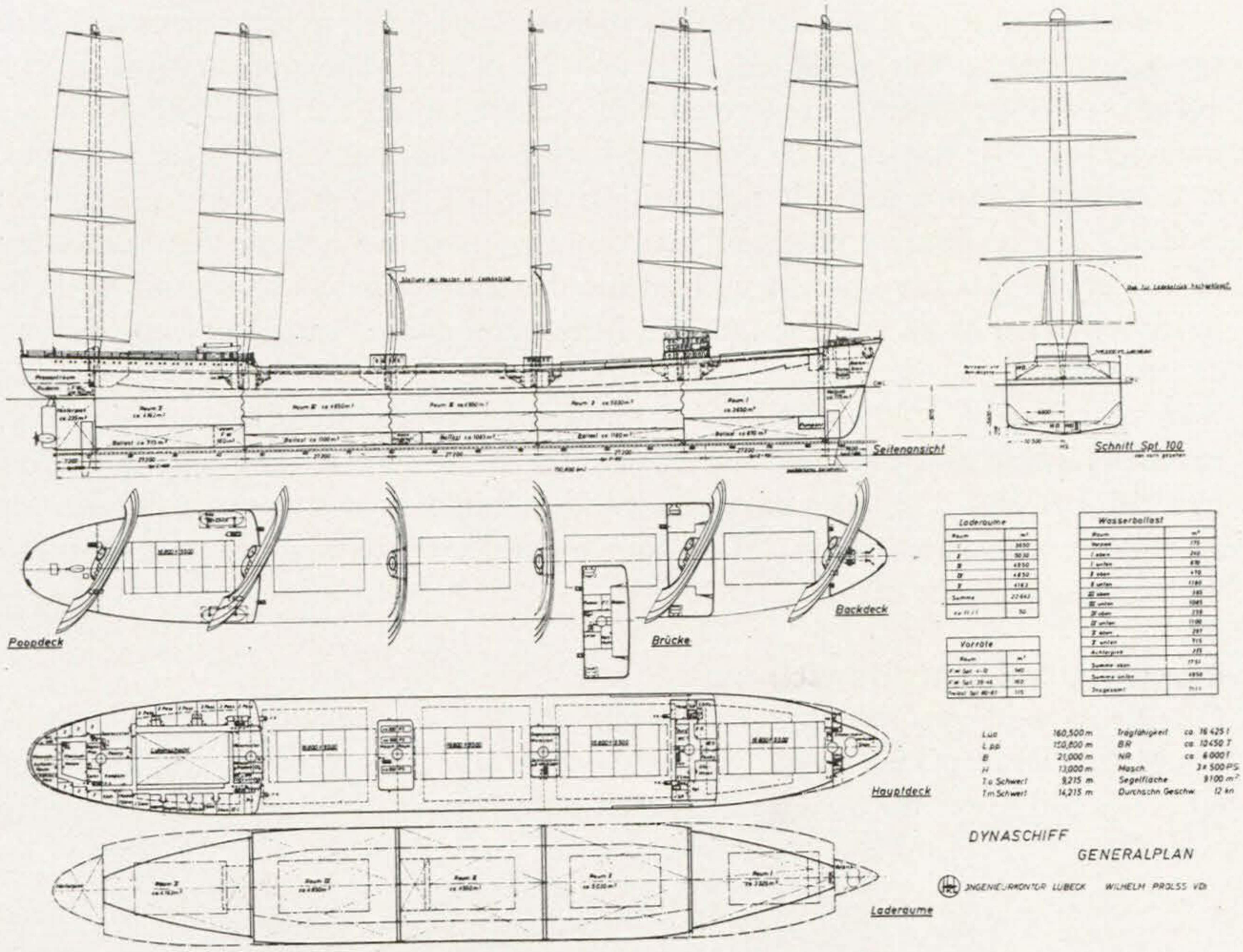


Fig. 9 General layout of a sailing bulk carrier

The operation of sailing ships

How should one sail such a ship? Mr. Wagner's (ref. 12) concept of 'Average target speed' is a good way of comparing ships types and sea routes, but only in exceptional cases does it give absolute and satisfactory journey times. For this we have to study the weather pattern so as to seek out zones of strong wind and deliberately sail at the boundary of high pressure zones. This, although increasing the distance sailed, will minimise the overall voyage time.

This type of navigation is age-old and well established, but only became reliably effective since the development of weather broadcasting and other meteorological aids, including the pictorial transmission of weather maps. The full effectiveness of this can only be assessed by experience.

There still remains the problem of being becalmed. At best it is time consuming, but can be dangerous if near a shore. Nowadays there are available auxiliary power units ideally suited to sailing ships. They can be push-button started, require no machinery space below decks, exert no drag when under sail and still provide good manoeuvring power. The optimum is provided by a small power unit and hydraulic transmission with a propeller placed into a pod. The same power unit can be used to drive the ballast pumps and provide power for the operation of the rigging. In this case, the auxiliary power plant will not have to be any larger than one conventionally employed on a similar size cargo ship.

Remote handling and automation is nowadays a self-evident necessity and the new rigging was designed with this in mind. The automation of the aerodynamic propulsion is provided by nature, since the wind blows on its own accord. If this is to be compared with a main engine of a cargo vessel, it is a much more difficult proposition to state how much automation is technically possible, commercially advantageous or acceptable for the safety of the ship. In any case, a conventional cargo ship has no stand-by propulsion system at all and the failure of the main engine can have very serious consequences.

In conclusion, the proposed arrangement offers a ship that is safe, manoeuverable and of sufficient speed. It can also be loaded and unloaded quickly. It also requires a small crew and offers pleasant working conditions and living accommodation. The ship is subjected to a minimum of noise and is more steady at sea.

Commercial considerations

Calculations of profitability for cargo ships is complicated and depends upon the assumptions used. These vary from case to case and one can compare only specific voyages. Therefore, in this short report, one can only

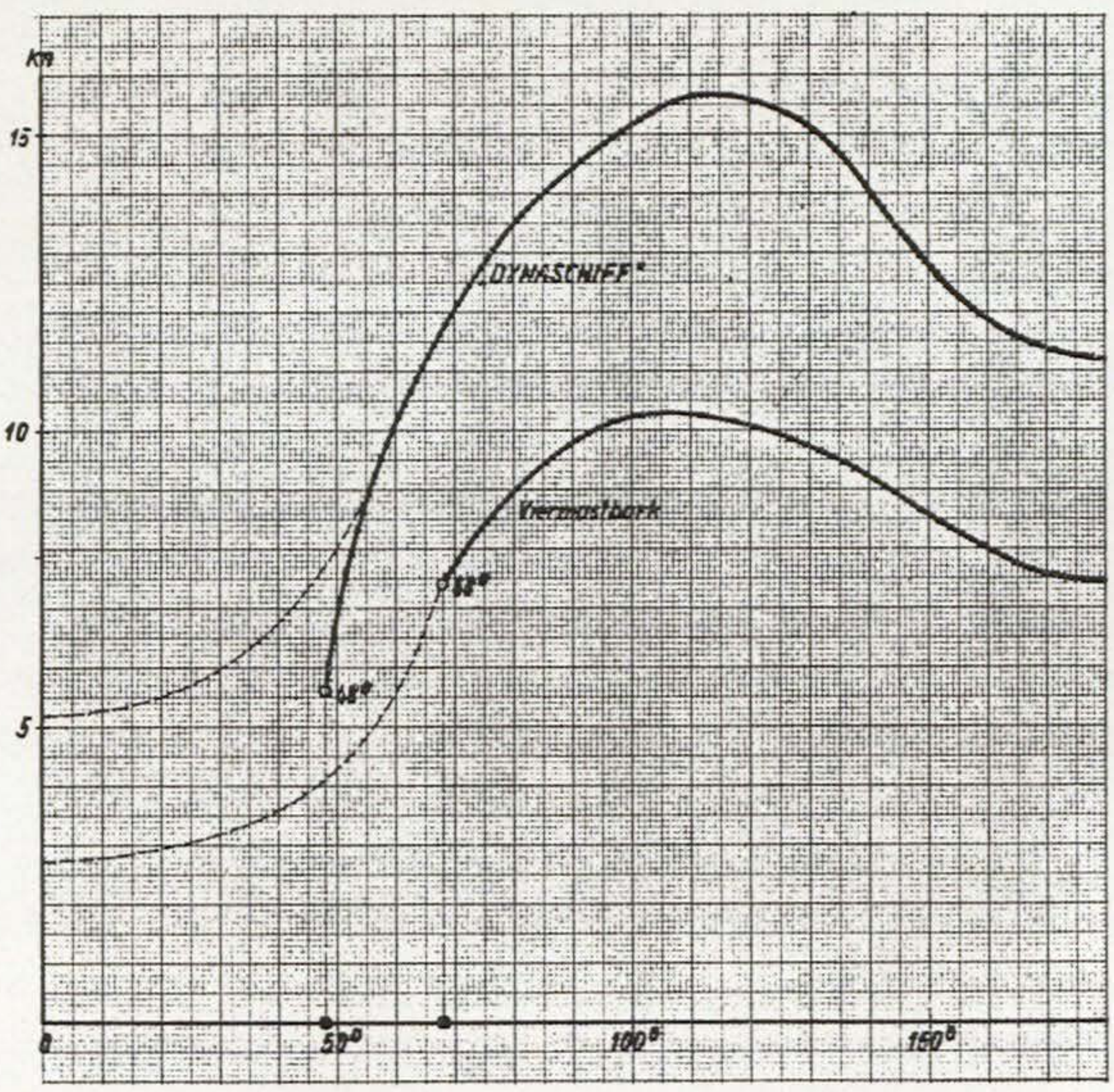


Fig. 10 Speed curves to course to true wind of four masted barque and *DYNASCHIFF*

indicate relative values, examples and facts to be considered. (13, 14 & 15).

Illustration 10 shows the gain of speed (60 per cent at wind force 4 to 5) to be had by aerodynamically correct sails. To this can be added any further gain due to meteorological navigation and the use of auxiliary engine.

Illustration 11 gives the effective sailing speeds for given wind force and course. This item is envisaged as a transparent perspex plate for use on the navigation bridge. The right hand half is used for determining the optimum

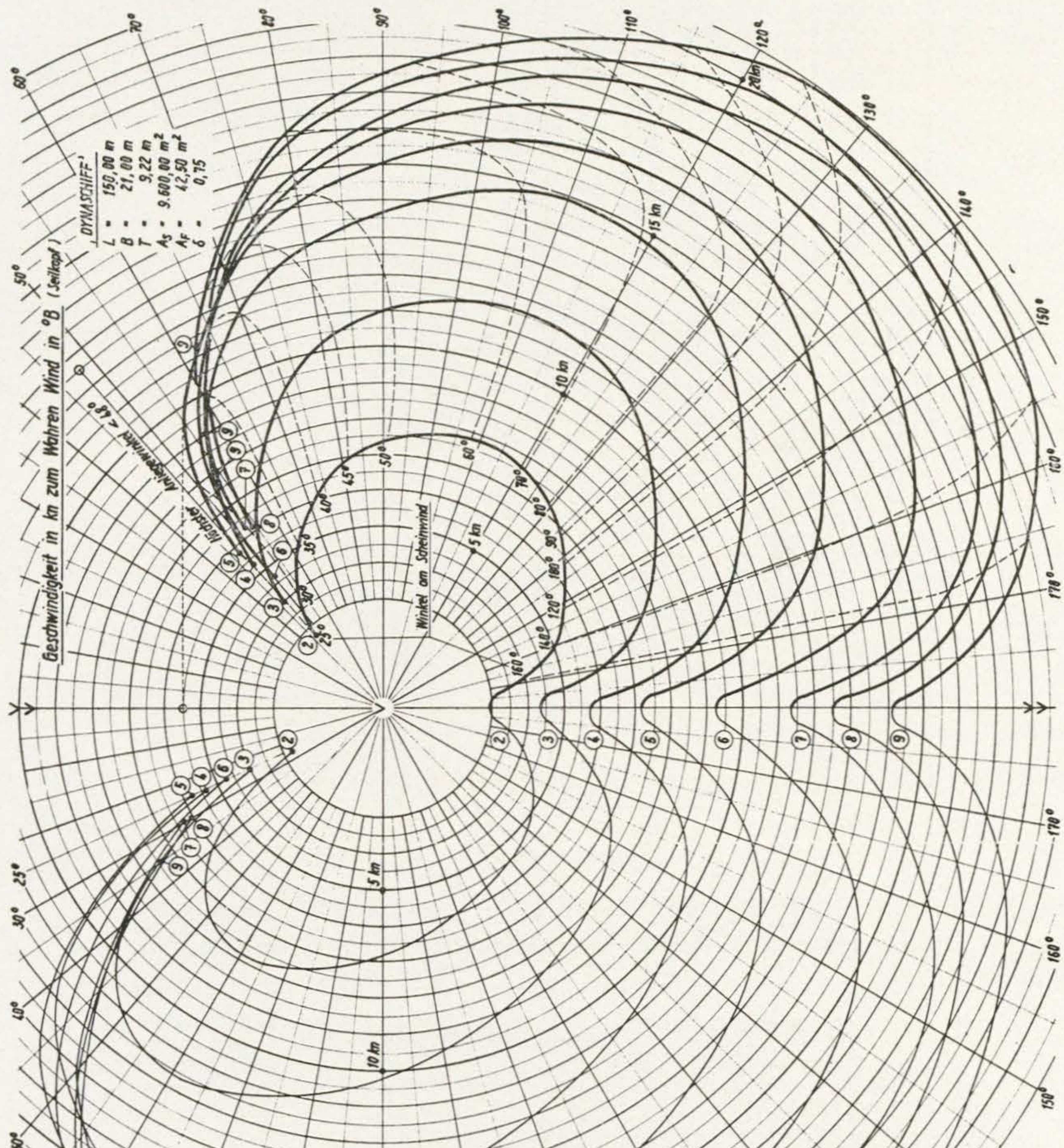


Fig. 11 Polar curves in Beaufort wind scales 2-9. Apparent wind curves on left. True wind curves on right

course relative to the wind direction. The left hand half can be marked with all other information required to achieve optimum sailing conditions. In conjunction with a wind and drift indicator, speed log, compass and chart, this diagram will permit a very close approach to optimum voyage speed.

Illustration 12 indicates the crew requirements for different type of ships.

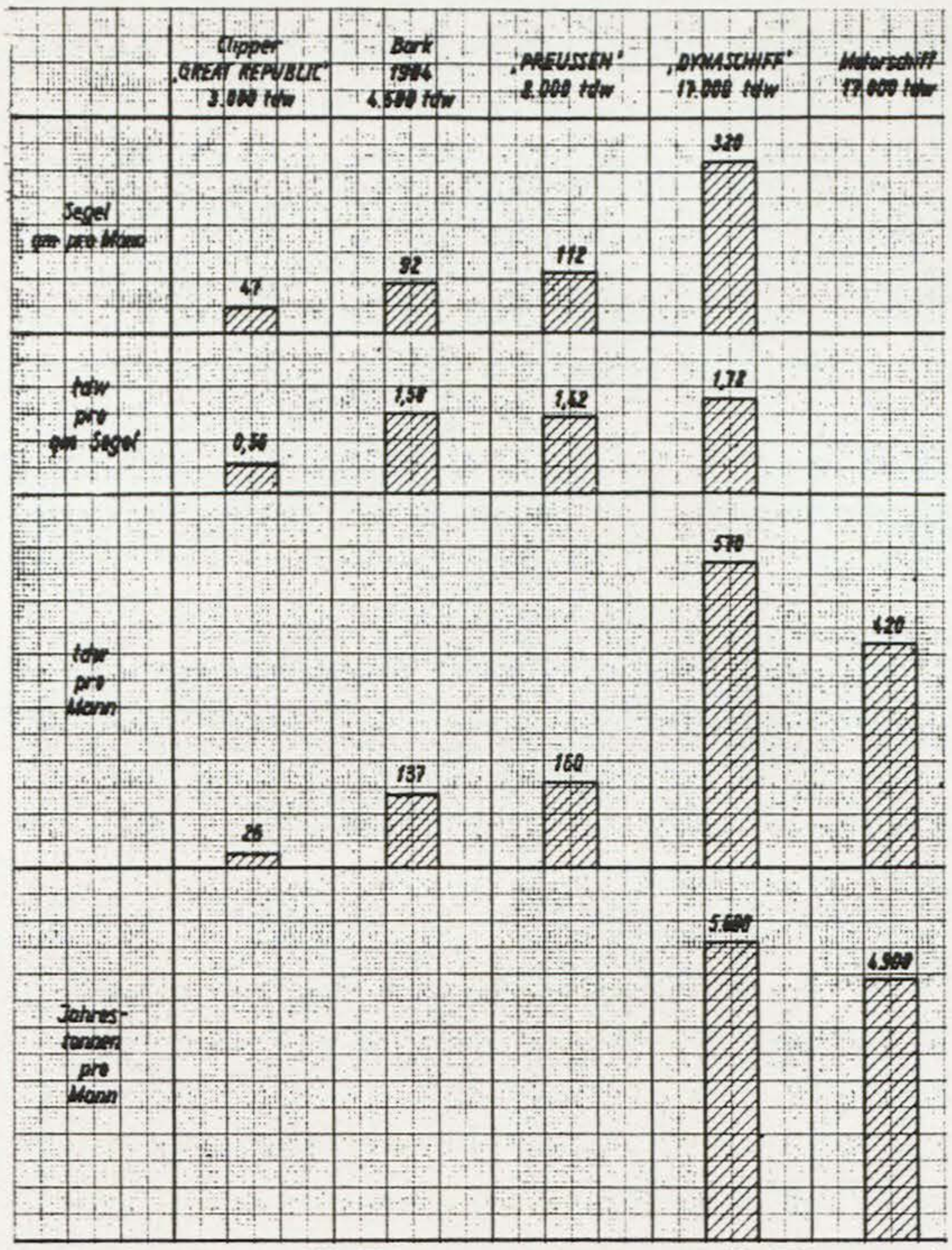


Fig. 12 (1) Sail area for man. (2) Tdw per sq meter. (3) Tdw per man. (4) Yearly tonnage per man

Illustration 13 indicates the commercial comparison required. The voyage Hamburg-Hampton Roads was selected for comparison, since a backlog of information was available as regards costs and weather conditions.

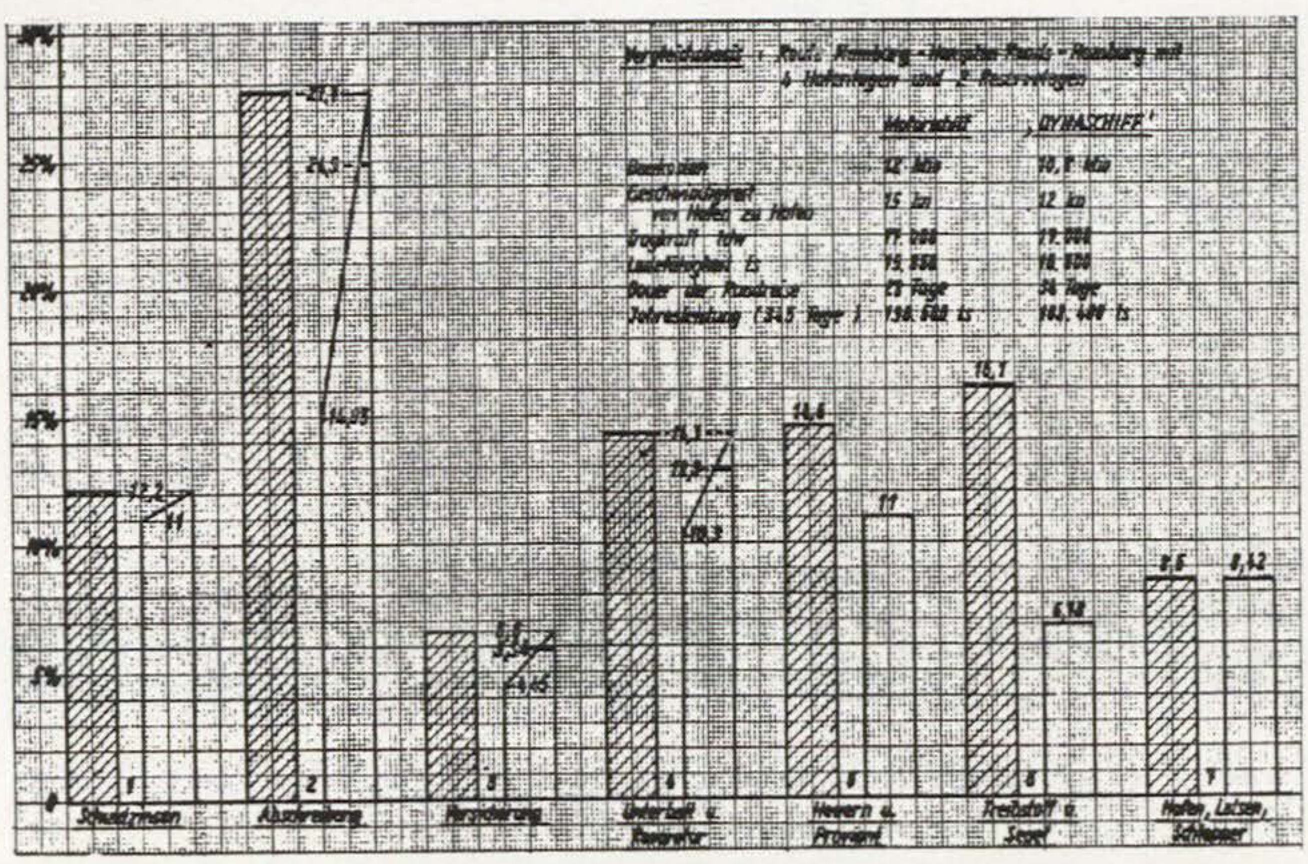


Fig. 13 Cost comparisons of motor cargo ship and *DYNASCHIFF* for 7 items

The shaded areas show the percentage annual charges of a motor cargo vessel and besides, for comparison, the anticipated costs of running a modern sailing ship.

Assumptions used

1 3.65 per cent Half value interests on total capital outlay.
2 The depreciation (12 years) can be shorter or final value higher due to less deterioration. (No motor or propellor vibrations or due to being less technically out of date).
3 Insurance 2 per cent of building cost due to being a smaller fire risk.
4 Maintenance and repair 4.3 per cent of building costs. Reduction due to to minimal use of machinery. Ready exchange of small components and shorter docking time.
5 Crew requirement for machinery smaller.
6 Fuel and sails—costs about same.
7 Pilotage costs, tugs and harbour charges are provisionally set at 1/5 higher for sailing ships.

If these annual costs are divided by the cargo carried, five possibilities can be considered.

a Equivalent costs when just considering the saving in manpower and fuel.
b 5.5 per cent costs considering the reduced capital outlay required.
c 10.5 per cent when considering the additional advantage of reduced insurance premiums and repair costs.
d 22 per cent when considering the reduced depreciation.
e 30 per cent when carrying bulky cargo due to more roomy cargo space.

It is understood that these percentages are only valid when the above assumptions are used and other assumptions will result in different costs. Additional days in harbour and docking during public holidays will bias costs in favour of slower ships regardless of propulsion used. Different size of vessel and other cargo routes require a separate study.

Conclusions

The original project aim was to establish if a sailing ship could compete with an engine propelled vessel, taking into account the present knowledge of aerodynamics and technology. During these investigations it became apparent that in many cases there was an appreciable cost advantage in favour of a sailing ship and of a magnitude, that could not be disregarded.

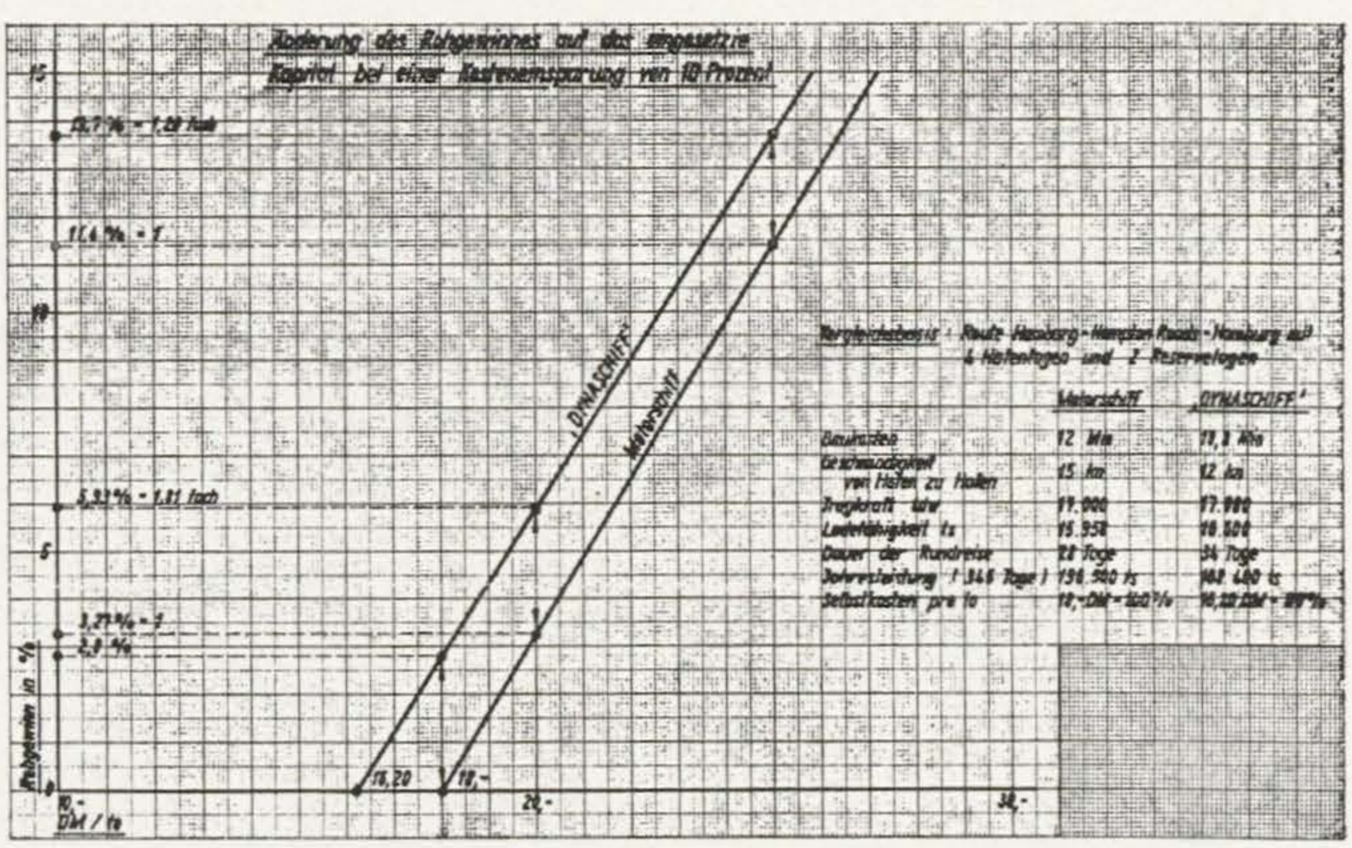


Fig. 14 Shows an increase of 10 per cent in return for the capital invested in *DYNA-SCHIFF* over a motor cargo ship

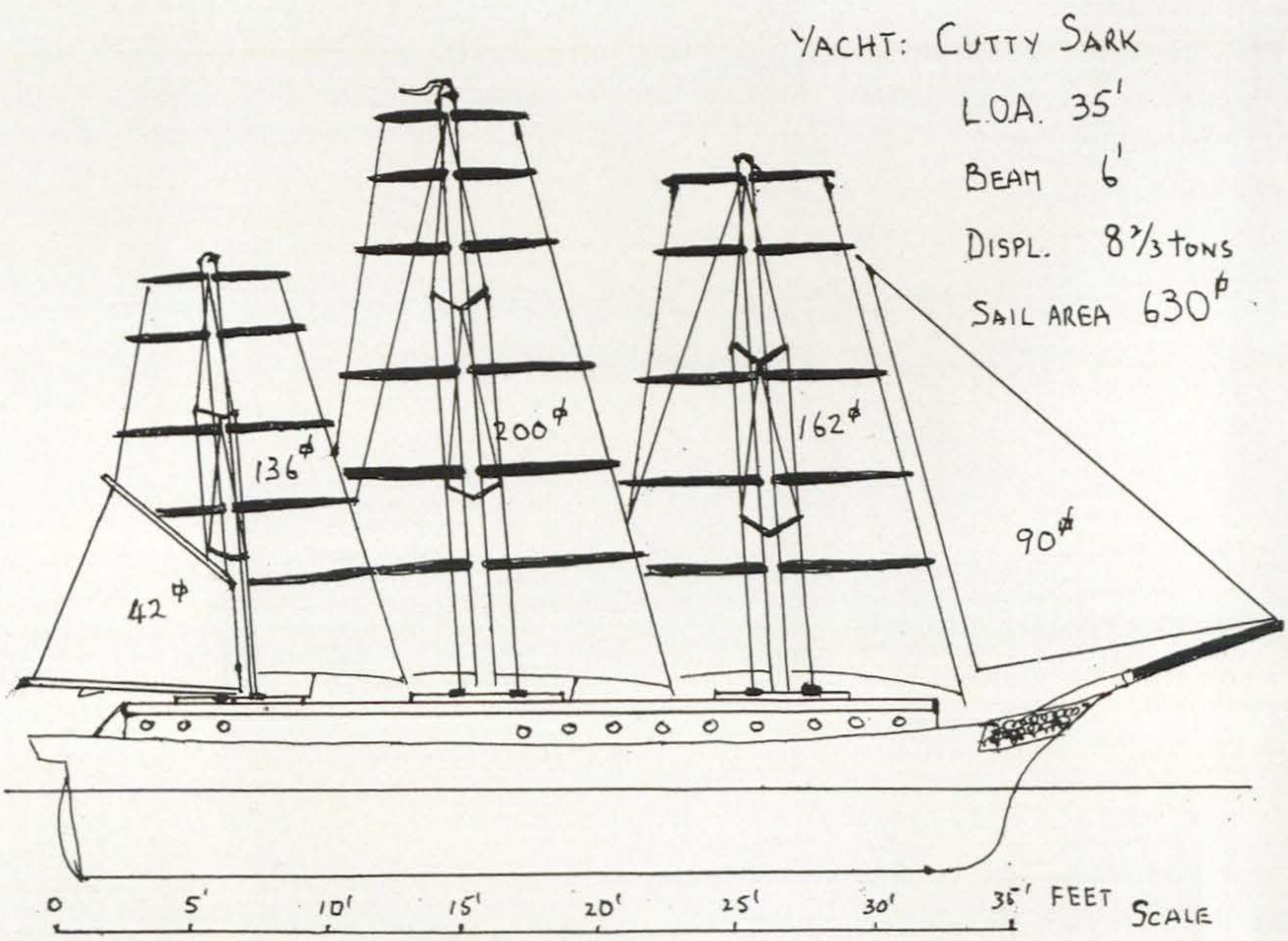
It is also true, that nowadays one can estimate the cost of a journey with appreciable greater accuracy than the accuracy of the assumptions used in the calculations and derived from the factual information available. The estimated advantages can therefore only be confirmed by a prototype. Due to the exceptionally thorough scientific and technical investigation, the unavoidable risks associated with such an undertaking have been reduced to a minimum.

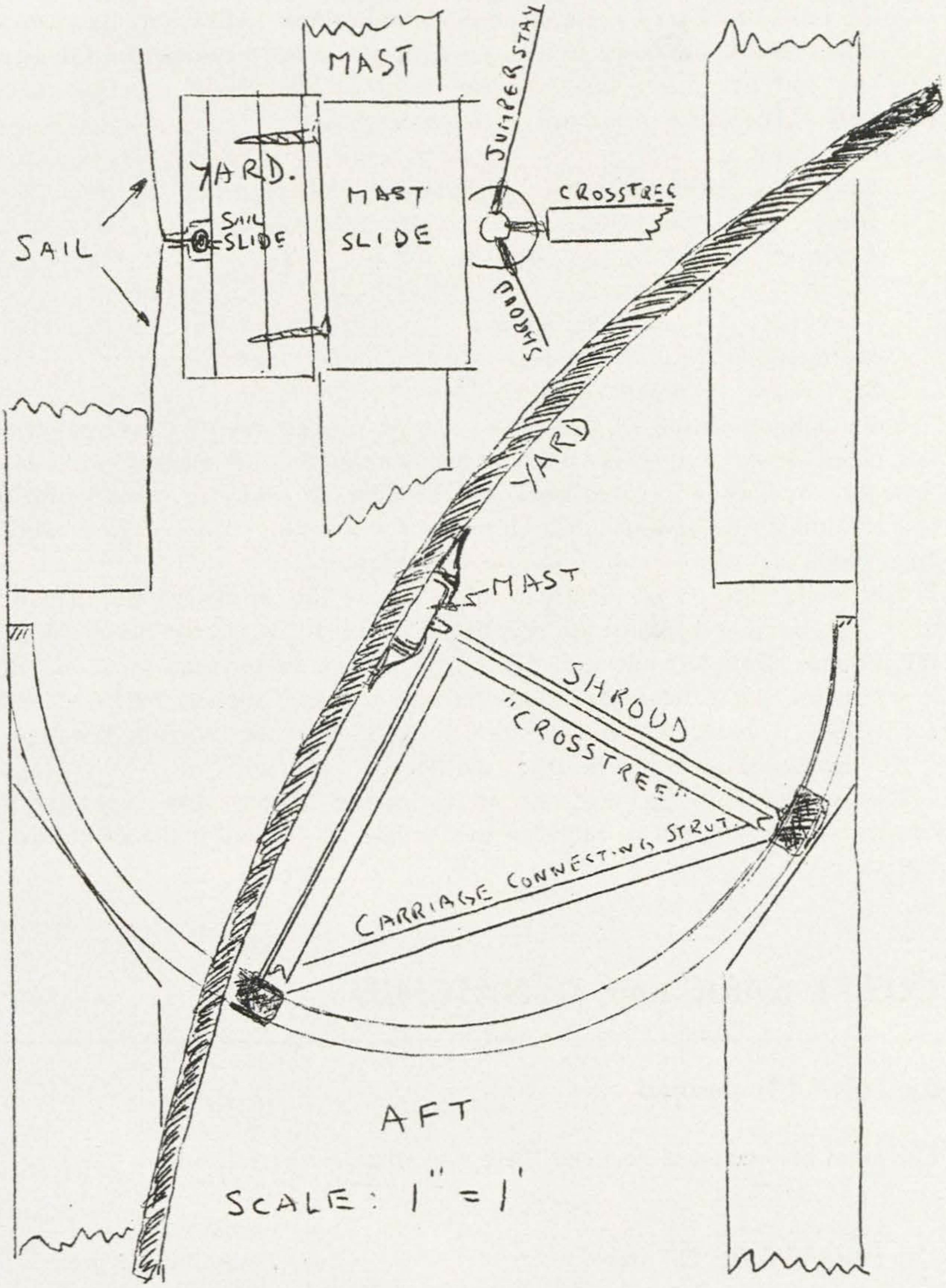
This short report has endeavoured to outline a development, which has covered 10 years. Without help and assistance the author would have been unable to complete this long task. It is impossible here to list even a small number of contributors. I would especially like to thank Dr. Ing. Weinblum, the Research Establishment and Authorities of the Hansatown of Hamburg and finally the Technical Institute of Shipbuilders.

A CUTTY SARK YACHT

by John Morwood

CUTTY SARK and *THERMOPOLAE* were the two fastest British square rigged 'Clipper Ships'. They could both sail 'within 5 points from the wind' when close-hauled at a speed of 14 knots, were fast when running in the 'Roaring forties' in the southern winter and their sea motion was the easiest possible.





My present suggestions is that a one sixth scale model of *CUTTY SARK* would make an excellent yacht. Professional yacht designers have been horrified by this suggestion, probably because the result doesn't look like the yachts which they are designing. However, we can know the expected performance as follows:—

The performance of models can be predicted with great accuracy. A one sixth scale model will behave just like the full scale in a windspeed of the square root of 6. That is, the yacht I suggest in a 10 knot wind will behave like the full sized *CUTTY SARK* in a 25 knot wind. However, by stowing the inside ballast low down in a way which would have caused the full sized ship to 'roll her masts out', we can improve the model's pefrormance, relatively. The dimensions are as follows:—

	CUTTY SARK:	*YACHT:*
Length	212 ft 5 in	35 ft
Beam	36 ft	6 ft
Draft	21 ft	3 ft 6 in
Depth	30 ft	5 ft
Tonnage	1,884 tons (laden)	$8\frac{2}{3}$ tons
Materials	Composite teak	PVC foam-fibreglass
Sail area	30,000 sq ft	630 sq ft

Some modernisation of the rig would be needed such as having bent, laminated yards sliding up plank masts; stainless steel rigging wire stays brought down to a circular track on the deck so that the yards could be braced almost fore and aft. On all masts, the five sails of the original would be a single sail but would appear to be separate.

The modernisation of the rig would increase the windward performance to be very comparable with the best of the R.O.R.C. or C.C.A. fleets. From the arguments already adduced, she might even be better than most, though it is possible that a 'false keel' might have to be added such as *THERMOPOLAE* used. I guess that this was rather like that of the Norfolk Wherry.

All sail handling would be from the deck.

The mizzen and 'Spanker' would be rather tedious and expensive to construct. They could be replaced by a single, jib-headed mainsail of about 150 sq ft.

CUTTY SARK and DYNASCHIFF

by John Morwood

The main comparisons between these two ships are as follows:—

DYNASCHIFF:	*CUTTY SARK:*
Five masts	Three masts
Lesser relative sail area	Greater relative sail area
Lower relative height of rig	Higher relative height of rig
Inelegant hull shape	Elegant hull shape

From these facts, we infer the following:—

1 Closer pointing to the apparent wind of *CUTTY SARK*.

2 Greater speed close-hauled of *CUTTY SARK*.

3 More drive for each unit of sail area of *CUTTY SARK*, on all courses, but especially to windward.

As regards the polar curve which has been drawn for *DYNASCHIFF*, this means that *CUTTY SARK* will improve the close-hauled part of the curve, as could be expected but it will also improve the downwind part from γ equal to 140° to 160°.

The close-hauled course

DYNASCHIFF will, according to the polar curve, sail close-hauled at a β angle of 45°. As I have said, I believe that the original *CUTTY SARK* could sail at a β angle of 28° and a *CUTTY SARK* model yacht of 36 ft in length with a 'cleaned up' rig should do far better than this. I see no reason from the polar curves of *DYNASCHIFF* to doubt this viewpoint.

From the *DYNASCHIFF* polar curves, it will be seen that at a γ angle of 110°, *DYNASCHIFF* will sail at 8 knots in a 5 knot wind. However, when close-hauled at a γ angle of 55°, the speed falls to 4 knots in a 5 knot wind. From the above and the noted behaviour of the original *CUTTY SARK* and *THERMOPOLAE*, where they did 14 knots close-hauled (this is approximately $\sqrt{L}$ for a 200 L.W.L. ship) our *CUTTY SARK* yacht will sail far faster than *DYNASCHIFF* close-hauled (in proportion to her size).

SPEED MADE GOOD TO WINDWARD

by Edmond Bruce

"Lewis Cove", Hance Road, Fair Haven, New Jersey, U.S.A.

The following discussion may startle many sailors. Theoretically, a sailing-craft may be too fast for achieving any worthwhile 'speed made good' to windward! One had better slow it down by reducing the sail area! An optimum sail area exists, for windward work, even when heeling is not the sail limitation. This discussion also will provide the magnitudes that are missing from the 'course theorem' which is only angular in content.

For understanding, one must be familiar with the well-known sailing vector triangle. It is shown in fig. 1 with all of its components labelled. β° is any course angle to the apparent wind, for the boat. This, in turn, is the sum of the drag angles of the sail and the hull, according to the 'course theorem'. γ° is the course angle to the true wind. V_B is the vectorial boat speed, showing magnitude and direction. V_A is the vector speed of the apparent wind while V_T is, likewise, the speed and direction of the true wind. V_{MG} is the desired 'speed made good' directly into the true wind.

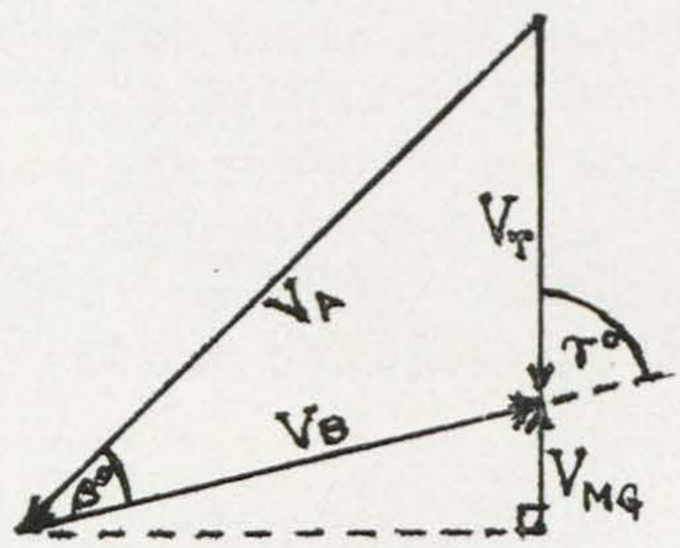
Knowing the sum β° of the minimum possible drag angles, also the specified boat speed V_B and the true wind V_T, the entire triangle can be completely determined. This is true providing that there is the proper amount of sail area to drive the boat at the speed specified. Any greater sail area would cause hull stalling. Thus there is an optimum sail area.

As an example, suppose that we have a very fast, non-heeling multi-hull having a large, but variable, sail area and light-weight hulls. Assume, for example, that the minimum drag angles for the sail and for the hull are each 15°. Then the minimum possible course angle β° to the apparent wind becomes 30°.

A lesser angle would encounter either a hull or a sail stalling condition. These are quite practical angles, not exceptionally low values.

Due to a sufficiently large sail area and the light hull weight, assume, as shown in fig. 2-A, that the resulting speed ratio $V_B/V_T = 1.73$. This was chosen so as to have a convenient 30°-60°-right triangle. Because it is a right triangle, as shown, the 'speed made good' to windward is zero on its highest pointing course!

Suppose the sail area is reduced somewhat so that the speed ratio becomes $V_B/V_T = 1.50$, in the same true wind V_T, as shown in fig. 2-B. The Class D



V_T is True Wind Velocity.
V_B is Boat Velocity.
V_A is Apparent Wind Velocity.
$\beta°$ is Boat's Course Angle to Apparent Wind.
$\tau°$ is Boat's Course Angle to True Wind.

Fig. 2-A.

$\frac{V_B}{V_T} = 1.73.$

$\frac{V_{MG}}{V_T} = 0.$

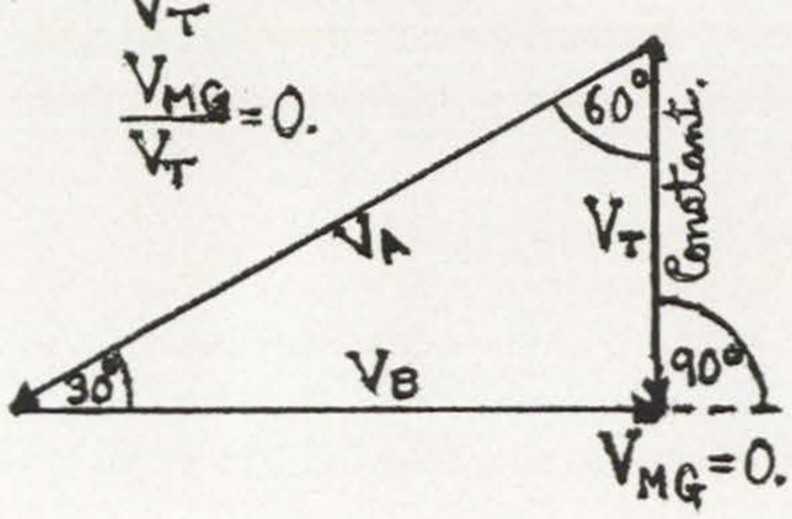


Fig. 2-B.

$\frac{V_B}{V_T} = 1.50$

$\frac{V_{MG}}{V_T} = 0.28.$

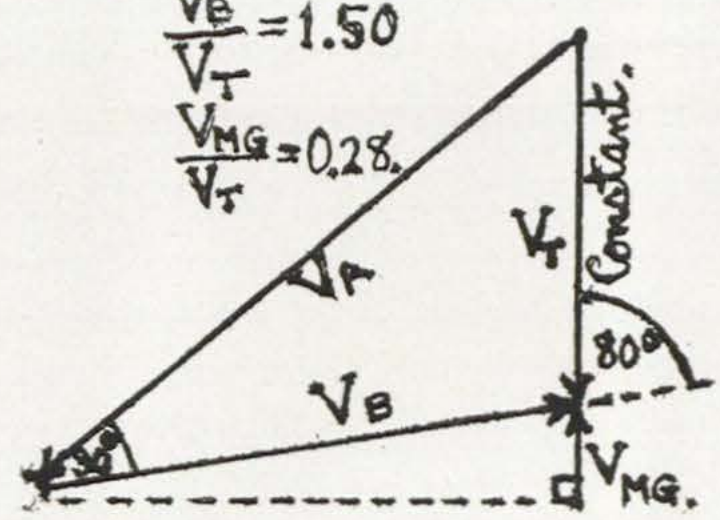


Fig. 2-C.

$\frac{V_B}{V_T} = 1.00.$

$\frac{V_{MG}}{V_T} = 0.50.$

Optimum.

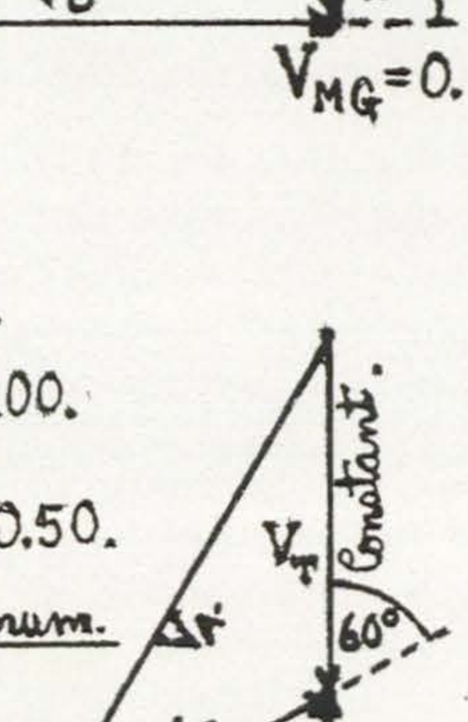
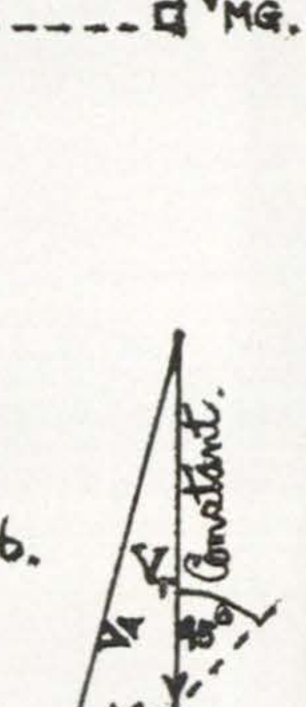


Fig. 2-D.

$\frac{V_B}{V_T} = 0.50.$

$\frac{V_{MG}}{V_T} = 0.36.$



Catamaran *WILD-WIND* and several Class Cs are supposed to have achieved this ratio. Thus all this is not fantasy. We are discussing today's developments. For similar shaped sails, there is no reason to believe that less sail area changes the sail's minimum drag angle, therefore the minimum course angle, $\beta^\circ = 30^\circ$, is as before. As a result, the 'made good' ratio now is increased to $V_{MG}/V_T = 0.28$ from the previous zero.

In fig. 2-C, the speed is further reduced to $V_B/V_T = 1.00$ by a still smaller sail area. Now $V_{MG}/V_T = 0.50$, a substantial increase. In fig. 2-D, a further sail reduction causes $V_B/V_T = 0.50$. Now one obtains only $V_{MG}/V_T = 0.36$, therefore the sail reduction has been carried too far. The case where $V_B/V_T = 1.00$ and $V_{MG}/V_T = 0.50$, as shown in fig. 2-C, can be proved to be the optimum situation for $\beta^\circ = 30^\circ$.

We have not been aware of the advantages of variable sail area, in practical sailing, because our sails have been, generally, on the skimpy side. This was forced upon us by a heeling limit. Non-heeling configurations will change this.

A mathematical analysis of all this is at hand but seems too involved to interest the majority of AYRS readers. It requires differentiation of transcendental functions, etc. One can simply scale the vectors and angles, of fig. 2, for an easy check, if desired. However, the final results can be stated mathematically.

For any minimum course angle β°, the largest 'speed made good', that is possible, can be written:—

$$\frac{V_{MG}}{V_T} = \tfrac{1}{2}\left(\frac{1}{\sin\beta^\circ} - 1\right).$$

This equals 0.50 for $\beta^\circ = 30^\circ$, as illustrated in fig. 2-C. Also, for this case, the boat speed is:—

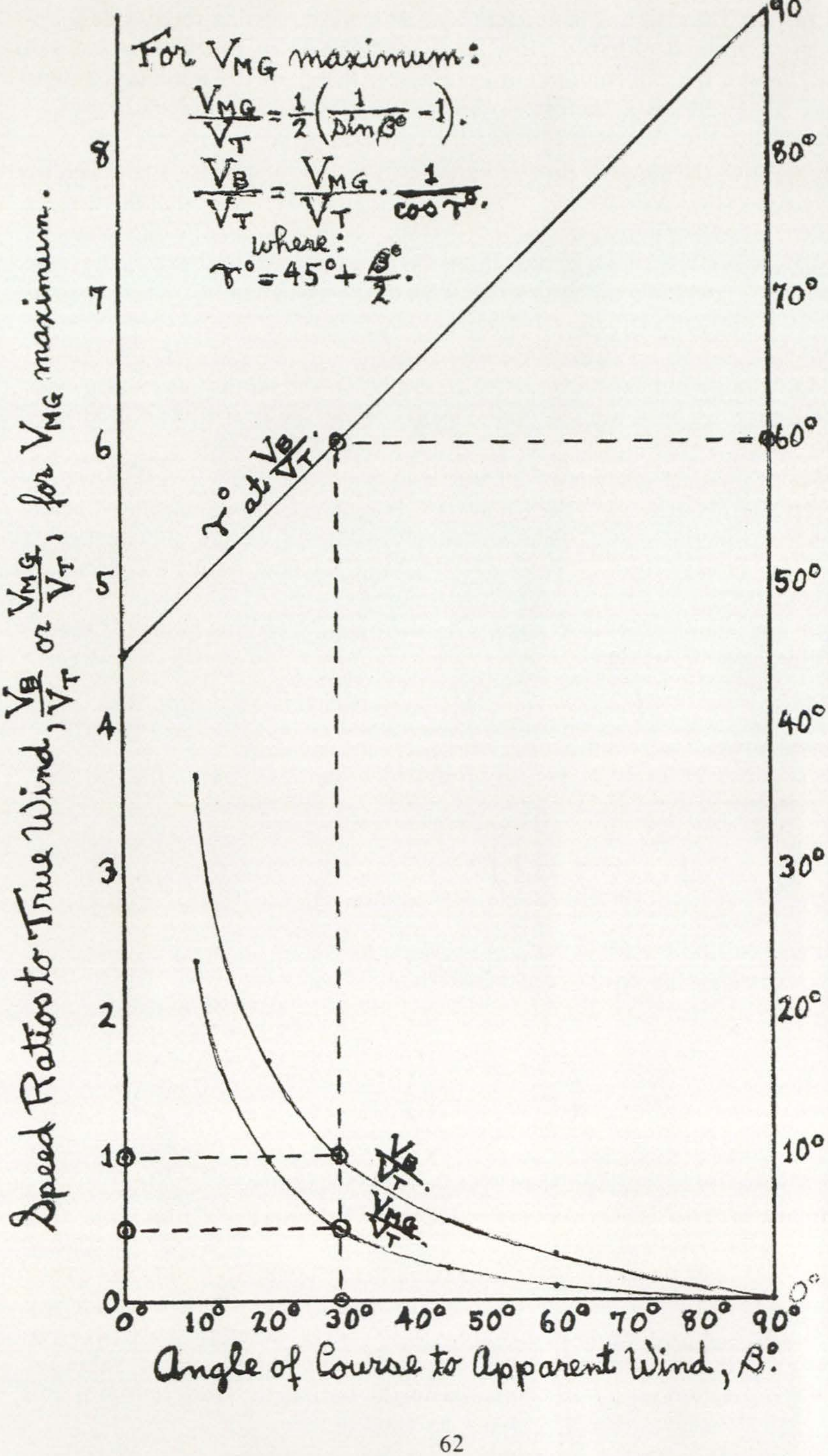
$$\frac{V_B}{V_T} = \tfrac{1}{2}\left(\frac{1}{\sin\beta^\circ} - 1\right)\frac{1}{\cos\gamma^\circ} = \frac{V_{MG}}{V_T}.\ \frac{1}{\cos\gamma^\circ}.$$

This equals 1.00 for $\beta^\circ = 30^\circ$, as shown. As for γ°, in previous equation, when achieving the best 'speed made good':—

$$\tan\gamma^\circ = \frac{1}{\tan\beta^\circ\left(\dfrac{1}{\sin\beta^\circ} - 1\right)}.\ \text{or } \gamma^\circ = 45^\circ + \frac{\beta^\circ}{2}.$$

It can never be smaller than 45° except by slowing down. See fig. 3 for a summary of V_{MG} curves for any value of β°. Lowering β°, thus the drag angles, is always benefiical.

Fig. 2-D is of further interest in that, rather than showing only the effects of a sail reduction, it also shows, for a fixed sail area, why it does not pay to 'pinch' when sailing to windward. It is sailing closer to the true wind, because of the smaller value of γ° for V_B/V_T. It has a reduced value for V_B/V_T and also V_{MG}/V_T as compared to the optimum. Note that it is still



For V_{MG} maximum:
$\frac{V_{MG}}{V_T} = \frac{1}{2}\left(\frac{1}{\sin\beta^\circ} - 1\right).$
$\frac{V_B}{V_T} = \frac{V_{MG}}{V_T} \cdot \frac{1}{\cos\gamma^\circ}.$
where:
$\gamma^\circ = 45^\circ + \frac{\beta^\circ}{2}.$
γ° at $\frac{V_B}{V_T}$.
$\frac{V_B}{V_T}$
$\frac{V_{MG}}{V_T}$
Speed Ratios to True Wind, $\frac{V_B}{V_T}$ or $\frac{V_{MG}}{V_T}$, for V_{MG} maximum.
Angle of Course to True Wind, γ°, for V_{MG} maximum.
Angle of Course to Apparent Wind, β°.
0 1 2 3 4 5 6 7 8
0° 10° 20° 30° 40° 50° 60° 70° 80° 90°

sailing at the lowest possible sail and hull drag angles, since they are unchanged. $\beta^\circ = 30^\circ$ as before. It is the reduction in the boat's magnitude of speed V_B that altered the apparent wind V_A so as to enable this.

John Morwood pointed out to me that a boat may be sailing at its best drag angles whether it is pointing on its highest course or striving for its best V_{MG} by sailing slightly freer. It was only after the above calculations that I realised that this was possible.

This statement is important. On *any* course, the sail area should be increased until the minimum possible apparent course angle β° is reached, for highest speed. This establishes the optimum sail area when non-heeling foils are employed. The actual sail area must be obtained from empirical curves of sail and hull as in the writer's article in AYRS No. 61. Such curves also reveal the drag angles.

The vector triangles, of fig. 2, can be used to illustrate why a slower boat often can point higher, to the true wind or a mark, than a faster boat but the former loses in V_{MG}.

Mr. Bert Goldstone of Sudbury, Massachusetts, U.S.A., a member of AYRS, has been working, for some time, on related analyses. He has obtained, among other things, an upper limiting speed along any course for an ideal boat. It gives a goal to strive for. He also pointed out the truth that the locus of the apex of β° is always a circle if β° and V_T are held constant. This greatly simplifies the mathematics required by employing the geometry of a circle. Possibly we will hear from him in the future.

Does the reader still insist on claiming to be expert on how to best sail to windward? We have a lot yet to learn. This is what makes sailing technology so interesting. Any discovery or new understanding is exhilarating.

POLAR CURVE OF *COQUI ARROWHEAD* TRIMARAN

by Henry A. Morss, Jr.

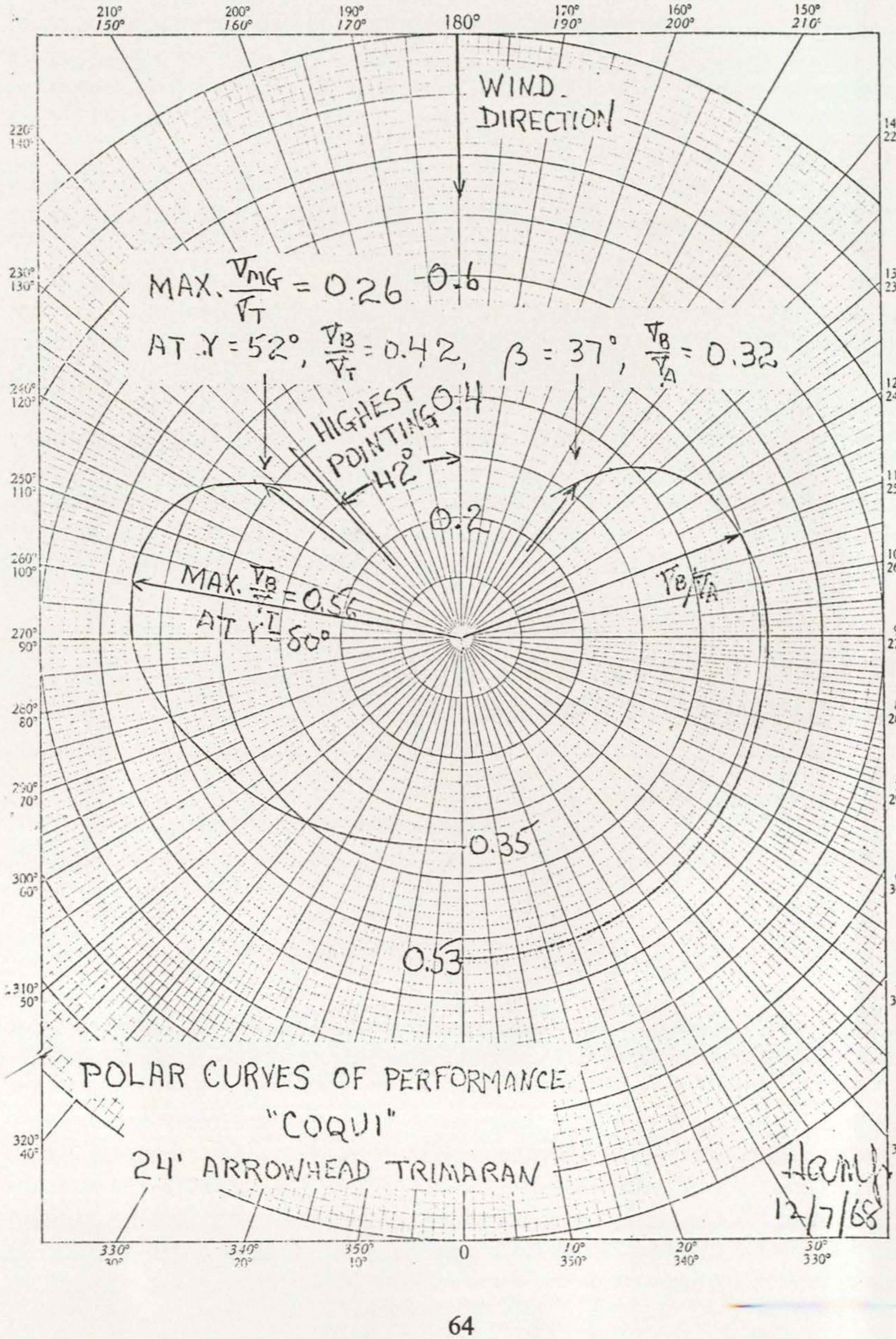
6 Ballast Lane, Marblehead, Mass. 01945, U.S.A.

LOA	24 ft	Rig	Sloop
LWL	19 ft 4 in	Sail Area	235 sq ft
Beam	14 ft	Weight (sailing)	1,600 lb

Designer: Robert L. Taber
Builder: Warren Products, Inc. Warren, Rhode Island **Cost:** About $5000

After more than four summers of fussing with instruments and trying to get readings with them, and after time out for every imaginable trouble (damp weather killing off one wind vane, balkiness in the outboard motor which was needed to calibrate the boat speed meter, malfunction of the roll-furl mechanism for the jib, and many another), a mountain of effort has brought forth a mouse. A few things have been learned along the way. (My wife thinks that instrumentation should somehow be easier!).

The graph shows the performance of the *COQUI* as measured with instruments patterned after those described by Edmond Bruce in *AYRS publication no.* 56, including the 'better or worse meter'. The wind instruments are at the top of the mast. Wind speed is corrected to that at the height of the centre of effort of the sails by the seventh root law (wind speed proportional to seventh root of height above water).



During some of the observations the boat was steered by automatic pilot guided by wind vane (*AYRS* 53).

The data are plotted as ratio of boat speed to apparent wind speed vs. angle between course and apparent wind in the right half of the diagram, and as boat speed to true wind speed vs. course angle to true wind in the left half. The data reflect performance in true wind speeds of about six to twelve knots. Through that range the ratio of boat speed to wind speed in about constant on the same point of sailing.

The curves have been drawn somewhat arbitrarily through a great number of widely scattered individual measured points to show the boat's good performance—better than average but not nearly as good as 'best'.

COQUI

Probably a principal reason for the wide scatter in the original data lies in the relatively unsatisfactory conditions of sailing under which the observations were made. It was essential to find smooth water. Salem Harbor was chosen for most of the measurements to meet this need. In Salem, because of the proximity of land, wind strength and direction were very unsteady. Sailing distances for a given reading were too short for optimizing and checking adjustments.

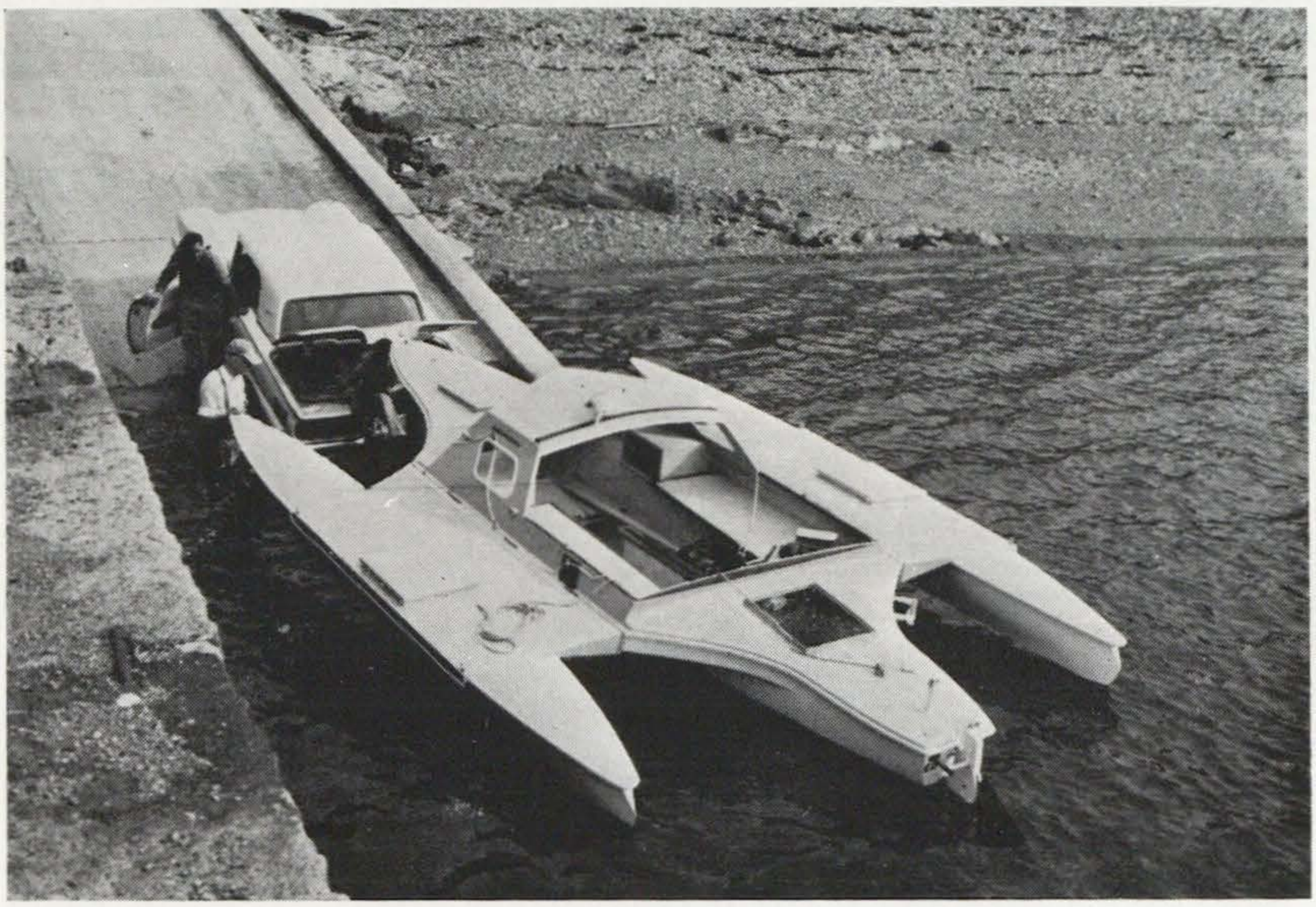
Another likely reason for the scatter in the original data is variation from the assumed relationship between wind speed and height above water and the consequent use of erroneous values of wind speed in the calculations. At best, the seventh root law does not always hold. In the variable conditions in Salem Harbor, the assumption may be less good than usual.

The data do not characterise a fast trimaran, probably mostly because sail area was too small for a boat of her weight, estimated for these tests at about 1,600 lb.

The regular centreboard of the *Arrowhead* design has an area of about 4.5 sq ft and an aspect ratio of about 3. Its location is too far aft. The *COQUI* has also a small forward board, 1.5 sq ft, aspect ratio about 1.5. Both were used during all the tests reported here (except when sailing off the wind). Even with the two of them, the *COQUI* carries a lee helm when by the wind.

Two experimental arrangements were tried in an effort to improve windward ability. One was a crude 'curvable foil' of about ten sq ft area and aspect ratio about 0.6; the other was a pair of 45°-sloping 'Bruce foils' on the outer hulls. Their combined area was about 15 to 16 sq ft, aspect ratio about 0.8.

Because neither of these installations was clean and fair, boat speed was somewhat impaired. Nevertheless, the boat pointed higher. A proper trial of one of these, probably the 'Bruce foils' is on the docket for next summer.



COQUI

The 'Bruce foils' had a remarkable effect of reducing the already small angle of heel of the trimaran, even though they were not nearly far enough out to the side to create the non-heeling situation. This observation lends more interest to this intriguing concept.

The *COQUI's* mainsail has the usual roach of a sail designed for a boat with a permanent backstay. It has five full-length batten pockets. Thus either full-length or short battens can be used. Both were tried. No difference between the two was found in tests of sailing to windward.

The wind vane-automatic pilot combination has proved to be a superb helmsman, especially in steering to windward.

Edmond Bruce has given examples of polar curves of performance and discussed them in *AYRS publications* 40 and 56; John Hogg in *no.* 61.

POLAR CURVES OF YACHT PERFORMANCE

by John Morwood

Various people have been publishing polar curves of yacht performance for many years now but all are slightly different from each other in one way or another. In an attempt to produce a standardised method of expressing a yacht's performance, Edmond Bruce, John Hogg, Harry Morss and I have been corresponding with a view to producing a 'Data sheet' of paper to be printed by the AYRS for the use of our members, and others if they want to use it.

Objectives

1 To produce a sheet of performance figures which will be the utmost value to a man who is navigating a sailing yacht. The size to be 18 in by 12 in. This will reduce nicely to fit the AYRS publications page.
2 To produce a sheet of performance figures which can be used to compare one yacht with another.
3 The ultimate objective is to make it obligatory for every manufacturer who sells a yacht to publish its performance figures in such a form that the yachtsman who buys it will know what to expect from it.

POLAR CURVE SHEET OF YACHT PERFORMANCE

This is the formidable title of the sheet we have so far produced. It has been tentatively drawn out and printed here for members' comments before we proceed with the actual preparation of the sheet for use.

The layout

In general, the layout must be more or less arbitrary. Uniformity of presentation is what is needed with reminders of symbols and figures which people may want to use.

A polar curve graph sheet has ordinarily two sides i.e., the circles are complete. We should therefore aim at expressing the yacht's performance in only two curves. If more curves are wanted, a second sheet can be used, however.

Our sheet has four sections.

I The first section

This gives the name and address of the person doing the study and the nature of the study itself. All such studies will be expected to have a curve for Vs (VB) and β, and this is the left hand curve. For the second curve, some people will want to graph Vs (VB) and γ, while others will want to have other curves such as $Vs/\sqrt{t}$ and γ. If they want to change the sheet, they can paste paper over our title.

Polar Curve Sheet of Yacht Performance

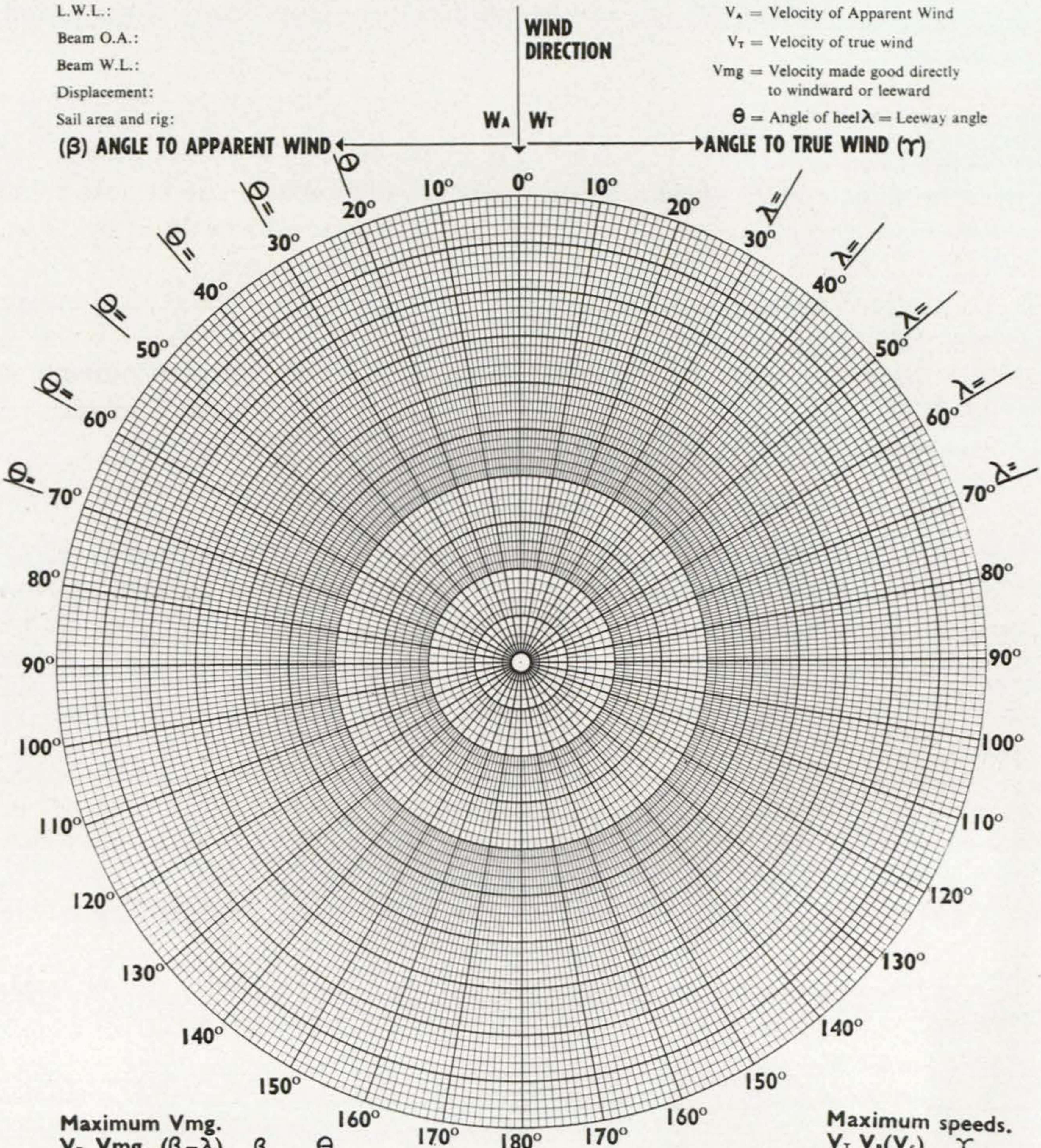
Study by: *Prepared by: The A.Y.R.S.,*
Date: *Woodacres, Hythe, Kent.*

Curves of V_B (V_S) to β and γ in 5(△), 10(x), 15(o), 20(□) knots of V_A and V_T

(USE BLACK BALL POINT FOR PRINTING)

Yacht's name:
Type and class:
L.O.A.:
L.W.L.:
Beam O.A.:
Beam W.L.:
Displacement:
Sail area and rig:

V_B or V_S = Velocity of boat (ship)
β = Course to apparent wind
γ = Course to true wind
V_A = Velocity of Apparent Wind
V_T = Velocity of true wind
Vmg = Velocity made good directly to windward or leeward
θ = Angle of heel λ = Leeway angle



Maximum Vmg.

V_T	Vmg.	$(\beta-\lambda)$	β	θ
5				
10				
15				
20				

Maximum speeds.

V_T	$V_B(V_S)$	γ
5		
10		
15		
20		

The windspeeds selected are 5, 10, 15 and 20 knots, corresponding to the Beaufort scale of Force 2, 3, 4 and 5. John Hogg suggests the following:—

Windspeed:	5	10	15	20 knots
Cipher for curve:	△	×	O	□
Beaufort Scale:	2	3	4	5
Windspeed range:	2-7	7-12	12-17	17-22 knots

The 'Windspeed range' thus varies from —3 to +2 in each case.

A reminder is given in this section that blue ink will not print. A black ball-point pen is, however, perfectly satisfactory.

2 The second section

This part gives the identifying statistics of the yacht, such as her name, type and general dimensions. The accepted symbols are also given to remind people of them and to avoid confusion. The only one of them which is open to doubt at the moment is Vs (Velocity, ship). This may be accepted by tank folk who have little to do with sailing boats but Edmond Bruce and others prefer VB (Velocity, boat) to avoid confusion with sail suffixes such as Fs and δs. VB would also be preferred by certain non English-speaking folk (Bateau, Barco).

3 The third section

This is the polar curve sheet itself, on which all the sailing characteristics of the yacht can be marked. The following items may be noted:—

a No speed or ratio figures will be printed. This will allow the worker to use what scales he likes. Ten main circles will be used and, for a yacht whose maximum speed is less than 10 knots, obviously each of these will represent 1 knot. If, however, the yacht's speed exceeds 10 knots, each circle will represent 2 knots.

b *Left side*. The curves here will give VB (Vs) to β, in windspeeds (Vt) of 5, 10, 15 and 20 knots, the curves being identified by the ciphers suggested by John Hogg, or in some other way. This is essential because the curves cross each other. On each curve, the point of best Vmg should be marked,

Around the outside of the left hand curves, blank values for θ, the angle of heel, will be printed. As shown by John Hogg, the θ angle can be used to keep a yacht sailing at its best Vmg.

c *Right side*. The curves here give yacht performance to γ, the angle of the true wind from the 'course made good'. The figure plotted may be VB (Vs) (see *DYNASCHIFF* polars) which give crossing curves. If these crossing curves are not liked, the figure plotted may be VB/Vt (Vs/Vt) which produces curves which do not overlap but the curves for the lesser windspeeds are outside of those of the greater windspeeds, in general.

Around the outside of the right hand side curves, we have blank values for λ, the leeway angle.

4 The fourth section

Many people cannot understand polar curves. Others could not study them while actually sailing a yacht. It is therefore of value to extract certain figures from the curves and put them where they can be used to help close-hauled sailing. The figures extracted here are those for the Vmg in the various windspeeds (5, 10, 15 and 20 knots) with the appropriate heading and heeling angles and, for good luck, β. These figures are out on the left hand side at the bottom of the polar curves.

The inevitable question asked by the 'pedestrian' who steps aboard a boat is "How fast is she?". It is obviously futile to give such a person a Vmg figure or show him the polar curves. From the curves, however, we can extract the maximum speeds attainable in the various wind speeds and give the γ angle at which they occur. On our sheet, we have space for these figures at the right hand bottom. The proud owner of a 'studied yacht' could show his acquaintance the answer to his question.

Summary

It is our intention to produce blank data sheets for our members to record yacht performance. These will be as rigid as we can get agreement upon while being as flexible as is needed in the field where members may want to try different methods of presentation.

The data sheet which we will eventually produce will not be regardvd as the ultimate and final type. It is more than likely that it will need to be modified in the course of time by the light of experience of its use and value.

For the present, the important thing is to have a uniformity of symbols and presentation of a sailing yacht's performance. We can hope that this preparation of a data sheet will stimulate many people to take their yacht's 'Sailing figures'.

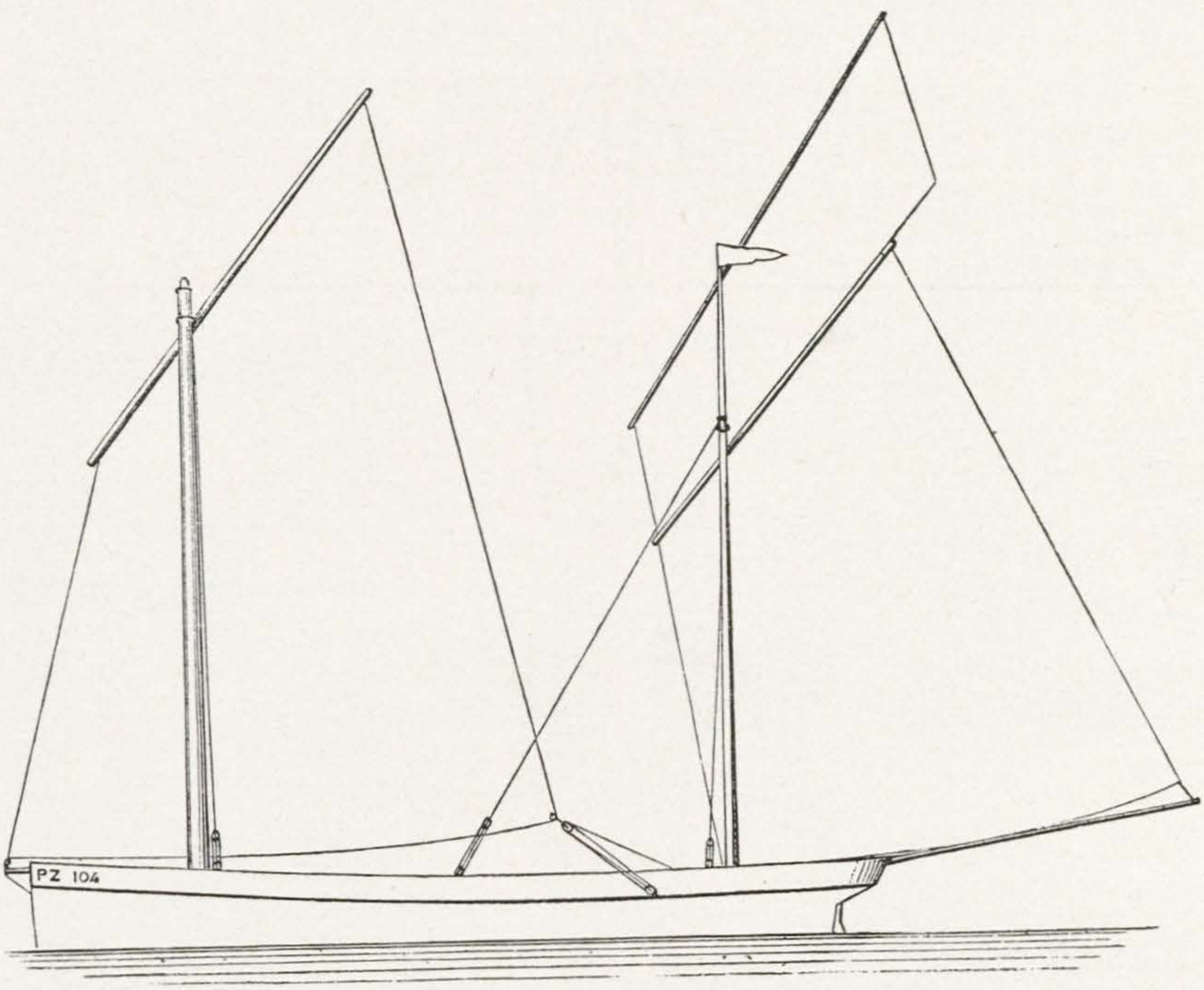
HOW SMALL CAN BETA BE?

by John Morwood

Looking through a copy of Dixon Kemp's book published in 1880, I came across the Penzance lugger and it stated: ". . . in this quality (weatherliness) they exceed the famour cutter yachts of this kingdom." Also, ". . . there is no doubt that they are capable of attaining a speed euqal to that attained by any other craft of similar length." These are strong words for Dixon Kemp to use and I have no doubt he was right and may still be right for the lines are lovely, the wetted surface is less than many modern yachts and the dipping lug is the neatest and cleanest of sails, aerodynamically.

While playing around with methods of getting the lug (modernised to semi-elliptical, of course) to sit around the gunwale forward, I happened to draw the construction of fig. 1 for the "10 DEGREE YACHT", using a lamda angle of leeway of 5°, which, it will be remembered from Edmond Bruce's article in *AYRS No.* 61, is likely to give the lowest drag angle possible. This gives the rather startling result that both the sail and hull forces act directly athwartships which would, of course, result in no forward motion whatever. This construction and the 10° yacht are therefore more than likely to be impossible.

In order for the boat to go forward, close hauled, the sail force must act at an angle forward of athwartships and I cannot think of this angle being less than 5°. If we still assume a drag angle for the sails and windage (δ_S) of 5°, the construction now becomes that of fig. 2 and the hull drag angle (δ_H) must be 10°.

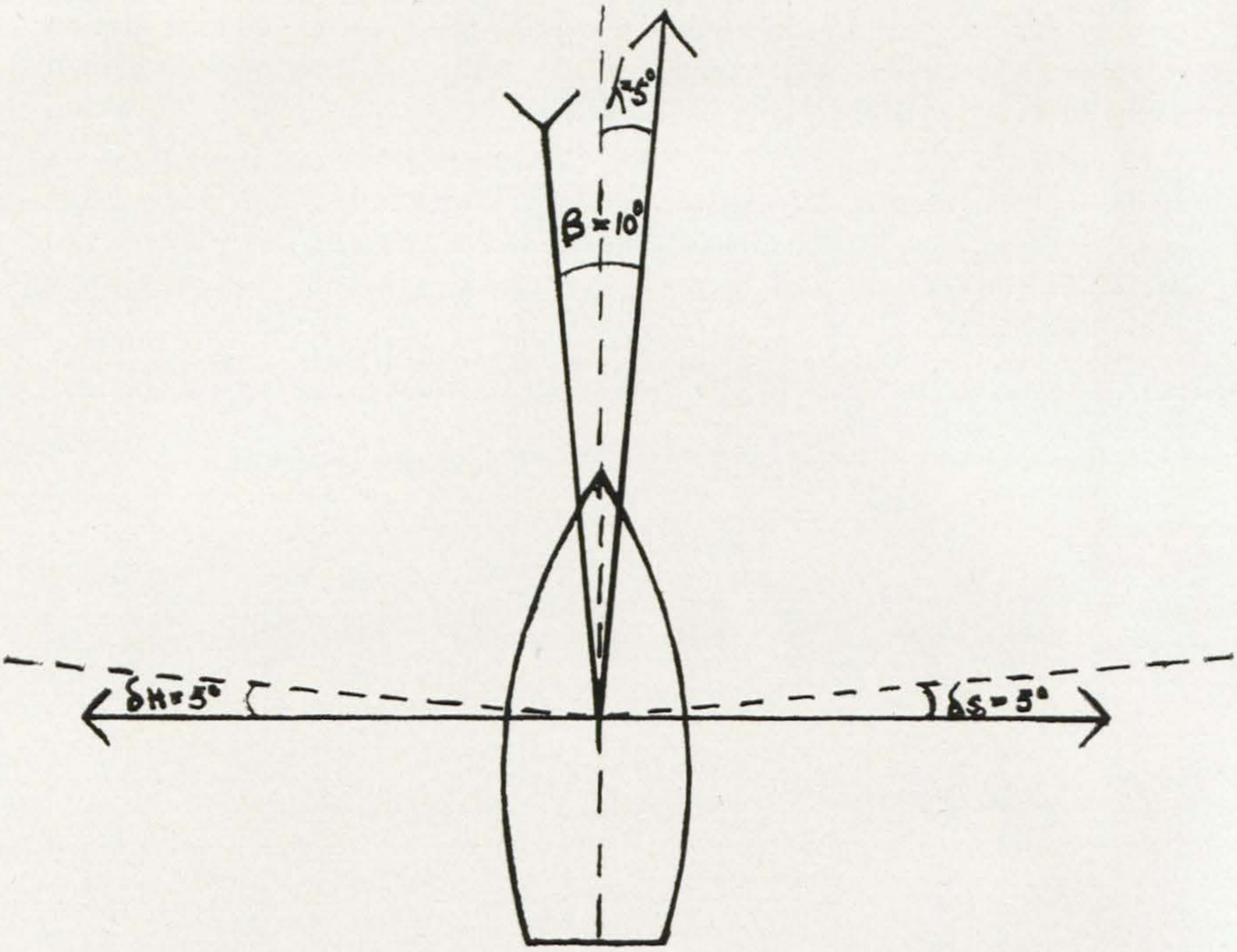


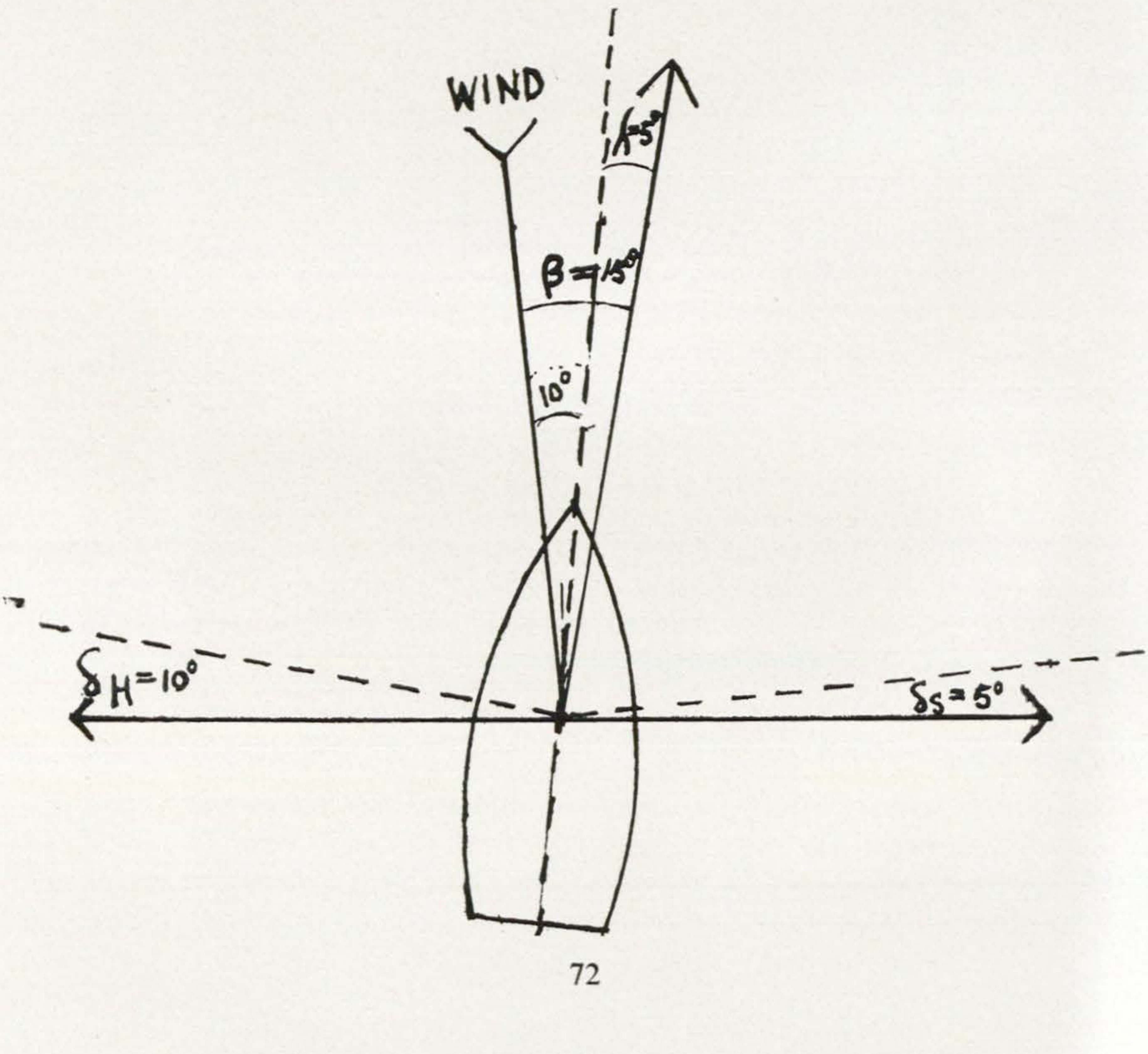
PENZANCE LUGGER.

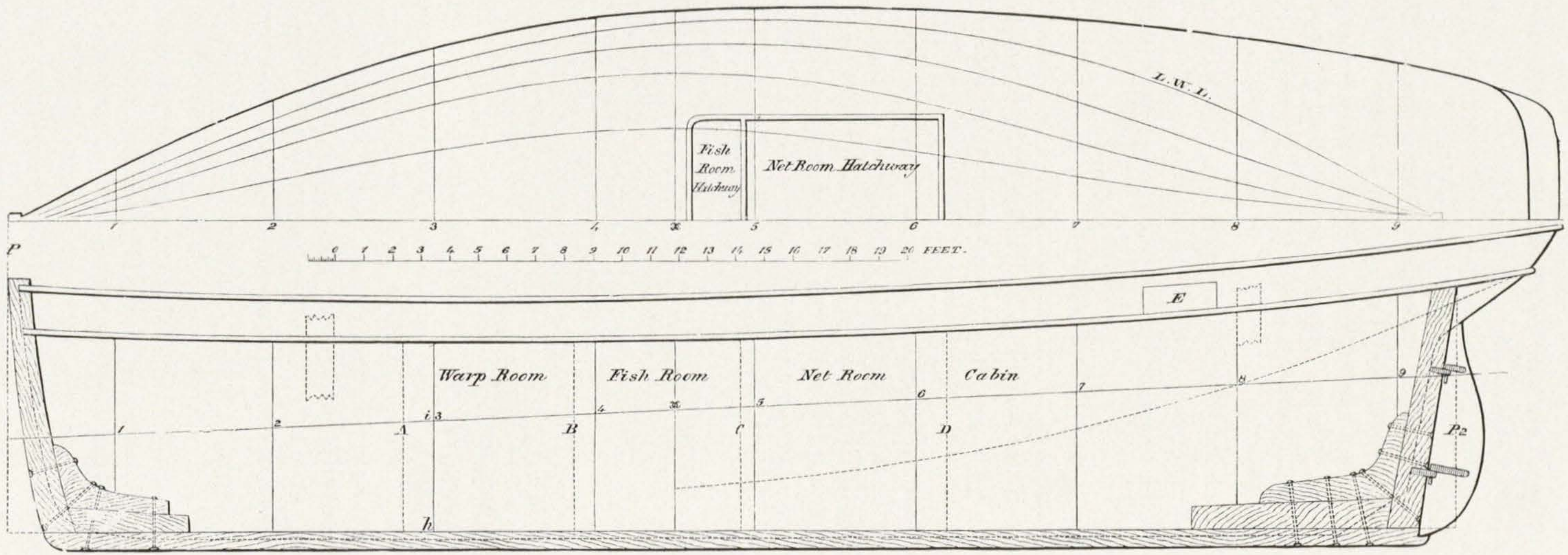
If the hull is capable of producing a drag angle (δ_H) of less than 10°, either the leeway angle must be reduced to less than 5° or the sail and windage drag angle (δ_S) must be also reduced below 5°, and by the amount less than 10° of the hull drag angle (δ_H).

Conclusion

Beta (β), the angle between the apparent wind and the course made good to windward is never likely to be reduced below 15° and, when the yacht is sailing at the same speed as the wind, the gamma (γ) will not be less than 30°, with intermediate angles for slower yachts.


λ=5°
β=10°
δH=5°
δS=5°


WIND
λ=5°
β=15°
10°
δH=10°
δS=5°



PENZANCE LUGGER.

Edmond Bruce "Lewis Cove", 69 Hance Road, Fair Haven, New Jersey, U.S.A. 07701

8th October 1967

Dear John,

Please reconsider the angular relationships in your article, "How Small Can Beta Be"? It is my belief that even though a total sail force should be perpendicular to the hull's centreline, it still can have a forward component in respect to the hull's actual course when there is an appreciable leeway angle. Like an ice-boat, a push would be required to get it started. It is a 'steady-state' situation.

The "Course Theorem", as you so perceptively propounded it from my L/D efforts, never mentioned the leeway angle. It did not need to. It is only the angle of the apparent wind to the actual course that is the sum of the drag angles.

It still seems to me that if a sail and a hull can each achieve a lift-drag ratio of 11.4 or a 5° drag angle, a "10-degree" yacht is still possible, even with a 5° leeway angle. If one assumes that the sail force is closely perpendicular to the boom, then it appears that forward progress theoretically ceases when the boom coincides with the course.

Instead of a goal, to shoot for, of a 10° course to the apparent wind, possibly this goal should be changed to zero-degrees. I have built a wind-mill model boat according to the teachings of AYRS articles. Using a large blower having its flow lengthwise along the tank, there is no question whatever that the model can sail rapidly *directly* into the wind without leeway.

Sincerely,

Edmond Bruce

John Hogg Parklands Cottage, Curdridge, Hampshire

11th October 1967

Dear John,

"How small can Beta be?"

I have no direct knowledge of Cornish Lugger performance but I would agree that the Dipping Lug is a fine sail. (Also their trim produces a long keel raked at an angle of about 10° which is of topical interest). Dixon Kemp does not refer to their pointing ability. Keble Chatterton says ". . . the lugger is wonderfully fast on a wind, as anyone knows who has matched an average cutter against one". I doubt if luggers would be considered to point at all high by today's standards, although they would sail closer than standing lugs I have measured.

I have never been very happy with the 10° yacht but 15° *is* a proposition, and I have measured 15° (β—λ). When a good yacht is really close hauled, with an excellent jib (which is chiefly the deciding factor) and although at this angle one is over the optimum 'knuckle' of Vmg the boat is sailing. Obviously the sails were in a very critical condition and the helmsman groaning with discomfort (as they always do when asked to point really high).

I can't get your point about sailing at the same speed as the wind. To be able to point at 15° the wind would have to be above say 7 knots and a yacht —even a large one—would not be doing that speed. Figures for a 20 ft keelboat, with good sails, taken this season are:—

V_A	V_S	$(\beta-\lambda)$	$\theta°$	λ	β	γ	V_T	Vmg
9.2	1.74	15	7.5	2	17	22	7.3	1.6

I am sure your article will arouse interest and hope you will publish it. Returned herewith.

John Hogg

SIMPLE HULL RESISTANCE MEASURING

by C. Sarsby

Downhams, Wraysbury, Nr. Staines

My last boat was a Colchester smack of 44 ft OA and about 20 tons displacement converted to yacht requirements with nine bunks. She carried the family comfortably, and earned her name *DUENNA* admirably—I have five daughters. On the other hand I failed her several times. I let her fall over (dry) to port twice because she was built to take the ground on the port side, and I had moored her starboard side to the quay.

She was not particularly close winded, and as a single-handed sailor I am below par. And I ran her onto some rocks in Weymouth Bay.

So I sold *DUENNA* to a better sailor and decided to build a boat more suitable to my requirements—which were:—

1 accommodation for six

2 shallow draft

3 close winded

4 naturally upright when drying out

and it should be reasonable to sail her single-handed.

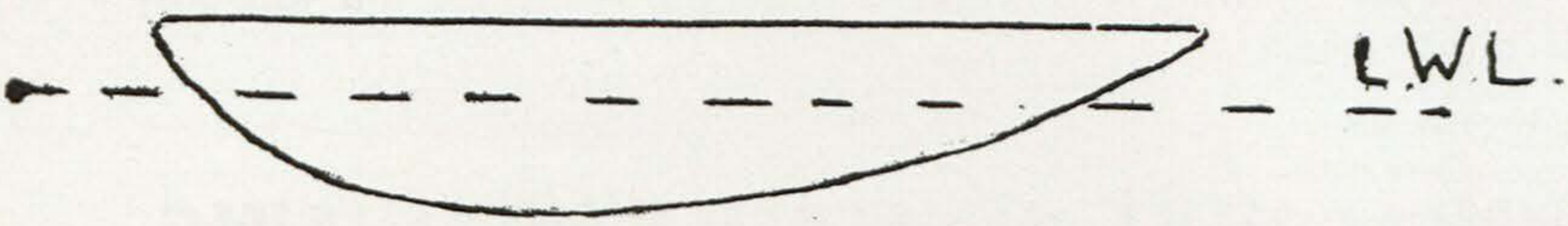
My first action was to buy the plans of a Waterwitch and to study them. They seemed to fulfil, (with only small modifications), requirements Nos. 1, 2, and 4, but I felt that requirement No. 3 needed more study.

It appears to be accepted that when close-hauled a boat needs a deep keel and minimum drag to give the least leeway and the most efficient sail force. In fact, when close-hauled we get the maximum angle of heel which gives the least efficient sail force and maximum drag. Furthermore, when a boat is heeled it has the greater bow wave on the lee side, and it follows, of course, that there is also the deeper trough on the lee side. We are therefore leaning over into a hole that we ourselves have made in the water. The angle of heel is, in fact, greater than the forces (statically) should justify.

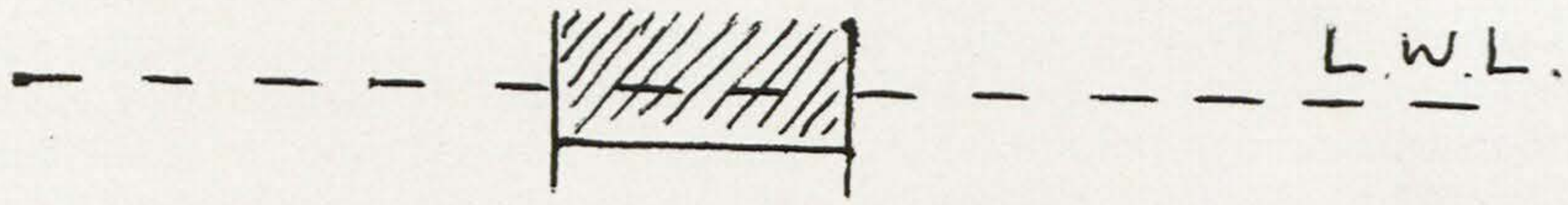
We talk or 'compromise' in yacht design, but this looks ridiculous. There seem to be good grounds for studying the basic theories and for beginning design from scratch.

I noted the editor's comments in *Yachting Monthly* September '68—"Another thing which always surprises me is the number of energetic young yachtsmen who tackle the building of a boat from scratch . . ." and to my mind, the much more useful reading of *Basic Naval Architecture* by K. C. Barnaby.

It is suggested that the beginning should be flat-bottomed, *not* the hollowed log from which yachts actually appear to be developed. The first model was shaped like a section of an aircraft wing—



The sides were flat and extended beyond the surface of the wing-section so that the cross-section was—

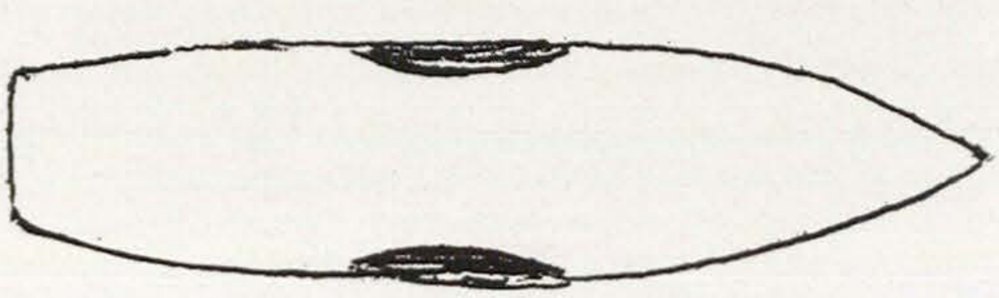


The model was ballasted and set in a flowing stream. When the ballast was moved to starboard, the model's position in the stream was displaced to port. The model was towed by a rod, not string, so that the heading could not change. It seemed to be fairly definite that if the model was ballasted to heel to starboard, it moved positively and took up a new position of stability to port of its original position.

The second model was of the same cross-section—but was built with a bow and a slightly tapered stern. This model began to look like a twin-keel boat, but in similar conditions of towing in a stream it did not show any tendency to move away from the 'lee side' as the first model had done

It must be emphasised that these were very rough tests, and that, if they had been done under laboratory conditions, they might not have given the result. I am only reporting my findings.

The third model was built with a camber on the inner side of each keel—



and the flow test was repeated, again without success.

After mulling these results over, I decided that the bow wave disturbance speeded up the water on the lee side and produced a drop in pressure of the water outboard of the keel on the lee side. To overcome this the fourth model was built with two bows—rather as a normal boat would be if it were sliced down the centre line and the two halves put on the opposite side, i.e. with their flat centre lines outwards—

Final twin bow model

This fourth model recovered the characteristic of the first model, i.e. when heeled to starboard it moved to port of the normal line of tow.

A fifth model of rather deeper keel surface appeared to give slightly better results. The theory was established to my satisfaction that if the bow wave were controlled to flow under the boat (i.e. to produce the trough between two aerofoil shaped keels), when the boat was heeled, a suction force would be set up to produce a side force to counteract that of the wind.

Note that the forces both on the sail and on the keel are of the form $\frac{1}{2}\ C_L\ \rho\ S\ V^2$ and that

V_T wind varies from 0-20 kts.

V_S water varies from 0-9 kts.

For water, $\rho = \rho$ wind $\times$ 816

and S is sail area for wind, and keel area for water.

There seemed to be grounds for hoping that it should be possible to develop an underwater shape which would produce sufficient lateral lift to counteract the side force of the wind.

A 12 ft model was built and rigged with cadet sails. Unfortunately, the boat was built strong enough for cruising. It took three of us to carry it, and as one of the porters was heard to remark—"There is one thing certain—she won't fly."

The sailing tests were not conclusive except in one respect. She was very stable. The boat was 12 ft OA and 3 ft beam, and with only one occupant she stayed upright when other dinghies of 5 ft beam needed a crew member leaning out on the windward side. The actual lee drift was very difficult to measure—"oh, well—back to the drawing board!"

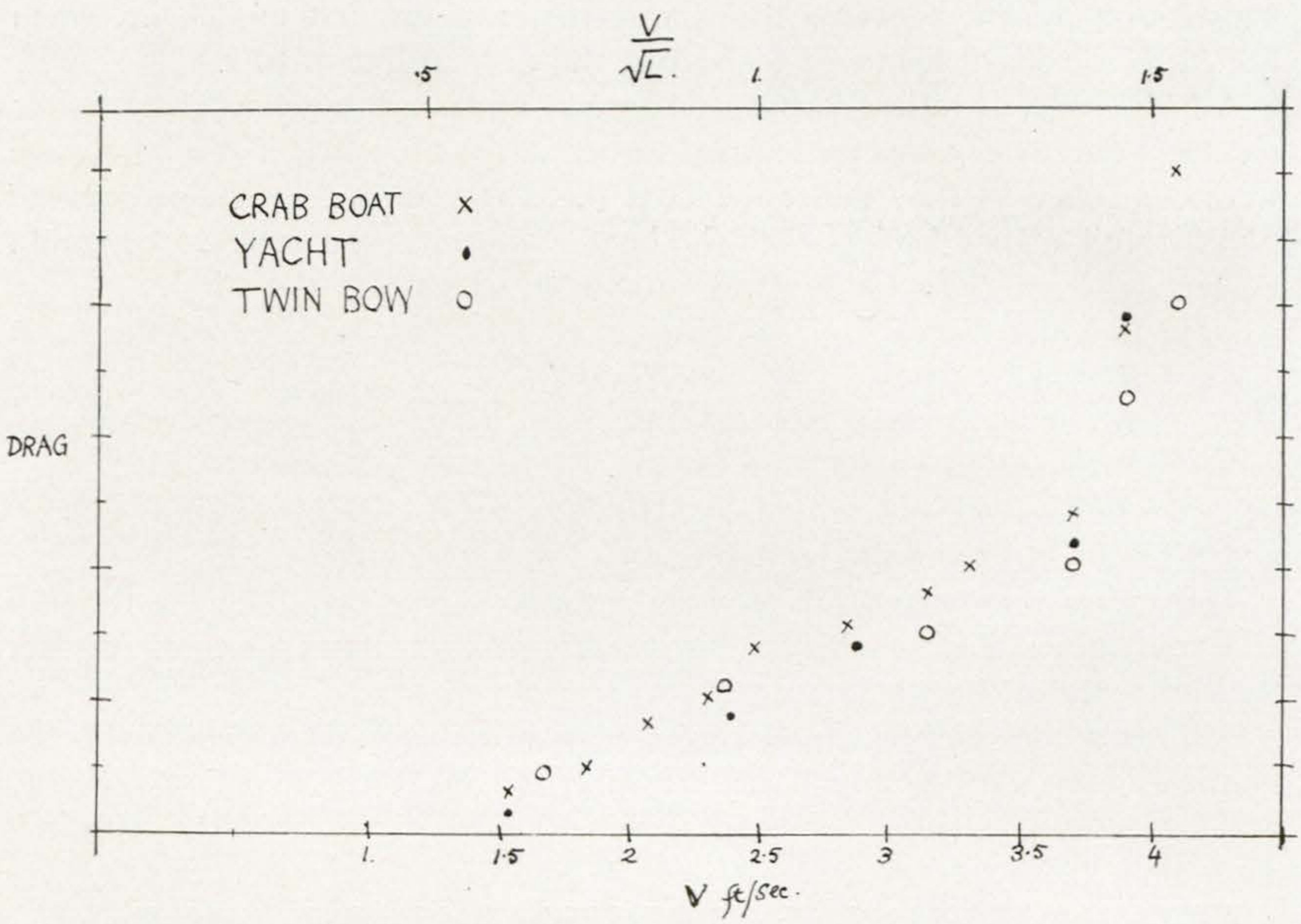
Tank testing is apparently an expensive business. A quotation of £580 for drag and leeway figures seemed excessive for me. The I.R.D.C. did not want to know, and, in fact, the naval architect said "Now don't beat about the bush. Was it faster than the other dinghies or not?" So . . .

A tributary of the Colne brook runs through the garden, and there is a stretch of 25 yards straight run below a bridge. The flow rate is low enough to be disregarded and the bridge is only about 18 in above water level. A structure was built on the bridge to carry a 'swing'. An electric motor, pulleys, capstan and drum were mounted on the swing, and the swing restrained by a coil spring. A model could then be towed for 25 yards at pre-determined speeds and the drag measured by pen recording of the distance the swing moved from the vertical against the spring pressure.

A model of a Norfolk crab boat (30 in water line and of known displacement) was used as a datum. A model racing yacht on 30 in water line and the same displacement were run on comparative tests. Two or three hundred runs were made to establish the graphs of drag/speed of the three hulls.

The parameters investigated for values of $\dfrac{V}{\sqrt{L}}$ were between .5 and 1.5 with 14 speeds between these values.

The resulting graphs are reproduced here for information. It will be seen that within the limits of error, the twin-bow model is not better than that



of the yacht model, and it is obvious that the wetted area will be greater. It will be greater, but wetted area is *not* the important factor. This twin-bow shape has a righting moment 1.9 times greater than that of a normal hull shape, and the factor to consider is $\dfrac{\text{sail area}}{\text{wetted area}}$.

It is also noteworthy that heeled resistance on the twin-bow hull is slightly less than when upright. The next step is a 27 ft model, which is progressing slowly. Photographs herewith. She carries 6 bunks in 4 cabins, has a designed draft of 2 ft 7 in and certainly sits upright. Will she be close winded? She looks like a Thames lighter, so it is proposed to name her *LIGHTER AYRS*, and I hope to have her sailing in 1970.

Next year I hope to do tests of drag/speed under motor and to measure righting moment at full scale. I would much like to receive advice on what sail area to carry.

Is there anyone sufficiently interested to consider the problem with me?

AERODYNAMICS OF DECKS AND TOPSIDES

by John Morwood

The sail of my Kinnegoe Cruiser, having abolished the ill effect of twist and mast eddies, is a good one. It develops a lot of power and allows the boat to point up well. But, it still has a boom eddy and a minor aerodynamic loss from the deviation from a semi-ellipse, though this might be more than compensated by the lowering of the centre of effort.

At the time of writing this article, I still am trying to find out how far off the middle line to place the boom to get the best Vmg to windward. Not being able to sail with her as much as I would like, I drew up a plan of the deck and drew a line coming from the bottom of the mast at 12° from the fore and aft line for the luff-clew angle on the analogy with the jib sheet setting which is usually thought to be the best. With the length of foot of 15 ft, this put the clew 3 ft 3 in from the centre line i.e., 1 ft 3 in outside the gunwale.

My original intention with this boat was to have no boom at all, merely sheeting the sail like a Genoa when close hauled. But my courage failed me when the boat was made and I made a boom with a bit at the fore end swivelling about a vertical axis to allow the mast to align itself with the airflow. However, it now occurs to me that if the fore cabin had been built up and of a shape suitable for the foot of the sail, so that the sail could be sheeted down to it, the boom eddy would not appear, the boom could have been abolished and the cabin would have been more useful. This idea is shown on Page 12 of *Hydrofoil Victory*, *AYRS No.* 62. Of course, with my present boat, the building up of the cabin top could not be extended to the clew of the sail and an outrigger would be necessary for sheeting.

Fore deck gunwale line

Thinking about the jib reminded me that the modern rig for conventional single hulls with a low cut Genoa sheeted down to the lee gunwale gets her windward ability from the abolishing of the Genoa foot eddy and probably uses quite a lot of her hull topsides forwards as sail area. This makes one wonder what shape the gunwale and topsides forward should be for maximum effect. It also makes nonsense of all wind tunnel tests of yacht sails where the hull windage is not included in the measurements. Hull windage may be parasitic in many places but not forward under a Genoa.

The ketch rig

The conventional ketch rig is not very efficient because, with the normal twisted mainsail, the main boom is sheeted at about 6° from the middle line and the lower part of the mainsail backwinds the mizzen, when close-hauled. With a twist-free mainsail, however, from an appropriately bendy mast, the clew is sheeted much farther out at an angle which might well be 12°, thus giving an extra angle of attack for the wind to the mizzen of nearly 6°. An after cabin, built to the shape of the foot of a loose-footed mizzen would abolish its boom eddy and improve efficiency still further.

Boom eddies on free-wind courses

These are almost invariably beneficial, the exception being when the wind is only slightly free from close-hauled.

Summary

1. The foredeck and bow topsides should be designed to fit in aerodynamically with the foot of the Genoa so as to abolish the foot eddy and increase the overall wind force.

2. The mast should be made to allow bend with the concavity to windward to abolish twist in the sail.

3. The deck-house under the mainsail could be built up to meet the foot of a loose-footed mainsail and its edge should be of the same plan form as the foot of the sail.

4. With the wider sheeting of a mainsail which is not twisted, the ketch rig should be efficient but the mizzen mast and sail should be similar to the mainmast and sail and the after deck-house should be built up to the sail in a similar fashion.

Benefits

1. A close-winded, ketch rig will be possible.

2. There is no boom (or booms). This will be of great advantage to me, when on inland waterways.

3. Large headroom internal accommodation.

4. The relatively high deck house might make such a boat self-righting without external ballast—their average beam will be quite narrow.

Disadvantages

1. There will be absolutely no leeward vision. Transparent windows in sails have a relatively short life. Perhaps windows of wide mesh net would be best with transparent panels 'zipped' onto both sides. Large windows in the built-up cabin top might be the answer.

2. Perhaps the greatest disadvantage from my point of view is that I don't know what the best luff-clew angles for the various sails should be or how much 'flow' or curve to build into the sail. I would have to know that before ripping off my cabin tops. If anyone can advise me, or better still write an article for all of us, I should be very grateful.

J. R. Anderson, D.F.C., A.R.Ae.S.

Anderson Aerosails, The Loft, 59 Penhill Road, Lancing, Sussex

9th December 1968

Dear John,

Thank you for the opportunity of previewing your article on topsides, my comments are appended below.

There is no doubt that closing the gap between the sail and the deck is worthwhile, and a craft-sails combination designed with this end in view should result in enhanced performance.

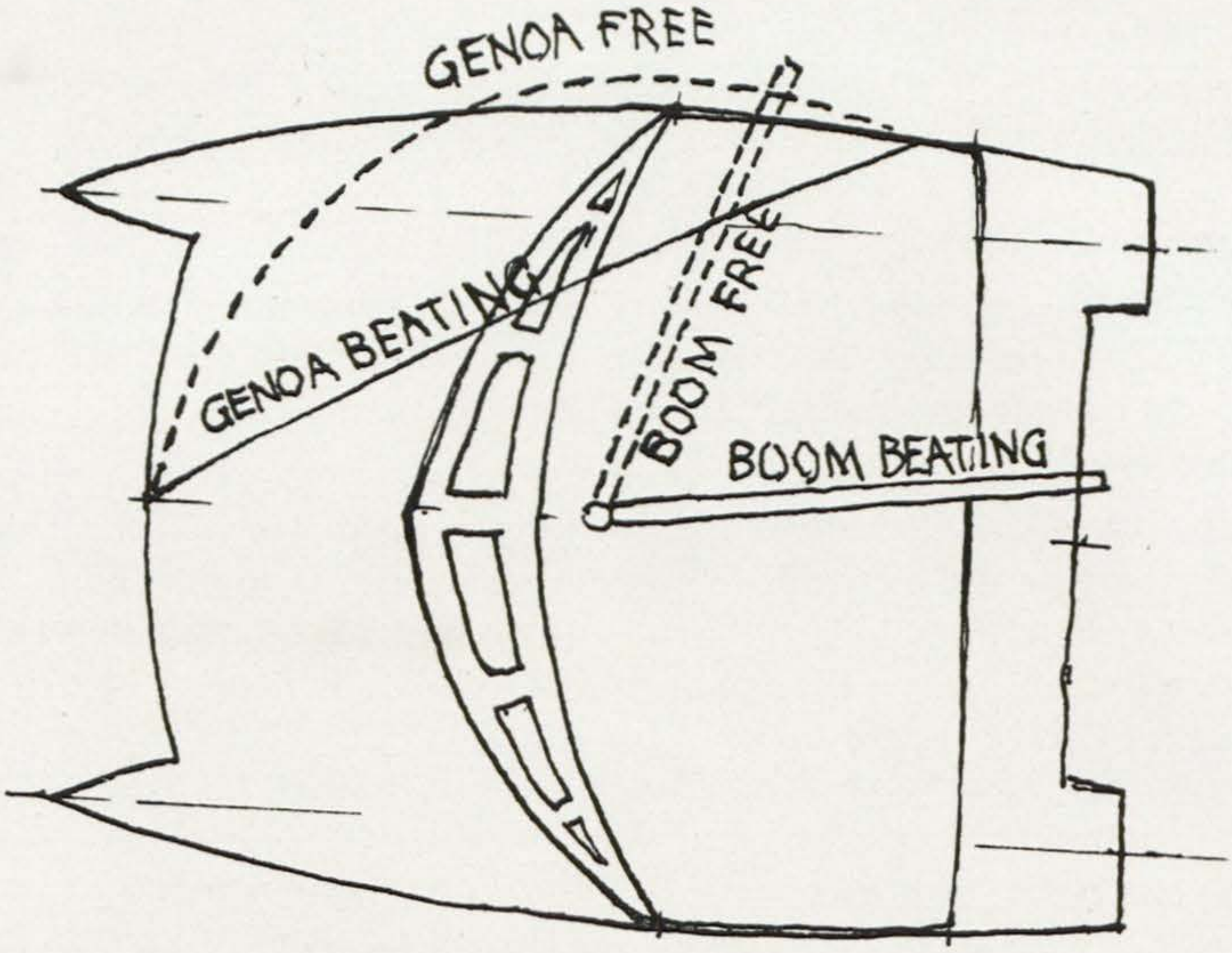
Multihulls with flattish decks to suit jibs or genoa, and with cabin tops similarly designed to fit mainsails, probably offer most scope for ingenuity and design in this connection, due to the wider angles of the sails from the fore and aft centre line, which they can accommodate.

The sealing of the gaps between genoas and decks can be accomplished on mono-hulls by using the droop feet which I pioneered on *FLYING DUTCHMAN* in 1962. We used similar large droop on genoas for *KURREWA V* the 12 metre.

A problem with such 'decksweepers' is clearing the rails when fetching or reaching. The large droop allows the genoa to be tacked high if required to get over rails or through an overlapped gap between pulpit and rails, whilst also accommodating itself to other obstacles.

On craft where sails overlap, the design would be quite interesting. It would have to be determined which should be most important, the mainsail gap when the sail was at a wide angle, or the close sheeting of the genoa when beating. The ideal answer which then presents itself is an unobstructed deck, slightly concave. See Sketch.

The cabin top gives wide angle of gap closing for main boom.



When tacking the genoa droop would have to be large enough to slide up the sloping windscreen.

When sailing requirements are such that the clew of a mainsail is outboard of the deck e.g. when reaching in light airs, it has been proved that it is beneficial to have a boom.

For instance my Shearwater III *BLACK MAGIC* was fitted in 1959 with the first Una rig and Una double luffed rig, to be sailed in Class; and was tested, (a) with a loose foot where the clew was connected by the mainsheet to a roller traveller on a circular track running the full width of the Cat at the stern, (b) with the same loose foot with its clew connected to a boom, the after end of which was connected by the mainsheet to the same traveller and circular track. The performance of the mainsail was much superior when it was boomed.

There appears to be no reason why a droop could not be fitted to the foot of a boomed loosefooted main, so that it closed the gap to the cabin roof, or topside, giving the advantage of booming and of gap closing.

With your rig (or any rig) it will be preferable to have the cabin roof filling the gap over as wide an angle as possible, i.e. until you come up against windage problems.

By fitting a boom you will be able to adjust the fullness of the sail to fine limits by an adjustable clew outhaul. Andy

A METHOD OF CALCULATING CATAMARAN HULL WINDAGE

by R. W. Godley

38 Mount Pleasant, Brixham, Devon

Consider the hull topsides, devoid of superstructures, when close-hauled, sailing at a β of 30°, as a very low aspect ratio, symmetrical winged biplane, fiying at a wind incidence of 30°. We know that a v. low A.R. foil will not be stalled at 30° incidence and may have a C_L of $2C_D$ (see calculation in appendix).

If we vectorially add the lift and drag components, we get a resultant hull aerodynamic drag angle of approx. 30°, directed therefore athwart the course to leeward.

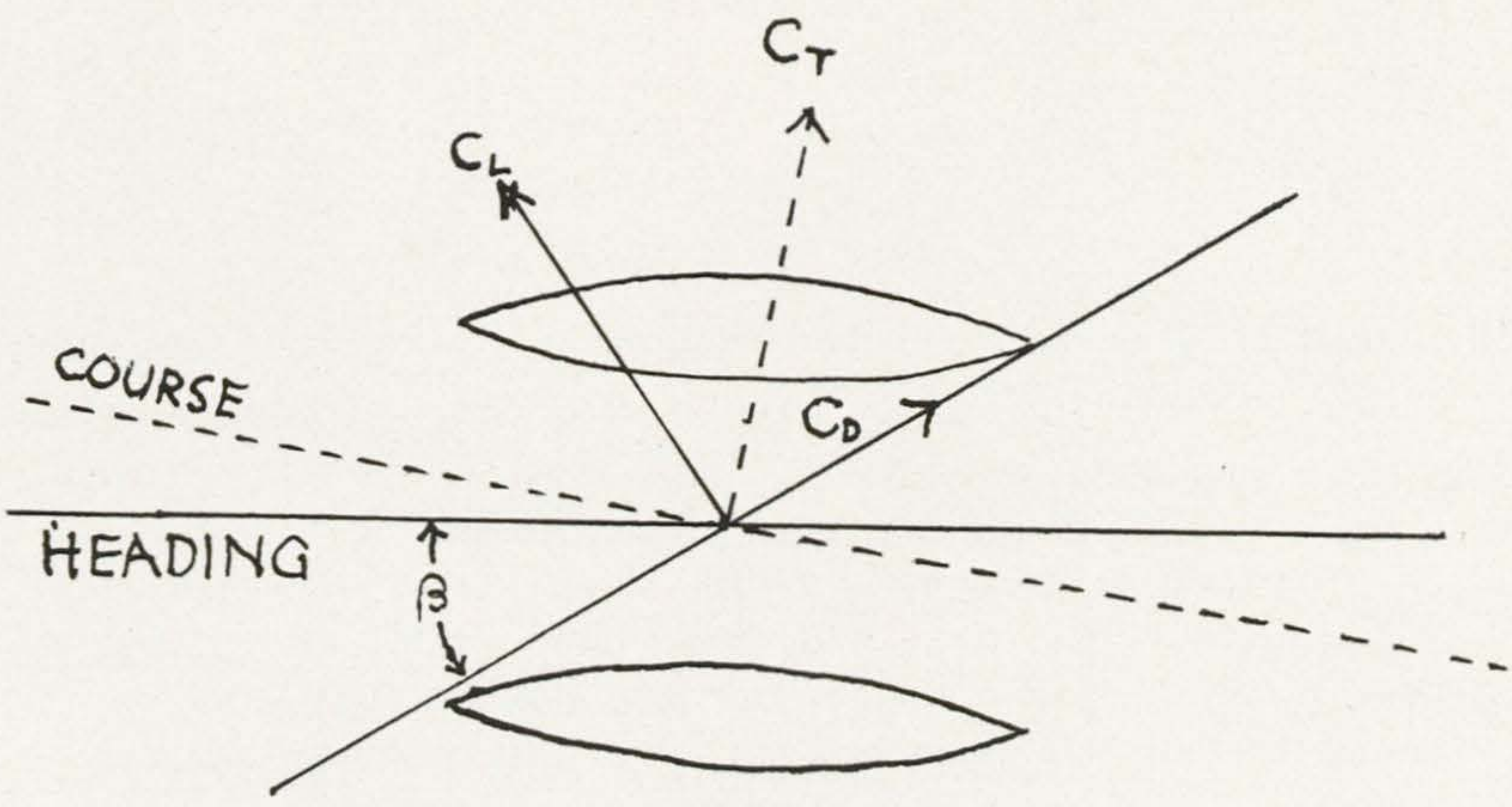
The magnitude of the force coefficient may be calculated as shown in the appendix.

We may conclude that the topside windage may be balanced by a hull side force only, not requiring a direct component of drive.

When additional superstructure has to be calculated for a medium size cruising cat, the cabin section may be likened to the motor car pod of appropriate vintage to suit the cabin aerodynamics. Maximum car speed from a known engine horsepower and drive efficiency are easily found in the car journals and text books leading to a simple drag force to the wind.

APPENDIX III

Consider for example a top side height of 3 ft on a 30 ft LOA hull. The effective aspect ratio because of mirror image in sea is $\dfrac{3 \times 2}{30} = 0.2 = A.$



Let $\beta = 30^\circ$

$\lambda = 2^\circ$

$\beta - \lambda = 28^\circ$ = half radian.

$$\text{Now } \frac{dC_L}{d\alpha} = \frac{2\ \pi\ A}{2 + A/.87} \qquad \text{......ref (1)}$$

$$= \frac{0.4\pi}{2.25} \text{ per radian.}$$

also C_L = o at α = o (symmetrical wing)

$$C_L\ (\text{at } \alpha = 28^\circ) = \frac{0.5 \times 0.4\pi}{2.25} = \underline{.28}$$

$$\text{now } C_D = \frac{C^2L}{\pi A} + \frac{CL}{12\pi} \qquad \text{......ref (1)}$$

$$= \frac{.28^2}{.2\pi} + \frac{.28}{12\pi} = \underline{.133}$$

$$\frac{C_L}{C_D} = 2 \text{ (Air drag angle about } 28^\circ)$$

Ref (1) Aerodynamics, Piercey

C_T, the resultant hull aerodynamic force

$$\sqrt{C^2{}_L + C_D{}^2} = C_L \sqrt{1 + (\tfrac{1}{2})^2} = \frac{.28\sqrt{5}}{2} = .31$$

at an angle 28° drag of the apparent wind direction, i.e. 90° on the beam.

Example of magnitude:— Area $= 3 \times 30 = 90$ft.
Wind speed (say) force 4 gusting 5 at 27 ft/sec. (mean)

$F = 0.00119 \times 90 \times .31 \times 27^2$ lb

$= 24$ lb per hull.

balanced by say 50 lb of hull side force from the hydrofoil action.

Hoping this may be of a little use to some other catamaran designer.

Leonard L. Tiemann 6 Hillside Drive, Malvern, Pennsylvania 19355
9th April 1969

Dear John,

It has been with considerable interest that I have followed the discussions by you and others in the AYRS Journal relative to the design of fins or centreboards for sailboats. I have been particularly intrigued by the work of Edmond Bruce. I believe that we are on the verge of seeing another major step in sailboat evolution. I do not believe that the hydrofoil alone will provide the basis for that evolutionary step, although the experimental work that has been done by Don Nigg and others has been most interesting and should certainly be continued. This work may well lead to the establishment of some racing classes.

My personal interests (of a long term nature) lie with the development of sailboat types suitable for extended cruising yet offering greater efficiency, comfort, ease of handling, safety, speed potential and economy than existing boats. I believe the catamaran designs of Rudy Choy come the closest to meeting these criteria at present.

It is my belief that the successful marriage of hydrofoils *and* hull design will provide the basis for this evolutionary step.

The question of the 'correct' shape (profile) of fins has arisen on several occasions. There seems to be agreement that high aspect ratio fins are best suited for low hull speeds. Further, low aspect ratio fins (A.R. = 1 according to Bruce) seem best for high hull speeds. This development can be seen clearly in the monohulls with the recent designs employing shortened swept back keels and spade rudders. (eal series of hulls and the 12 metre boats). However, many diverse opinions can be found for fin shapes ranging from trapezoids, to triangles, to circle segments, to compound curves.

I have an observation to offer which, if it proves to be correct, implies that all of the above shapes may be 'correct' if they are applied properly.

I shall provide a statement of my observation after a slightly circuitous route.

Background

The development of the jet airplane permitted aircraft designers to achieve levels of performance previously deemed impossible. The jet engine provided vastly more power than the reciprocating engines and propellor combinations. Initially, these jet engines were coupled with conventional airframes. After a number of refinements; namely pointed noses, slimmed fuselages and swept low aspect ratio wings with reduced thickness to cord ratios (fig. 1); it was found that the 'sound barrier' could be broken consistently and with safety (see figs. 2 and 3). The reason for these refinements was to reduce the wave drag (or compressibility drag) that began to predominate as Mach 1 was approached. Naturally, attention was given to producing even higher speeds. A number of different planforms were evolved which performed with varying degrees of success.

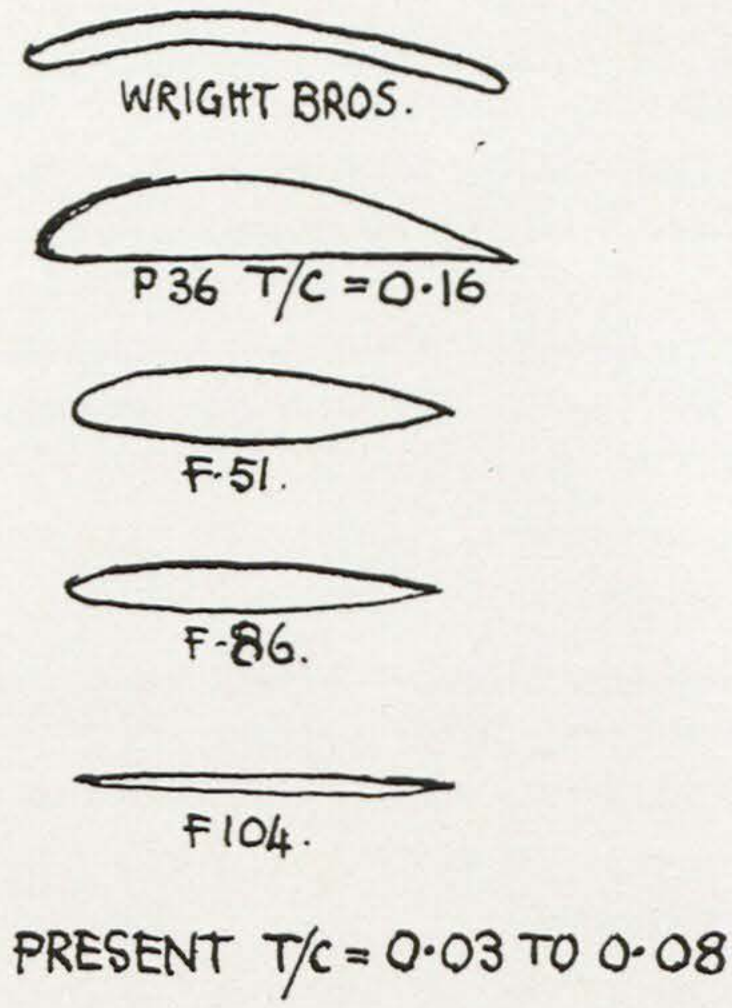
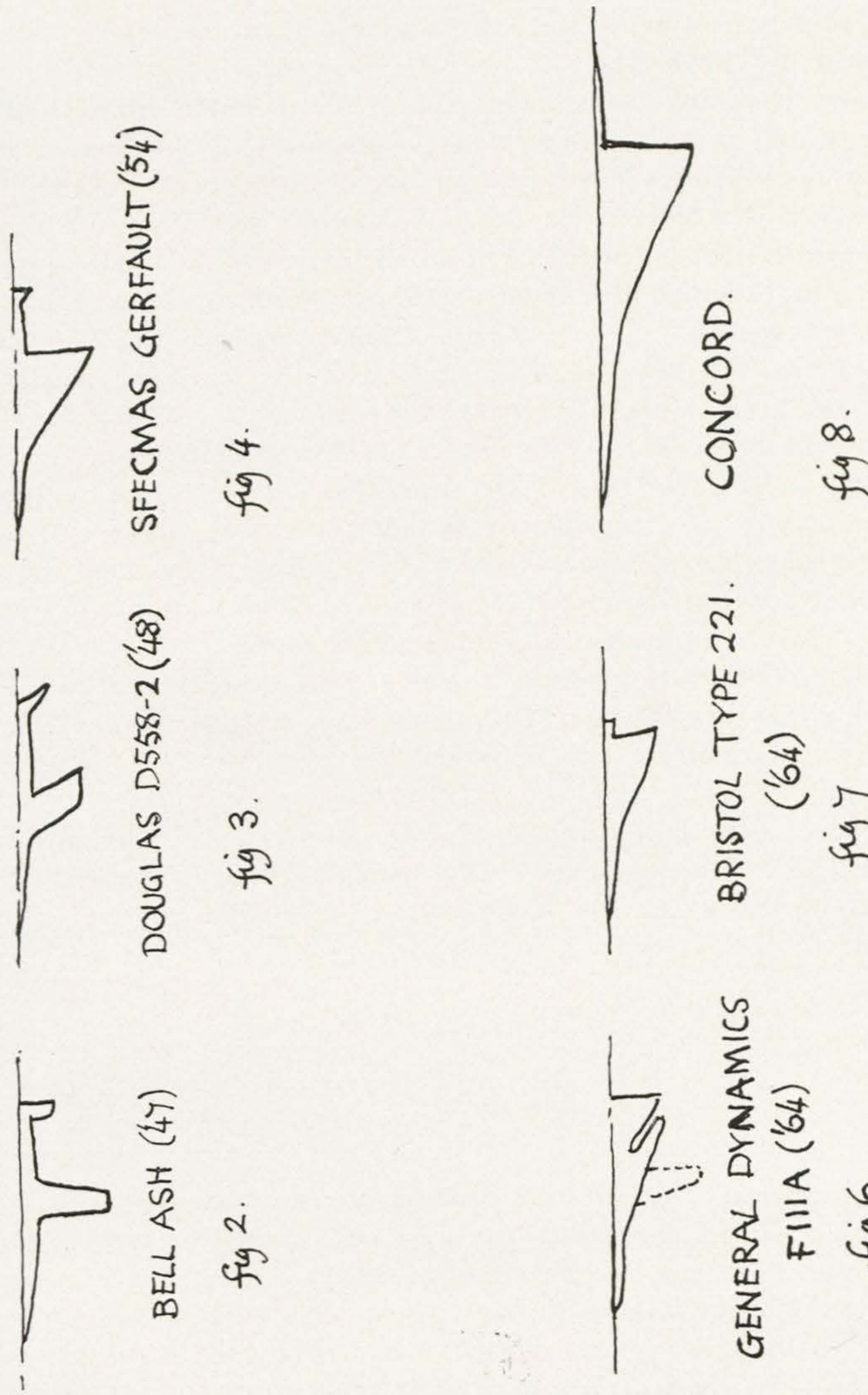


fig 1.

However, it became apparent that more drag was being experienced at higher Mach numbers than was expected. In 1953 a new aerodynamic principle was formulated that provided an explanation for the difficulties that were being experienced in high speed flight. This principle is called the 'area rule'. It can be stated very simply as—a plot of the total projected area of the body per unit of length in the direction of motion must present a smooth shape. In other words, the fuselage, wings, tail elements, and all other portions of an airplane must be considered in relation to each other as they displace the medium. The first turbo-jet powered aircraft to fly supersonically straight and level without afterburner or other assistance was the Sferman Gerfaut (fig. 4), and the area rule had been used in its design.

The application of the area rule led to the designing of fuselage with a 'coke bottle' effect. This of course reduced the area of the fuselage at the wing to allow for the area of the wing.

Latter development has shown that conventional fuselage shapes can be used, if the wing assumes a compound curve of 'OGEE' shape (figs. 6, 7 and 8) such as has been used for the Concorde.



Observation

The above discussion has a striking parallel in terms of sailboat development over the last several years.

Increased hull stability/improvements in sail shapes, materials and configurations; the rigidizing of sails with battens, and wing masts have all combined to produce more available sail thrust.

In like manner, hulls have narrowed radically. It appears however, from the available evidence, that although present low wetted surface hulls (i.e., semi-circular cross-section) do receive some dynamic lift, they nevertheless continue to act as displacement hulls.

These very narrow hulls are able to exceed their theoretical hull speeds due to their low wave drag.

There are obviously many differences in the mediums of air and water. This is especially true since an airplane is completely immersed in its medium whereas a boat operates only on the surface of its medium. In the first case the situation is three dimensional and in the second essentially two dimensional.

It is suggested that the area rule or an adaptation of it should be tested for application to the design of sailboats. The first problem would be to ascertain what the area distribution should be. A good way to attack this would be to plot the area distributions of existing fast hulls—less appendages. Once this has been accomplished, the next step would be to perform comparison tests between a measured fast boat (either full scale or model) with its standard appendages and another boat of the same type with area ruled appendages.

One problem that is immediately apparent in the application of the area rule to a boat is the presence of the surface waves. These tend to distort the immersed area distribution. A conventional hull is limited in its maximum speed to about the equivalent of a wave length equal to the hull WL length. Narrow hulls can travel at wave lengths equal to several hull WL lengths. Therefore, it may be necessary to adjust the hull area distribution by a cosine function to approximate the immersed area lateration produced by the wave shape.

A second problem is that of the dynamic lifting effect. This also has the effect of distorting the immersed area distribution, but in a different manner from that of the waves. Unfortunately, no guidance can be offered on this point.

Leonard L. Tiemann

J. R. Moar 49 Colonsay Road, Thornhill, Ontario, Canada
27th April 1969

Dear John,
I read with interest issue *No.* 66*A* concerning centreboards. There are two questions I would like to raise which were not covered by this issue. I am afraid I don't have any answers, only questions.

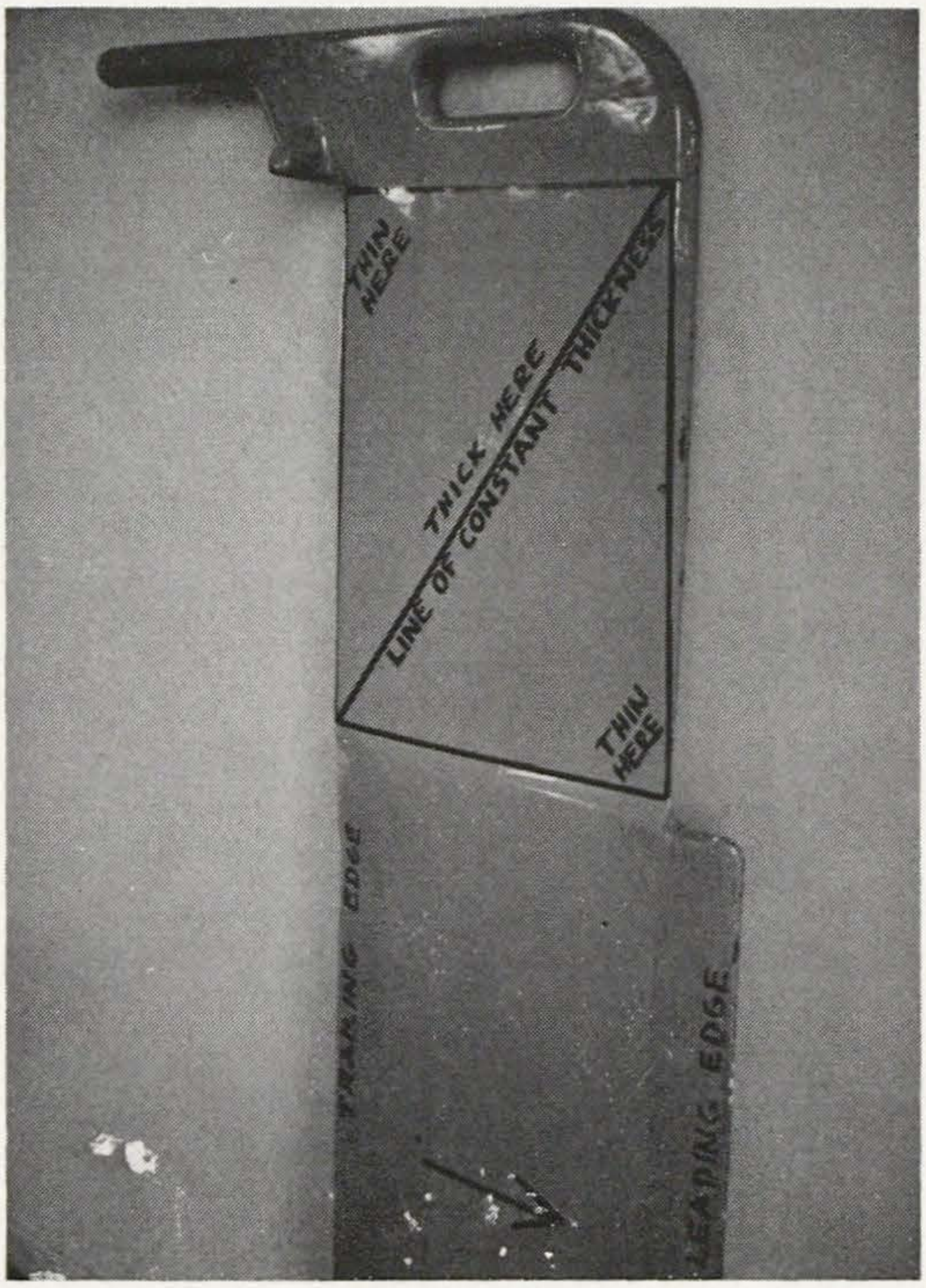
Many of the boats in this area use what is called a jibing centreboard, and I feel that no discussion of centreboards is complete without considering their value. The term jibing is very descriptive of their action. However, I am not sure how generally they are used, so I will describe them.

The part of the board fitting into the box is shaped in the form of a double wedge. The sharp end of the wedge faces forward where the board passes through the keel strip. The second wedge faces aft near the top of the centreboard box (see photo). When the boat comes about the leading edge of the board will jibe over as the force of the water changes from one surface to the other. The leading edge of the board is always inclined upwing at an angle of 4½ or 5° limited by the included angle of the wedges. The theory is that when going upwind the centreline of the board is at a 5° angle of attack relative to the centreline of the boat. The hull, therefore, does not have to make 5° leeway in order to give the board an angle of attack to the water. By comparison then:

On a boat with a jibing board the hull moves straight through the water in the same direction as its centreline. Course headed is the same as the course made good. The centreboard moves at an angle of attack of $4\frac{1}{2}°$ or $5°$ to this direction of movement.

On a boat with a conventional centreboard the hull and the centreboard both scrub through the water at an angle of about $5°$. Course headed is about $5°$ above the course made good.

Since the centreboard in both cases moves at $5°$ through the water, the improvement (if any) lies in the drag of the hull. *The drag of the hull when moving straight through the water vs. the drag of the hull when moving at $5°$ leeway.*



The board rocks about the oblique line of greatest thickness between the two wedges

One hears a good deal of argument in yachting circles about whether or not a jibing board will also allow you to sail closer to the wind. I will leave this subject untouched and would enjoy hearing your thoughts on this matter.

I originally said that there were two questions I would like to air concerning centreboards. The second is really a second subject concerning the relation of the centreboard to the rudder with regard to fore and aft location of the board, area, and angle of attack. Is there a relation or are the two completely independent? As the size of the rudder is increased, is it necessary to move the board forward in order to maintain a neutral helm? Can the rudder be regarded as a second vertical hydrofoil which is also capable of producing a side force to prevent leeway? Is it desirable to maintain 5° of weather helm in order that both the rudder and the centreboard will help to hold the boat on a true course down its centreline? Edmond Bruce apparently had something to say on this subject at an AYRS meeting held in New York, reported in number 56. I would appreciate hearing some AYRS thoughts on these questions.

J. R. Moar

John Morwood to J. R. Moar

Dear Mr. Moar,
The 'Jibing Centreboard' is well known in England but seldom used, though I am sorry to say that I don't keep in touch with developments in the dinghy fleets. The opinion of Austin Farrar in the matter several yeras ago was as follows:—

1 Jibing centreboards do abolish leeway, resulting in a hull which goes striaght through the water.
2 The overall speed to windward, however, is *not* increased.
3 A tactical advantage may sometimes be achieved by a dinghy fitted with them 'eating its way' to windward either to fetch a mark or get out of another dinghy's dirty wind.

The dynamic advantage

The resistance of a dinghy, especially one with a good 'deadrise' to the floor on either side of the midline, must be less without leeway than it is. However, when the dinghy has a flat floor as with the "505" and *FLYING DUTCHMAN*, the only resistance caused by leeway is a small amount of turbulence at the bow. This might well 'pay for itself' in lateral resistance.

Dynamic disadvantages

1 The 'downwash' or leeward deviation of the waterflow caused by the board will be under the weather quarter when the board is fore and aft. It will be under the lee quarter when it is angled at 5°. The water added to the waterflow past the boat will, by Bernouilli's equation, *reduce* the stern wave on the appropriate quarter. A 'Jibing Centreboard' will therefore have a *reduced* stern wave at the lee quarter and an increased wave on the weather quarter. This may increase resistance. The fore and aft board will probably have little effect on the relative sizes of the stern waves.
2 The 'Jibing Centreboard' needs a wider box than the fore and aft one. This results in extra weight of water carried and extra turbulence where it comes out of the hull.
3 On a beam reach, a 'Jibing Centreboard' may cause 'weather way' (as opposed to leeway) by pushing the hull up to windward. This would cause extra resistance. An exact reduction in area would prevent this, of course.

As regards your second question, the rudder is indeed a hydrofoil which helps to prevent leeway. It should always align with the centreboard, being fore and aft with a fore and aft board and angled at 5°, when the board is angled thus. If the rudder is increased in size, the centreboard should be moved forward or the rig may be moved aft in order to align with the centreboard.

Summary

1 'Jibing Centreboards' abolish leeway and can produce tactical advantages.

2 As usually tuned, they do not appear to increase the speed to windward. However, if the sail balance is made exactly right, they might well increase windward performance for dinghies with a high 'deadrise' floor. Any improvement expected will be only very marginal.

3 Very exact adjustment of the centreboard in area will be needed on courses other than to windward for maximum speed. Perhaps the angle of attack should be removed, as well.

I do not believe that catamarans and Thames barges should use angled boards (leeboards with the Thames barge) because the hulls have so much lateral resistance in themselves. On the other hand, the Dutch *BOIER* and other barges with very rounded bilges use angled leeboards.

It would be interesting to know if the boats in your area with jibing boards do better in the races than other boats with the usual board.

John Morwood

IS THERE ANY CASE FOR SWEEPBACK?

General H. J. Parham

Dear Sir,

I believe I am right in thinking that aeroplanes with swept back wings are liable to tip-stall. That is, that the outer portion of the wing stalls before the part near the wing root, unless precautions are taken in the design to modify the wing section near the tips, or add to them slots or similar devices.

If this is so—and I hope someone with more knowledge of the subject than I have will give his views—then it must be due to a twisting of the air flow, plus possibly some spanwise flow, as one approaches the tips.

All our normal mainsails have twist. Might it not be that the twist, or 'washout' in aeronautical terms, might be advantageous (or at least not so disadvantageous) if the mast had some aft rake?

It is known that swept wings are less efficient than straight ones, so the rake would have to be fairly small. But there might be a degree of rake which struck a happy balance and re-captured some of the lost efficiency of backward sweep by neutralizing some of the loss due to twist.

Yours sincerely,

Jack Parham

Jock Burrough 44 Bedford Gardens, London W.8
11th September 1968

Dear John,

Regarding centreboard size there seems to be some conflict here. You quote Harrison Butler giving a comparison of lateral plane area below LWL as 1/25th to 1/35th of sail area. The effectiveness of the sail area will depend upon many things but notably heel angle and wind speed; the effectiveness of the lateral plane area will also depend upon angle of heel and ship's speed through the water. All of which are variables.

Your precise definition of size as that which gives the smallest possible drag angle appears to beg the question. The requirements in performance from centreboards are variable. If we could measure the lift/drag ratio continually we could adjust the exposed centreboard area to give the highest lift drag ratio. In the final requirement we require a Vmg meter and centreboard size is just one of the many fine adjustments to trim of the vessel to obtain maximum Vmg.

All of which is unhelpful.

The disadvantage of *the very low aspect ratio fin* as on *OCEAN RANGER* is that it is fixed and thus not only unadjustable for varying conditions for optimum Vmg but cannot be retracted altogether as in the case of a centreboard. This facility seems to be particularly important in severe conditions when lying ahull and the ability of the vessel to move sideways away from an advancing wave crest maybe its only chance of survival.

Jock Burrough

Denny Desoutter Larchfield, Westhumble, Dorking, Surrey

SAILING A BICYCLE

Anyone who would like to sail a bicycle should not be put off by the theoretical difficulties. I sailed an army-issue bicycle about twenty five years ago, using a bamboo mast and boom, with a sail made of a special low-permeability cloth (army rubberised groundsheet).

I cannot claim that I was very scientific about it, but with the sheet held in one hand, and a handlebar in the other, none of those who tried it had any difficulty.

I think it has to be remembered that one is not solely dependent on the dynamics of the machine itself for balance. The centre of gravity can be quickly shifted, and the sheet can be eased. A human being soon learns what must be done, even though he does not understand why. That's how we all learned to ride bicycles, anyway.

Incidentally, when bicycling on the wind, we used to start with the machine in a heeled attitude, sitting out to windward with the knee crooked over the saddle. Small boys are quite used to riding a bicycle in that canted fashion, and can change the angle very quickly.

Denny Desoutter

THE MARINE STEAM ENGINE

by John Morwood

The first Constitution of the AYRS said that we were: 'To study boats propelled by sail, power or human agency'. Our present constitution says the same thing but uses a paragraph or two to express it, being written by a lawyer.

So far, we have greatly neglected our last two objectives and articles on them would be welcome but our bias must essentially be on efficiency or new developments and the following titles are suggested:—

1 Light-weight, low-powered diesel engines.
2 The Wankel engine.
3 Marine Drives.
4 Folding propellors.
5 A review of racing 'Sculls' (one-man boat), 'Pairs', 'Fours' and 'Eights'; one and two man Kayaks. The efficiency of the 'Yuloh' or Chinese skulling oar.
6 Any new development in any of these fields.
7 The suppression of noise in marine propulsion.

However, members must realise that it takes some time to collect enough articles on a subject to make a publication and this results in considerable delay between our acceptance of an article and its appearance.

In order, therefore, to get the proposition going, I would just like to state here something about the marine steam engine, which is the true delight of all inventors. It stirs our romantic feelings as nothing else can—and inventors are surely all romantics of the first water, almost by definition.

The Marine Steam Engine is quiet. That is its main delight. In terms of running cost, it is not too bad if run on paraffin (kerosene) in many countries where the tax on petrol or diesel is high. With a condenser, its efficiency can be about 10 per cent to 20 per cent as compared to 45 per cent to 50 per cent for a petrol engine (25 per cent for an outboard) or 65 per cent for a diesel. These figures are only approximate and we would be grateful for more accurate ones.

I believe that a steam outboard engine is possible with the boiler inboard and that would be a good object to aim for. The main requirements are as follows:—

1 Compactness. For instance, with an outboard, the piston could be mounted vertically down the shaft with the connecting rod working a crankshaft on the propellor axle.
2 'Instant power' which means that the water to be boiled is a minimum. The mechanism of the 'Stanley Steamer' motor car of the early part of this century should be stated in this connection.
3 'Throttle control' must be fine which, for economy should mean fuel control.
4 Instant stopping and reverse.
5 An adequate condenser to increase the relative pressure on the piston. Atmospheric pressure is 760 mm of mercury; that of water vapour is some 14 mm.
6 Adequate safety valves.

These are the requirements, gentlemen. We wish you happy inventing. Nothing absolutely new is likely to be produced because steam engines have been thought over by a million inventors in the last 200 years but our members are so ingenious that I feel sure that someone, somewhere will come up with a delightful design which will please at least the romantic yachtsman, if not the generality.

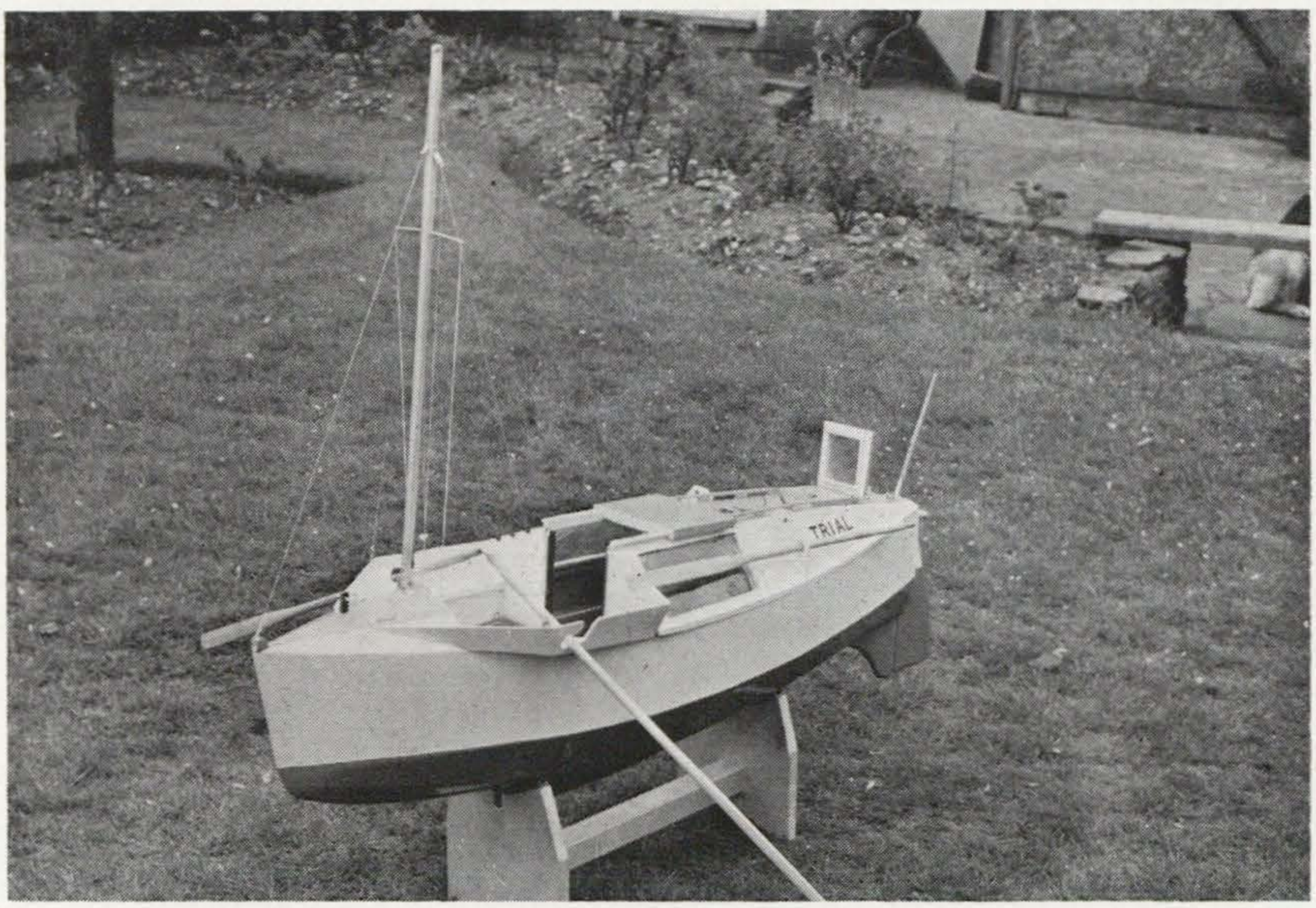
TO ROW THE ATLANTIC, THERE AND BACK!

by P. A. Townsend

29 Knipersley Road, Sutton Coldfield, Warwickshire

I have thought for some years now, that provided one had the right sort of boat, it ought to be possible to row across the Atlantic and back again. Leaving from the British Isles and returning to the British Isles.

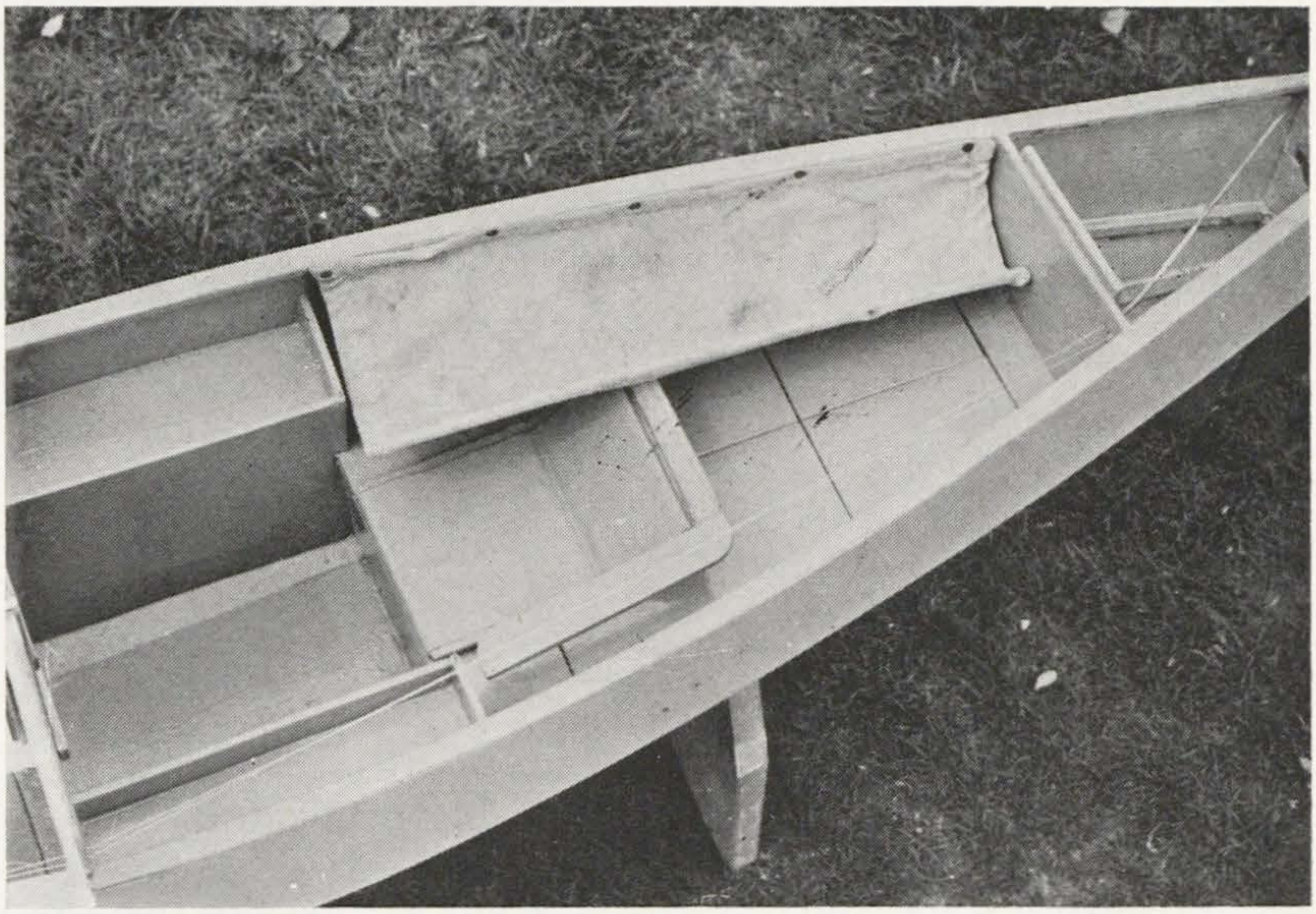
The secret of success in such a venture would be, of course, the boat. It must be light enough to row, and yet large enough to carry a fairly large



P. A. Townsend's Trans-Atlantic rowing boat model

quantity of stores. It must also be sufficiently dry and comfortable to protect it's crew from the worst that nature can offer. It has been said over and over again that the crew fails before the boat does. Therefore the most important consideration in the design of such a vessel must be crew comfort.

The boat I have designed (see photographs) is 22 ft 6 in long, but only 5 ft in beam. It has a ballast keel to make it self-righting, and all hatches are watertight. Ventilators are not shown on the model, but would, of course, be provided. The boat is totally enclosed except for a small cockpit. The crew would row in a standing position facing forward. Sitting down and looking at where you have been seems to be a purely Western custom.



Model with deck off showing the bunk

Because of the size of the boat the oars would need to be 12 ft long. They would need to be light and slightly whippy, therefore they would have to be made of fibreglass. The boat would carry two spares.

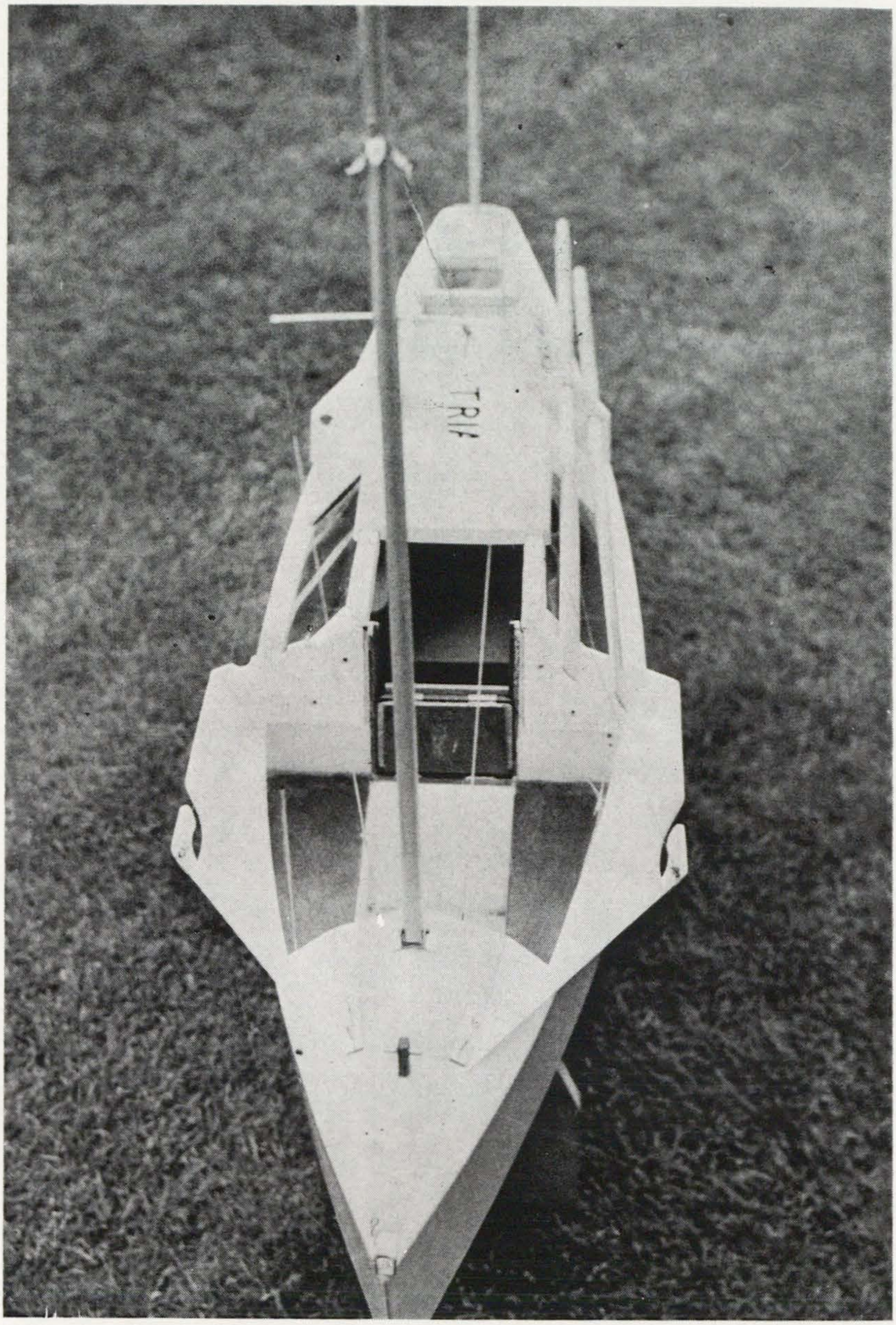
Forward of the cockpit are the ship's stores, and forward of them a watertight bulkhead. Aft of the cockpit is the cabin. It is 10 ft long and contains all the normal fittings (Except a toilet; I am afraid a bucket will have to do!). The bunk is canvas on a steel frame, and rolls up out of the way. There is a folding armchair for the skipper, from which he can cook, shave, read and do all other daily chores.

Aft of the cabin is another watertight bulkhead.

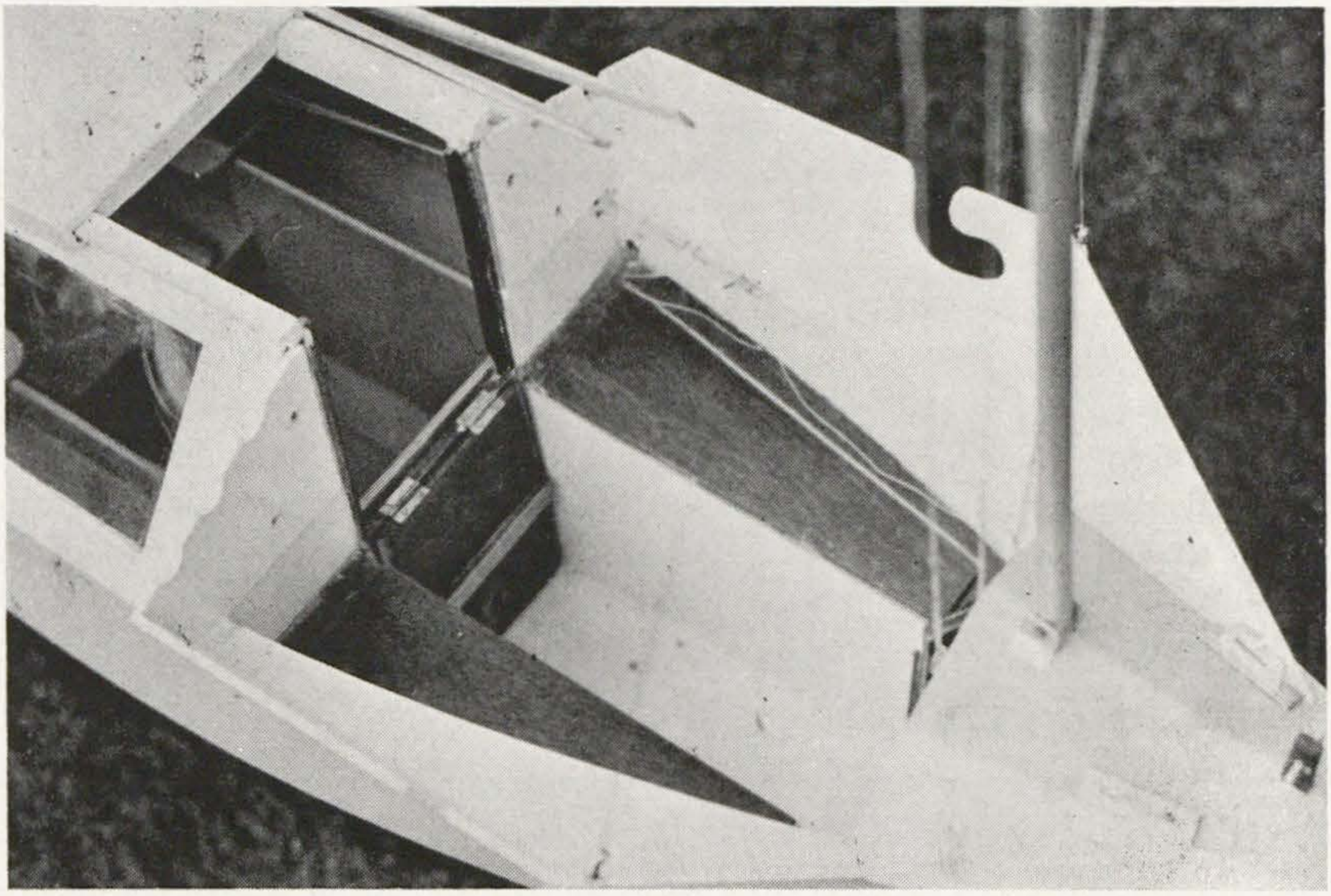
The cabin contains a tank for forty-five gallons of water. There is also storage space for a further twenty gallons or so in two gallon plastic containers. A large polythene water catcher would also be carried.

Fuel for cooking would come from disposable tins of butane, stored in the cockpit lockers.

Oars and radio/signal mast are secured in their racks by clamps in case of heavy weather.



Bow view of P. A. Townsend's model



The rowing position

The model in the photograph is two inches to the foot scale, so it is large enough to give some idea of how the actual boat would behave. It has been found that the model 'Sails' quite nicely down wind!

The most difficult and hazardous part of the trip is undoubtedly from point of departure to Finnisterre. Having thought about this for some time, I have decided that the best course would be to leave from Stranraer in Scotland, make round the North coast of Ireland and then make the best course that nature will allow between West and South, leaving the rest to the Gods.

P. A. Townsend's model showing keel

Once in the trade winds it should be fairly easy until a convenient piece of America comes up under the bow. Then depending on which convenient bit of the U.S. A. you happen to have hit, you then make your way up the coastal waterways to New York for the rather more uncomfortable, but quicker trip back.

I estimate that the trip would take about ten months. I think that the best time to start would be October to arrive in New York in the Spring for the trip back.

I am hopefully planning to start this enterprise in October 1970. It is regrettably impossible this year owing to lack of funds. Should any people be interested in being associated with this venture I should be delighted to hear from them. It is, however, a single handed trip, but people interested in forming a back up team may contact me.

SEAWORTHY

by R. D. Leakey

Sutcliffe House, Settle, Yorks

Ed.: It has been said (on what authority I don't know) that about 10 *per cent of 'Ocean Cruising Yachts' are lost at sea—mostly single hulls, of course.*

Unless you compromise with the word 'seaworthy', when applied to a boat, it means that the vessel is fit and safe to be at sea in all conditions of sea, including hurricanes and breakers. Under the 1967 Misrepresentation Act, this word will have to very carefully used, because without watering down its meaning, it could not be applied to a great many boats, such as the Hull trawlers that rolled over when iced up, and the many other boats which could, and in fact do founder in some conditions that occur at sea, however uncommon they may be.

What boat designs can in fact be considered seaworthy? In my view, very few indeed, perhaps only some sail-less catamarans, submarines, ships too big for a wave to roll over and some unsinkable dinghies, if the crew can't be tipped out. But as a boat is a device for floating a crew, rubber dinghies and even boats that roll over and right themselves would not qualify as seaworthy any more than one could describe a water tight barrel with a good bung as a seaworthy boat—unless or course the crew were inside. Anything less than this, including our latest life boats, are unseaworthy.

It follows from this that either we compromise with the meaning of the word, or, with the Act in mind, we must draw a clear line between what is sea worthy and what is not. Such a line, if drawn, might well be the best thing that could happen to the ship and boating business. It could also be the most devastating revolution imaginable when one considers that most of our boats must be described as unseaworthy, and that organisations like fishing companies, the Admiralty and the R.N.L.I. could be liable to criticism or worse if life or property were lost by sea action, however rare it might be.

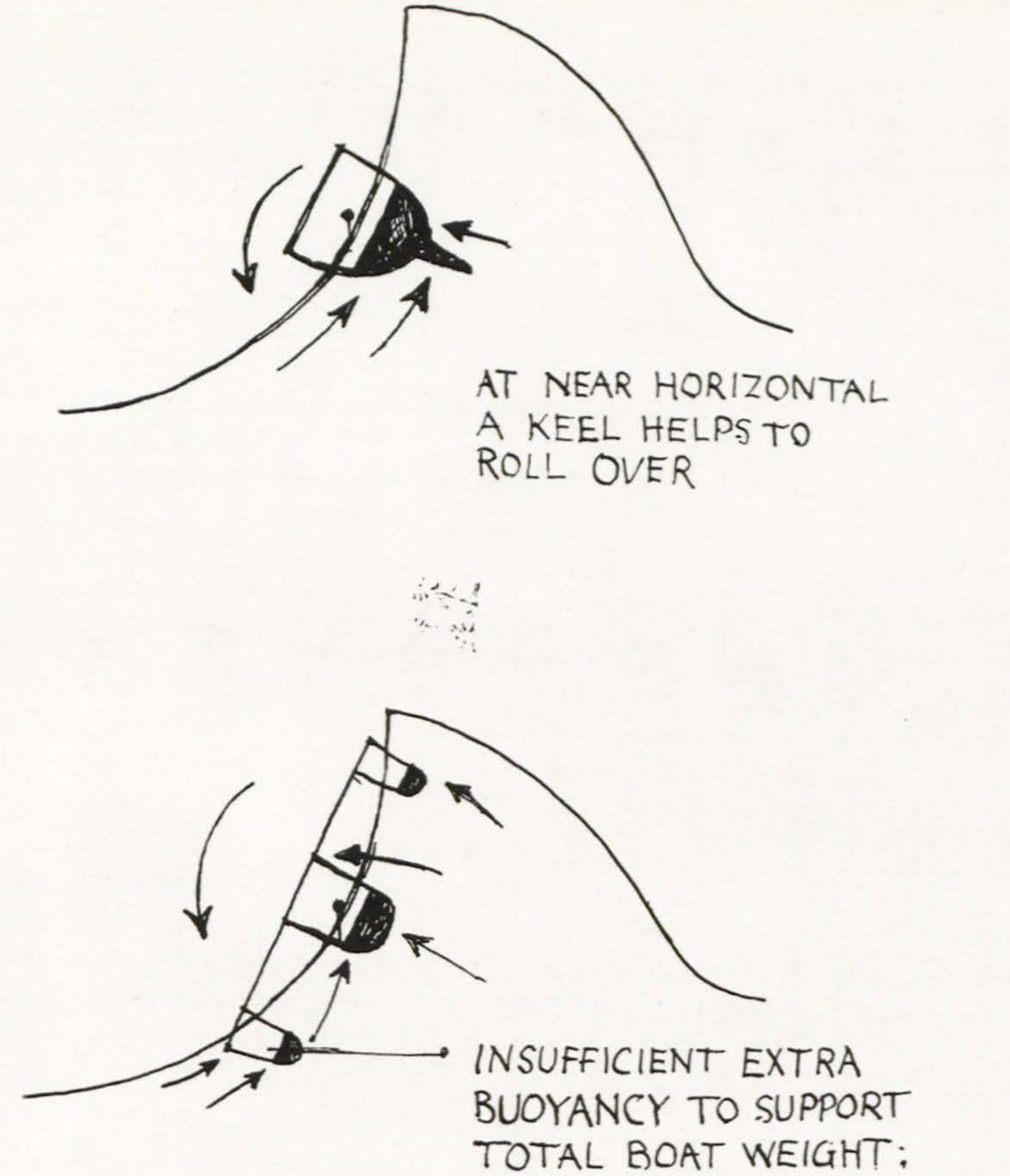
Yet from the design angle, drawing this line between seaworthy and unseaworthy would not be such a problem once one accepts that certain boat configurations are basically unseaworthy, such as mono-hulls and trimarans. But before explaining the reason for this assertion, I must mention the word 'wind-worthy' as applied to sail boats. Wind can blow over or flatten almost any sail boat. But sails can be removed for safety just as a bung can be put in a barrel to stop water entering. So although no doubt a sail boat can be designed that is both sea and wind worthy under all conditions, I refer here only to boats without sail.

The worst condition that a boat can get into is a vertical or near vertical wave or breaker that is higher than the boat. Such waves have water rising at the foot, as surf riders know to their joy, and horizontal water motion towards the top being driven forward. When broached-to in such a wave, a single hull boat, as is well known, rolls over. If a boat has a keel and it is tilted over in the rising water at the foot of a wave, the keel can act as a lever to help the rolling. Some of these boats of course finish right way up—minus the odd crew members on occasions.

A trimaran, again without sails in such conditions, will also turn over because the weight of the hull plus the weight of the upper float pushes the comparatively small lower float into the rising water at the foot of the wave which stops it, if not also pushing it backwards. When tilted, the large central hull presents a wide bottom to rising water on its lower surface and to water moving horizontally or falling on its upper side. In fact the horizontal hull also acts as a surface to deflect horizontally moving water forwards so it pounds against the upper wing, while at the same time shielding the lower wing from being pushed away, so over she goes. Like a keel on a single hull boat, the floats each side of the main hull on a trimaran add to its sorrow in such circumstances, and make it a most unsafe boat. I notice that some trimaran designers are presumably aware of this and are making the side floats larger and longer. One day they will reach the logical conclusion of this trend where the central hull becomes no more than a blister in the deck of a catamaran.

In the wave conditions described above, it is my contention that a well designed catamaran, again without sail, cannot be rolled over. Once you tilt the long narrow lee hull of a catamaran sideways, you not only increase its buoyancy—so much so that the one hull can float the weight of the whole boat—but you also cant it at about the same angle as a surf rider's surf board. So in the rising water at the foot of a breaker, this hull tends to 'surf' away from the wave. The big size of this bottom hull also shelters the upper hull from being pushed up by rising water as happens to a mono-hull and to the centre hull of a trimaran. So the only rolling force that can act on a catamaran in such conditions is from horizontal water pushing at the bottom of the upper keel where on a narrow hull type, resistance is minimum. This upper hull in fact tends all the time to sink back as the cat is surfed along at the foot of the wave, which, when it finally curls over and pounds down, tends to push the top hull back to the horizontal. And once this happens, the rising water is turned to less buoyant foam that further helps this hull to level out. So of the three major boat configurations discussed, the well designed catamaran is the only one that can be considered seaworthy.

All this means that if the naval architects and mono-hull traditionalists cannot shoot my arguments to bits and put us back to square one, they must go



WHY A CATAMARAN IS THE SAFEST BOAT

back to school and learn about catamarans. Because if my arguments are sound, and it will not be too expensive to test them, it means that to go on using monohulls and trimarans can only be justified as dangerous expediency. The only other alternative is to take the easy way out by accepting a double meaning for the word 'seaworthy', ignoring the implications of the 1967 Misrepresentation Act, and treating the whole subject as irrelevant.

But which ever course we choose, one thing must happen. The word 'multihull' must be considered a dirty word when discussing boat safety. Far too often the popular press, and even the technical boating press have been damning catamarans unjustly for the sins of trimarans by indiscriminate sweeps of the 'multihull' brush. The word 'multihull' must now be considered a dirty word, and its use in safety talk a measure of a man's ignorance of matters boating.

"AT THAT SPEED IT ONLY TAKES ONCE"

by Guy Bagot

194 Conway Road, Colwyn Bay N. Wales

To start where Jock Burrough finishes off on page 74 of *AYRS Journal No.* 65, 1968. "We have yet to be educated".

Is this *fetish for speed* leading us into the wake of other craft . . . or up the garden path!?

Today we are being encouraged to compete in races round Cape Horn, or around the World, single-handed. With all these modern scientific electronic devices to aid Navigation, is one apt to forget the *fraility* of small craft for running into storms whose influence can be felt 1,000 miles away?

It is just as well that Jock reminds us of the immense forces at play when we are dealing with the elements of WIND & WATER. Let us acknowledge the *frolics* of the ocean waves and design and construct craft to be worthy of the elements with which they must compete, when sailing single-handed round the World. For is not the contest comparable with the stories of David and Goliath!

When going deep-sea one must be prepared to encounter something even more furious than the average gale. In these comparatively sheltered waters around our native shores, we are not so often troubled with *revolving storms* in the categories of TYPHOONS and HURRICANES; for they play around in oceans of greater depth where larger waves are added to the forces of the wind.

Hulls and Sails of Eastern craft have changed little throughout the ages. Junks, Dhows, Catamarans, each designed for the Oceans in which they sail keep clear of the tracks of *revolving storms*. They have specially protected anchorages for shelter during the Seasons for these storms.

DINGHIES, in which one learns how to sail today, are like water-skis compared to ocean-going Yachts. These dinghies are designed for *speed* and one has to ballast the boat by using one's own weight, moving rapidly from side to side, or suspended from the mast as conditions require, to compensate the boat for its *unseaworthiness*! If she doesn't capsize one has a chance of winning the race.

One sees larger yachts competing for the America Cup fitted out with the most up-to-date instruments, almost on computer level, yet with conventional hull and sail design with the crews sprawling on deck, either to ballast the boat or to avoid unnecessary *windage* while racing.

Did not this *fetish for speed* introduce the Bermudian Rig to sail faster on a course closer to the wind, just to win a race around some buoys?

Some of us were taught how to sail by the old school of Sailors and were told to keep still and low in the boat to improve her sailing qualities. In fact, it was considered a disgrace to *capsize*; and to be seen sitting on the gunwhale would inevitably invite corporal punishment! There was just as much excitement and enthusiasm to win the race.

Today, *speed and light displacement* are said to go hand-in-hand. But this statement seems to completely disregard the power of the WIND & THE SEA.

Surely, it is more important to study the effect of *stream-lining*, than the effect of *weight* when designing craft to compete with such powerful adversaries as the Elements?

Vehicles are becoming more and more *stream-lined* as their speed increases and vice versa; it increases their speed. The Aeroplane leads in this design. Cars are becoming more stream-lined, but Railways and Ships are slow to follow suit.

Cars and Trains often do speeds of 100 mph or more. Ships encounter storms of Hurricane force (100 mph) and have to heave-to or else run before the storm. The proudest owner of a sailing craft is one who says "she is an excellent sea-boat in rough weather". It is only common sense that the more stream-lined she is, the better she will stand up to the force of the waves and the winds.

Jock also mentions in his article the importance of C.E. in relation to C.R., both of which increase their importance when a craft is sailed single-handed and has to reef-down, perhaps in a hurry.

One cannot of course compete against *freak waves* or *stray whales*; but as a tail-piece, to keep afloat perhaps the most important thing of all is, A RADAR REFLECTOR!?

FLYING HYDROFOILS FOR *KINNEGOE*

by John Morwood

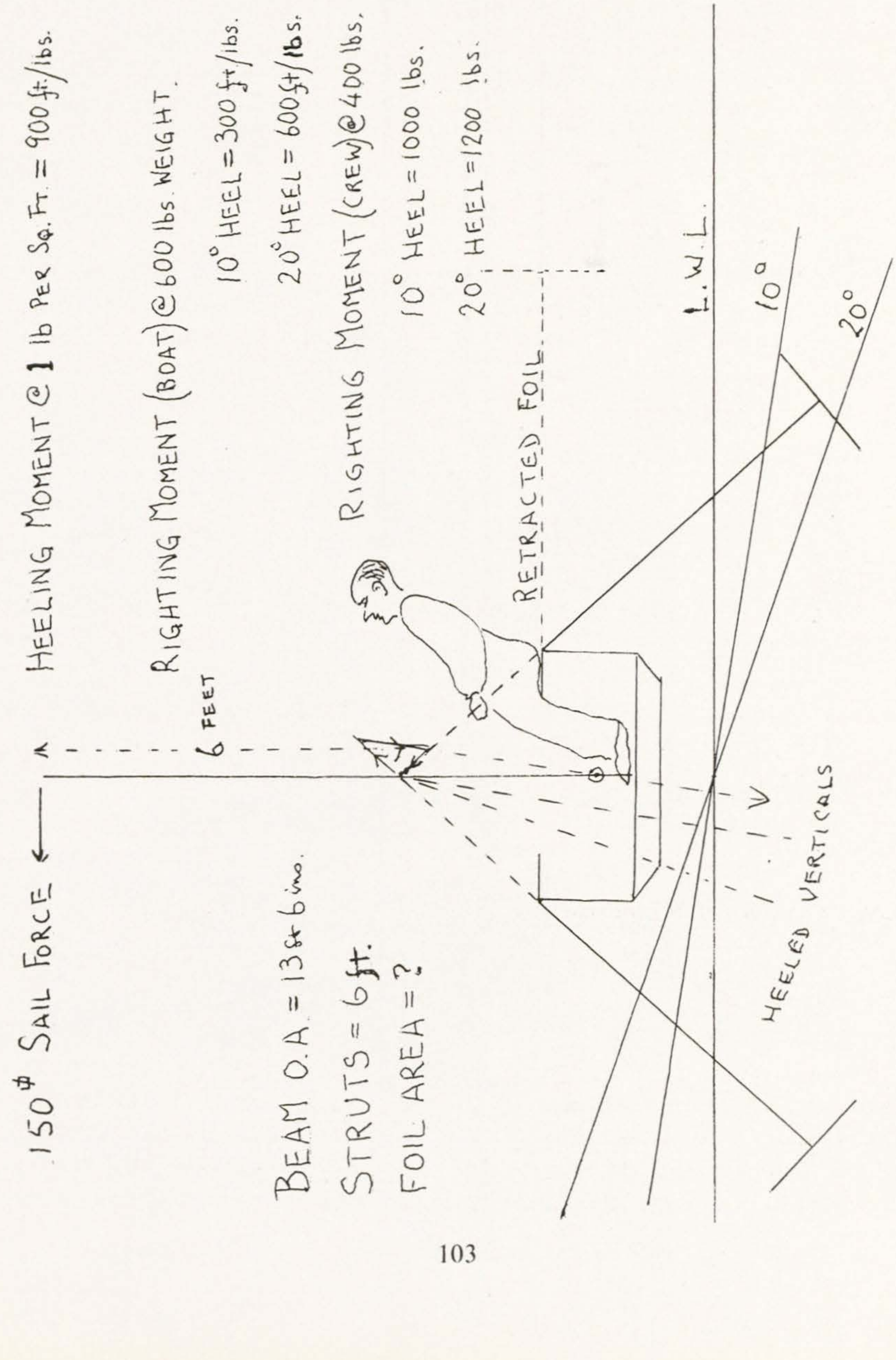
Having worked out hydrofoil stabilisers for the 'Retirement Yacht' article, and seeing the latest photograph of Dave Keiper's boat, I cannot resist showing my design of a flying hydrofoil, which looks simple and useful. When I finish my current sail development on *KINNEGOE* I will try this out. Other people, however, might want to do so first.

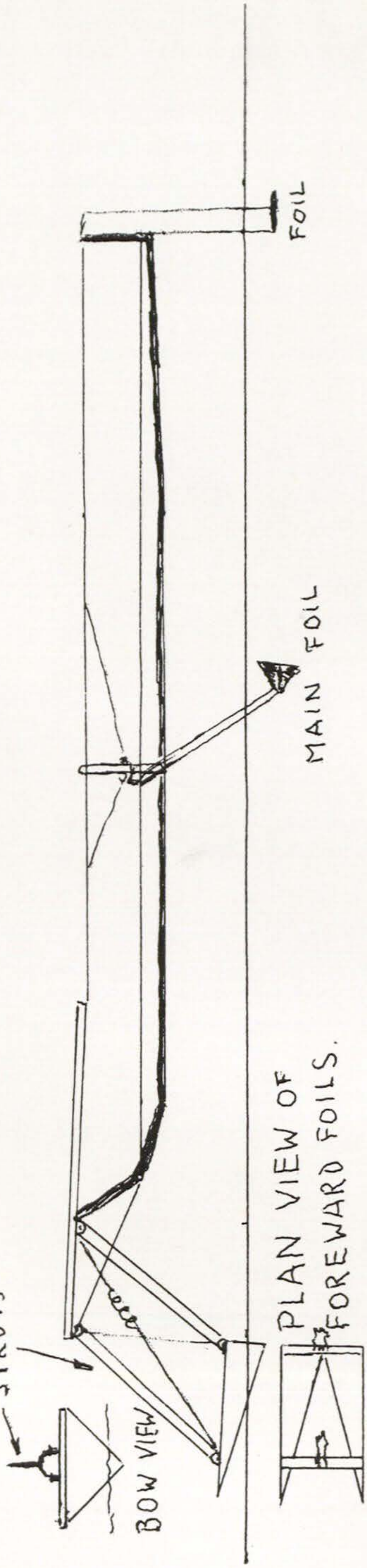
Introduction

One of the difficulties about hydrofoils is the trouble and cost of making a special boat to fit them on. Another is the fact that all those which have been produced to date cannot be launched from a beach or slipway. The foils described here can be fitted to any dinghy (and would be better on a catamaran). They can also be retracted for launching and slipping.

Principles of design

Rotating, inverted T foils are used with the struts sloping down to the water at 45°, from the gunwales. With *KINNEGOE's* 4 ft of beam, this produces




FOIL
MAIN FOIL
PLAN VIEW OF
FOREWARD FOILS.
STRUTS
BOW VIEW

some two thirds of the righting moment for a sail force of 1 lb per square foot (which occurs in a windspeed of about 17 knots). If the beam were 7 ft, which I could achieve by a short cross beam, nearly all the side force would be neutralised. The crew weight is then available to take extra heeling moment.

This stability is got from the dihedral of the foils and the rotation of the struts and it makes any devices for relating the foils to the surface of the water unnecessary. The struts can easily be retracted either to the horizontal position for beaching or put vertically for tying up alongside another boat in deep water. The struts for *KINNEGOE* need only be 6 ft long.

The result of this concept is that three should be far less fuss and resistance at the water surface with these foils than with either Don Nigg's or Dave Keiper's. At present, I feel that there can be no doubt that this design will be far superior to any other.

The front foil system

As compared with the main foils, I am not confident that I have found the best forward foil system. Other types could well be tried.

The purpose of the forward foil system is to keep the craft 'flying' level and at a roughly fixed distance above the water surface. The foils, which I think may well be best, are two triangles 4 ft fore and aft and 2 ft wide, each at a dihedral angle of 45: attached together by bars across the top and at the lower tips. They may be absolutely flat in fore and aft section.

This foil 'cart' is attached to a bowsprit by two' pantographing' arms which keep it at a constant angle of attack to the water flow of 5°, irrespective of its height. The arms allow the 'foil cart' to be retracted right out of the water and decree the height at which the whole boat will fly. The 'foil cart' is pulled down by a cable in which there is a spring so that it can profile short waves without altering the trim of the whole boat.

The system shown has the following advantages:—

1 The foils have an aspect ratio of 1 : 1, which has been shown to be best by Edmond Bruce.
2 The shape is a bit more immune to flotsam and jetsam as it will ride over this better.
3 The shape should ride over waves (or jump from crest to crest) without having any effect on longitudinal trim. One hopes here that the upward and downward movement of water in waves will not affect the foils adversely. However, this doesn't seem to be a problem with other foils.
4 The foils should be fairly easy and cheap to construct.
5 The foils can be retracted.

The stern foil

This is an inverted T foil, the strut of which is the rudder. This is, of course, Dave Keiper's system and avoids having to steer from the forward foils. It has the following advantages:—

1 There is no change of steering when changing from sailing as a displacement boat to 'flying'.

2 Fore and aft trim is more stable.
3 Useful and efficient lift can be got from the stern foil.
4 The rig can be placed further back which may be advantageous when sailing in light winds.

Summary

A hydrofoil system is described with the following assets:—
1 It can be used with many dinghies and most catamarans.
2 The foils can all be retracted for beach launching, or light wind sailing.
3 The efficiency of the main foils should be better than some other systems.

Finale

I have no idea what size to make the main foils.

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