

YACHT RESEARCH II

A.Y.R.S. PUBLICATION No. 41



Col. Bowden's X Boat with Streamers, Close Hauled.

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(Founded June, 1955)

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EDITORIAL

October, 1962

The Annual Subscription to the A.Y.R.S. is now due. It remains at £1 or \$3.50 as before. Please send to the Secretary-Treasurers in the various groups. British members please send it to the "Membership Secretary," Woodacres, Hythe, Kent,

Again, as usual, it is requested that, if anyone has had a misbound or faulty copy of a publication or has not had his full four, will he let me know.

Reprints. Publications No. 1, *Catamarans*, No. 10, *American Catamarans* and No. 15, *Catamaran Design* have now been reprinted and are available at 4s. or 75 cents each.

The 1963 London Boat Show. Will members with models or photographs for display at the next London Boat Show please contact Tony Millard, 138 Fulham Road, Chelsea, London, S.W.10 who is organising it this year.

Publications for next year. These will be on catamarans and trimarans and technical subjects as for this past year. People with boats to describe or articles to write may send them in to the Editor as soon as possible. It makes things very difficult to get articles in at the last moment and some have had to be deferred to the next year for this reason.

The A.Y.R.S. Clubhouse and Sailing Waters. Fred Benyon-Tinker, John Long and others have been doing their best to get these facilities but no clear cut success can yet be reported. The search continues.

The change of British Secretary. Mrs. Ruth Evans has had to resign from the post of British A.Y.R.S. Hon. Secretary for private reasons. During her term of office, she did sterling service for the A.Y.R.S. not only in the routine matters but she organized the *Research Fund* and manned the stand at the Boat Show as well as making some very beautiful models, including the model for the A.Y.R.S. *Yacht Wind Tunnel*.

Our new Hon. Secretary is John Long, to whom we offer our best wishes for a long and pleasant association with us.

Advertisement in the A.Y.R.S. Publications. A full page advertisement in our publications costs £5 for an inside page, £10 for the back page. Matter for these advertisements is only accepted at the discretion of the Hon. Editor and must be in our hands at least one month before the publication is due. The cost of blocks and type-setting is extra to the above charges, which only barely meet the cost of the blank page.

The A.Y.R.S. Tie. The A.Y.R.S. tie is available from Mrs. Mabel Robson, 10, Eastvale, The Vale, Acton, London, price £1 or \$3 each.

An International Trimaran Challenge. Victor Tchetchet and I think most of the A.Y.R.S. members would like to get an International Challenge series of races going for Trimarans similar to that which is now going on with 25 foot Catamarans. The size of the craft would be L.O.A. 25 feet. Maximum beam 14 feet and total sail area 300 square feet. As a tribute to Victor Tchetchet, I feel that the challenge should come from Europe, Africa, Asia or Australia and be issued to the International Multihull Boat Racing Association, Kings Point, Long Island, New York, U.S.A.

The A.Y.R.S. Yacht Wind Tunnel. I am sorry to say that the A.Y.R.S. yacht wind tunnel has had no use this summer. My partner in my medical practice was off work for three months due to illness which greatly reduced my spare time. I also felt that it was unreasonable to neglect the continual cleaning up which has to be done at Woodacres for a second year. No work was done on Woodacres last year when the wind tunnel was being built. All this goes to show that the work of the A.Y.R.S. is far too much bound up with what is done at Woodacres and underlines the need for a clubhouse nearer London where members can meet and do work. There is enough work for one man in editing the publications and in collecting the material for them. Any member of the A.Y.R.S. is, of course, welcome to come to Woodacres and use the Wind Tunnel.

YACHT RESEARCH II

The objective of yacht research. This must be simply to know and understand exactly how, why and by what amounts our yachts are driven through the water. As a result of this knowledge, we hope to increase the speed of our present yachts and design faster ones in the future. The factors of seaworthiness and comfort should also be studied.

In practice, what we mostly want is the performance of a yacht reduced to figures which can be set out in graphs. These can be of two kinds; (1) conventional rectangular coordinate graphs and, (2) "polar diagrams" where the quantities in which we are interested are given as distances from a single point, the angle at which they are drawn being the course of the boat from the wind.

The uses of polar diagrams. The conventional rectangular graph is easier for most of us to read as the boat speed is the vertical distance above the base line. In the polar diagram, one has to run ones eye around in a circle to find the figure. This is more difficult. However,

in various practical problems such as tacking to windward or leeward where the best course is given by a horizontal tangent on the polar diagram, it is easiest to use that presentation. We must all therefore accustom ourselves to polar diagrams.

The presentation of A.Y.R.S. research. The practical sailor thinks in terms of "feel" or "muscular sensation" aided by visual and auditory images. In my opinion, the abstraction of "muscular sensation" is mathematics, which has to be learnt. Now, few A.Y.R.S. members are very highly mathematical and even they must reduce their theory to practical terms of what will be useful to them when sailing a boat. It also seems fruitless to me to become highly abstract without having a great deal of practical experiment and figures to use and to check the abstractions when they have been made. As your Editor, catering for members of very different degrees of mathematical knowledge, I think the articles by Edmond Bruce should be the type we should use as regards intellectual level and we should try to make them even more simple, if we can.

In this publication, we are lucky to have another study of a full sized dinghy by Harry Hunter along the same lines as that of Edmond Bruce but quite independently and differently studied. Perhaps we should say that this is the "traditional method" of sailing ship study but merely more accurately instrumented. It must have been used since the invention of the log on a string and the hour glass. What is different, however, is that it is now possible to get the figures more accurate and we are more vitally interested in the results. All studies of this kind or by the Bruce method should be the basis of our studies.

The idiom of presentation. It would be unwise at any stage for us to decree the idiom in which members should write their articles and we do not want to do this. However, if we ask members to learn one idiom of presentation and ask members who depart from this in their articles to explain the new idiom, we can carry our members forward with us far better. The idiom at present used is as follows:

(1) The sail force coefficient as a rectangular graph or polar diagram to the heading of the yacht from the apparent or true wind. This can be split up into "Thrust" and "Side force" coefficients.

(2) Hull force as a rectangular graph or polar diagram to the "Course made good" which differs from the heading by the angle of leeway. The coefficient cannot ordinarily be used because the force varies irregularly with different boatspeeds. This could also be graphed to the heading and care should be taken as to how it is done, when reading articles.

(3) Boat speeds on all courses in various wind speeds given as a rectangular graph or polar diagram.

The mathematical analyses. Every time we have had a publication on yachting technicalities, I turn out the files on the subject and find some mathematical analyses done by members. All these are clever and have taken a lot of work to prepare. In general, the material is similar in each. With aeronautical data and assumed figures for various things like sail, hull and centreboard performance, graphs are produced for a yacht's performance in various ways and conditions.

Now, very few of our members are mathematical enough to follow these analyses and the final results are often of minor interest to the practical sailor. One or more of the analyses would probably have been used had it not been for the interesting articles produced by Edmond Bruce in which he showed how the actual performance of full sized yachts and models could be precisely measured. This approach seems to be of so much greater value than the analyses from estimated performance figures that it has been preferred.

People writing for us must always remember that we are all practical yachtsmen and we mainly want to know how to sail our boats a little better. Yacht research and mathematics must therefore have the end product of telling us how our boats sail so that we can improve on them.

Conclusion. All yachting articles should finish by telling us how the boat or part of the boat performs or may be expected to perform. In technical or research articles, the performance may be expressed as heart-shaped curves (polar diagrams) or with the same information graphed in the more common manner.

Acknowledgement. The photographs and material used in Col. Bowden's article have previously appeared in *Yachting World*.

A FULL SIZE DINGHY TEST

BY HARRY HUNTER

1 Graham Park Road, Gosforth, Newcastle on Tyne, 3

By a strange chance, Edmond Bruce's contribution to A.Y.R.S. No. 40 covers a subject I also have been working on for the past few years since my retirement after a lifetime in the shipbuilding industry with sailing as a hobby. Put very briefly, I have thought that references to the performance of sailing craft are expressed in very ambiguous terms as compared to the precise figures in relation to the speed, displacement, deadweight, horsepower, fuel consumption etc. one has to deal with in sea going powered ships. Also, in the case of relatively small sailing craft, it seems that a lot more could be learnt from working on a full sized craft rather than from tank testing of models. With the big ships, the "Moment of truth" is the Sea Trials when full

details of the performance are obtained and I have accordingly been working on a technique for getting corresponding data from sailing craft.

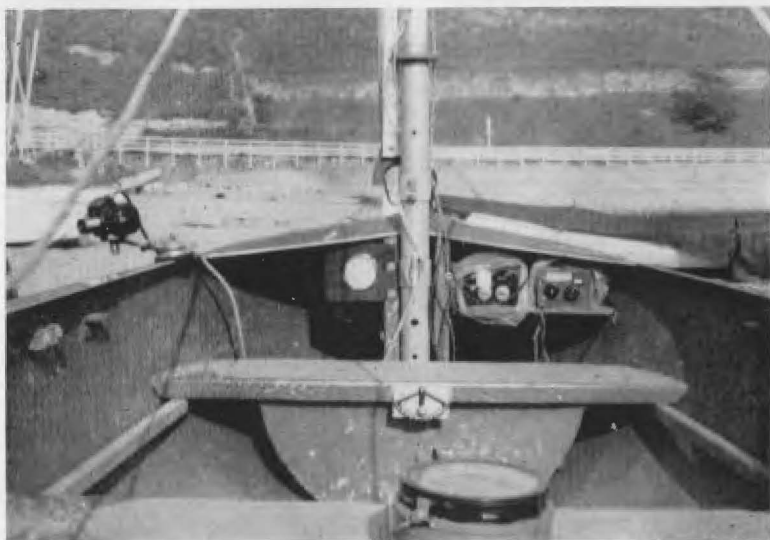
For convenience, I used a small dinghy which, as will be seen from the table below, corresponds fairly closely with Bruce's 12 foot one design.

	<i>Bruce's 12 foot dinghy</i>	<i>Hunter's 10 foot Viking</i>
Builders:	Anchorage of Warren, Rhode Island, N.J.	Viking Marine Co., Gosport, Hants.
Material:	Fibreglass.	Welded aluminium alloy.
Sail area:	80 sq. ft. (with roach).	60 sq. ft. (with roach).
	2 Battens.	2 Battens.
	Luff: 16 ft.	Luff: 12 ft.
	Foot: 8 ft.	Foot: 7 ft.
	Dacron.	Cotton.
Mast:	Streamlined rotatable aluminium alloy.	Circular aluminium alloy sleeved sail.
L.O.A.:	12 feet.	10 feet.
Beam:	56 inches.	52 inches.
Draught:		Keel mean 8 inches.
„ C.B. down:	4 feet.	2 feet 6 inches.
Weight, rigged:	207 lbs.	233 lbs. including oars, buoyancy, technical equipment.
Weight of crew:	336 (assumed) lbs.	336 lbs.
Total weight:	543 lbs.	569 lbs.

The vital data for a sailing craft seems to be the speed of the boat through the water at various headings to the true wind. Throughout the following, I use "Headings" and not "Course made good" in the interests of brevity and simplicity. After many trials and errors, I have arrived at the following "set up" and procedure:—

Speed through the water. A "Walker" log special equipment with rotator 45 feet astern of the transom. The "register" is fitted on the transom and contains an electrical contact which closes the circuit every 2 revolutions of the rotator, actuating an electro-mechanical counter fitted under the foredeck (see photo 30A). For calibration, the boat is driven by an outboard motor (or oars below about 2 knots), pairs of runs being made alongside a measured length of the

North Tyne Pier. This pier is 3,000 feet long, is dead straight and of solid masonry so that no cross currents are involved. The rotator, being 45 feet astern and well submerged is consistent whether the boat is driven by oars, sail or motor. A large number of runs on this

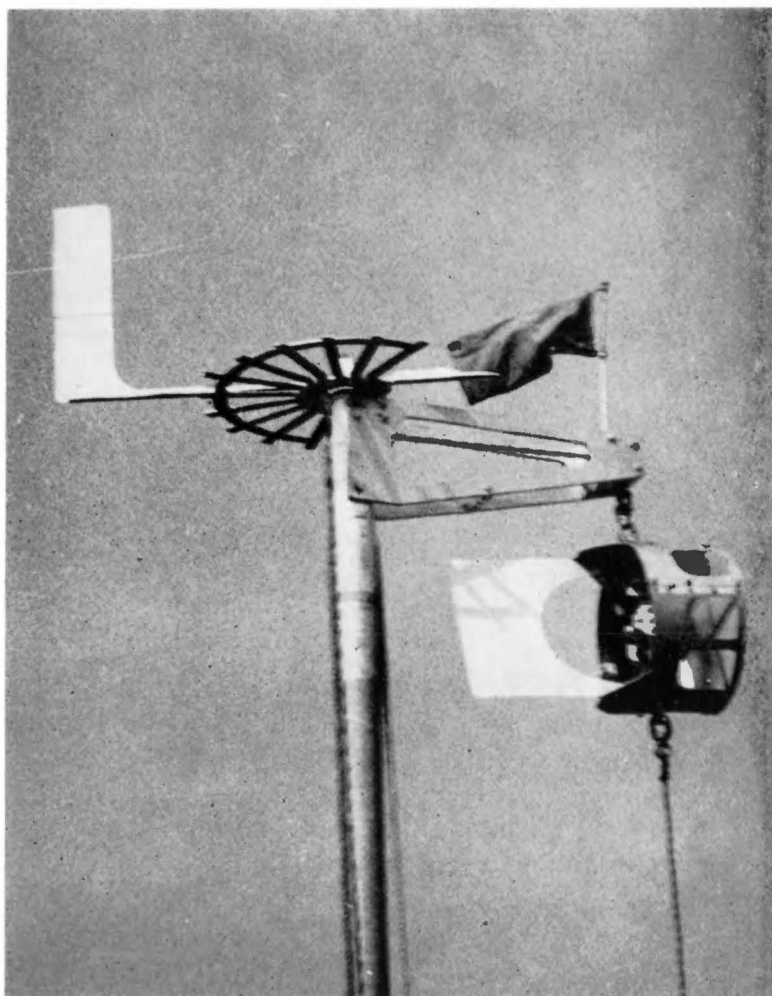


course have given extremely regular data and the accuracy of the "speed through the water" is something better than ± 1 per cent.

The true wind speed. The anemometer is suspended by halliards of electric flex from a "Spur" at the masthead (Photo 30E). Its propellor actuates a contact which closes the circuit through the halliards every 60 revolutions and the halliards are connected to an electro-mechanical counter alongside the log counter.

The anemometer was calibrated partly when fitted on a car top jury mast on calm days but mostly on a mast in open country with a hand held National Physical Laboratory calibrated anemometer held alongside. The "Halo" and vane shown in the photograph are for obtaining data when sailing on a "Relative wind." Since the photograph was taken, the anemometer has been raised 2 feet by an extension of the mast so as to keep the anemometer more clear of the sail effects—a problem which arises with the wind abeam.

Trial procedure. Firstly, proceed under sail with the craft in trial condition to a position where the prevailing wind is free from



effective upwind interference and is steady. Then, luff and keep the craft in stays for several minutes whilst the true windspeed is obtained by the anemometer and its direction by the steering compass.

Next, the boat is sailed on the required "Heading off true wind" course and when steady, the log and anemometer counters and stop watch are switched on and the course held for, usually, about 2,000

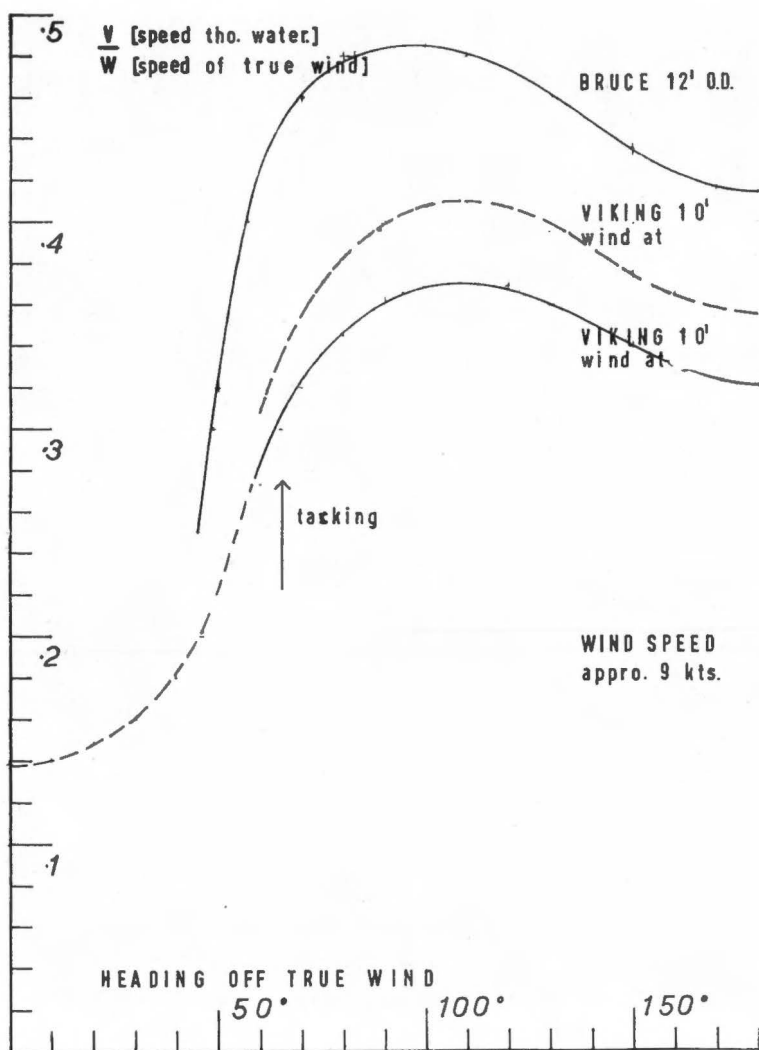


Fig. 1

feet when the instruments are stopped, their readings noted, and the boat is luffed into "between stays" to obtain "True wind after run" which is also the "True wind" before the next run.

The data so obtained on many runs has been plotted on the graph Fig. 1 from tests taken in 1960, 1961 and 1962 on which I have also

plotted Bruce's data from his Fig. 19. I have taken the liberty of transposing his data from Polar to Rectangular coordinates which I think preferably as the latter "open out" the plotting in the very critical close-hauled condition. The "Centre of Area of Sail" curve is added to line up with Bruce's curve, the measured correction factor—Masthead to centre of area being 0.905. See Fig. 1

The assessment. Assuming that the curves of performance of the two craft are of similar reliability, we can assess the performance of these similar craft by "Big ship" methods when a commonly used criterion is the Admiralty Coefficient:—

$$\frac{V^3 \times D^{2/3}}{P}$$

where V = speed in knots.

D = displacement.

P = horse power delivered to the propellor(s).

The Admiralty Coefficient assumes that the resistance varies as V^2 and from Bruce's Fig. 17 it seems that between 4 and 5 knots the resistance is in fact varying with V^2 . Also, it is, I think, quite appropriate to substitute Sail Area (S.A) for Power (P) since both are directly related to thrust.

Assuming the above, we get the following :—

	<i>Bruce 12 ft. O.D.</i>	<i>Hunter's Viking</i>
Max. speed in 10 kt. wind	4.85 knots	4.1 knots.
Displacement	543 lbs.	569 lbs.
Sail area	80 sq. ft.	60 sq. ft.
Admiralty Coeff. (Sail)	95.5	84.5

Edmond Bruce's performance is therefore some 14 per cent the better and it would indeed be interesting if his "Synthetic" speed could be substantiated by some appropriate procedure. In the meantime, I am studying Bruce's important paper and hope in due course to effect considerable improvements in the *Viking* performance.

Summary. A method has been evolved for studying the sailing performance of a dinghy.

OPTIMUM SIZES OF CENTERBOARDS

BY EDMOND BRUCE

Lewis Cove, Hance Road, Fair Haven, N.J., U.S.A.

During September 1961, the writer observed, from his cruiser, two of the International Catamaran Races on Long Island Sound, U.S.A. These races were between the British *Hell-Cat* and the American *Wild-Cat*.

There followed a lot of spoken and written discussion saying that *Hell-Cat* was superior to windward because of a higher aspect ratio sail rig. Personally, I do not believe there was a marked advantage in either sail rig. From my towing tank experience, I feel it was those large wooden centerboards on *Hell-Cat*, compared to its rival's smaller boards, which provided the difference in windward performance.

As to the sails, the actual areas were the same for both boats. Also the foot of both mainsails appeared to be about the same length. Merely transferring a small narrow strip of cloth from the head of *Hell-Cat's* mainsail to the roach, as in *Wild-Cat*, should make a negligible difference in sailing to windward.

As to centerboards or centreplates, many catamarans need larger boards than conventional hulls since, when shallow, rounded hull sections are used, they have lost their lateral grip on the water. Tank tests show that then their maximum lateral lift-drag ratio is less than 2.2, without their centerboards lowered. Hulls designed to favour running resistance differ in shape from those where the design gives preference to windward performance.

There is no reason why a rounded section catamaran cannot be designed to point as high or higher than conventional sailing craft provided two things are done:

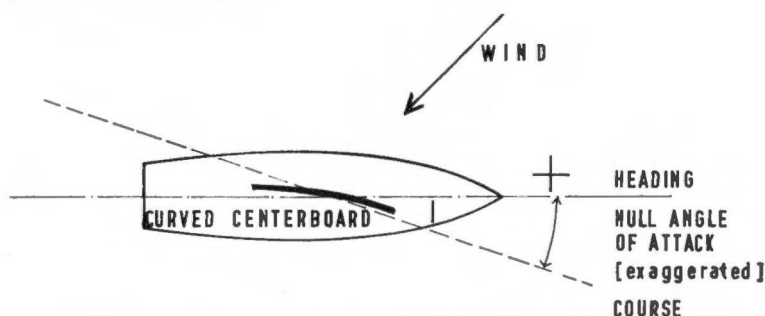
First, the hull windage should be reduced by "turtle-back" bows and "tumble-home" elsewhere above the water-line. Overhanging sitting platforms must be abandoned.

Second, a greater than optimum size, adjustable centerboard should be fitted to complement the lift-drag characteristics of the hull. The board should be well-formed, well-located and adjusted to a proper angle of attack. Strange as it may seem, this optimum angle with the boat's centerline is often negative rather than positive when curved plates or foils are used rather than flat plates. The failure of some attempts at angled boards has been due to this discrepancy. Negative angles result when the optimum angle of attack of a centerboard is less than the angle of attack of the hull. See Fig. 1.

In the belief that the average reader prefers graphical explanations rather than mathematical, the writer has devised the graphical method shown in Fig. 2. It will be advantageous to use combined lifts of hull and centerboard in the presence of their least combined drags. By plotting the centerboard lift and drag components in the upper right hand quadrant and those of the hull in the lower left hand quadrant, we have a graphical layout that automatically adds the separate lifts and drags and also shows the respective optimum angles of attack

for each. It also indicates the optimum area of the centerboard for the fixed speed as stated. In general, larger centerboards are desirable at greater speeds due to the rapidly rising resistance of the hull.

Fig. 2 was drawn for the hull speed of three knots through the water simply as an example of the method. The scales of lift and drag, as drawn, are not the same. This is to permit a less crowded diagram. At a higher hull speed, the centerboard curve would have its shape unchanged if the coordinate labels were increased by the square of the speed ratio. However, the drag of the hull curve would increase at a greater rate, due to wave-making. This would require a different hull curve.



Assume that a rectangular flat plate is to be used as a centerboard. Its depth is to be three times its fore and aft dimension. Due to the presence of the hull, preventing an end-effect, the aspect ratio is 6, by the theory of images. Examining N.A.C.A. Reports for such a foil, the coefficients of lift C_L and drag C_D , for various angles of attack α° , are extracted as follows :

Angle α°	0°	2°	4°	6°	8°	10°	12°
C_L	.00	.14	.26	.39	.52	.64	.73
C_D	.035	.037	.042	.059	.085	.123	.161
L/D	0.0	3.8	6.2	6.6	6.1	5.2	4.5

Now for either lift or drag and a hull speed of three knots (5.1 ft./sec.),

$$\text{Pounds} = C \times \text{Density} / 2 \times \text{Area sq. ft.} \times (\text{ft./sec.})^2$$

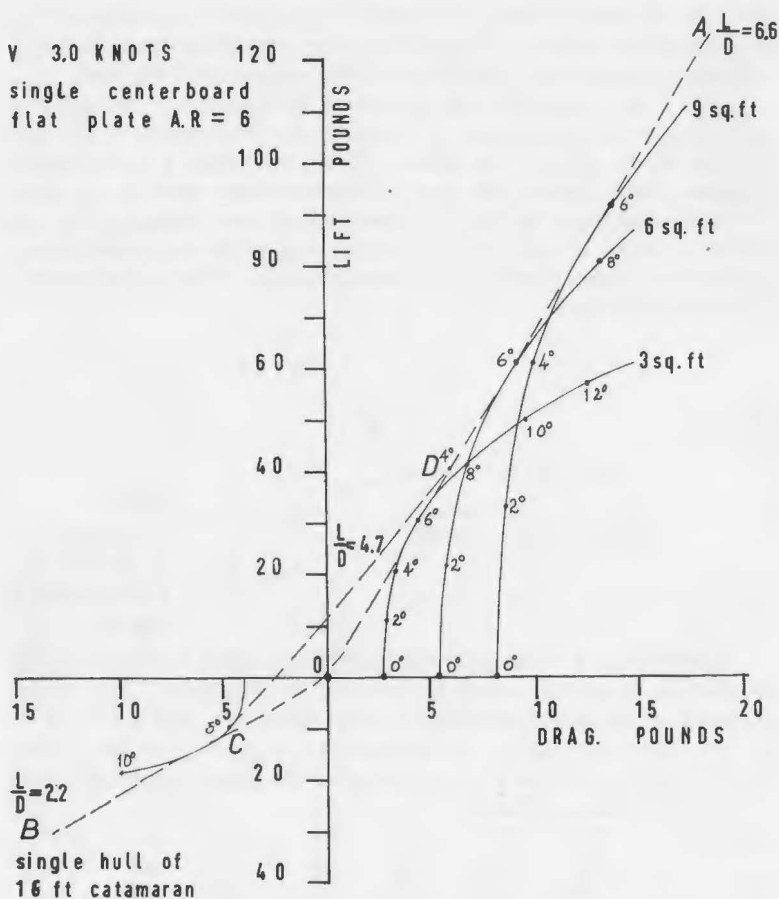
where area is for one side only.

or

$$\text{Pounds} = 25.8 \times C \times \text{Area sq. ft.}$$

for three knots in sea-water.

In the upper right part of Fig. 2, the lift and drag, in pounds versus angles of attack, have been plotted for centerboard areas of 3, 6 and 9 square feet for a hull speed of three knots. Note that the



curves of the several areas intersect. This proves that optimum centerboard area exists. For example if the centerboard alone is asked to develop 50 pounds of lift to counteract sail forces, it can do this with less drag when 6 square feet of area is used rather than either 3 or 9 square feet.

Notice that dotted line O-A represents the highest possible ratio of lift/drag = 6.6 for these centerboards. Also, the optimum angle of attack for all areas, beside those drawn, is 6 degrees, the point of tangency of the dotted line O-A with the curves. Dotted line O-B, in the lower left of the sketch, is the maximum lift/drag = 2.2 for one of twin hulls having shallow, rounded sections. The catamaran hull

curve was extracted from towing tank model data of a typical form of such a hull 16 feet long, $L/B = 8$ and a prismatic coefficient of 0.54.

Of course, for the complete boat, the optimum lift-drag ratio of the centerboard alone will be degraded by the drag of the hull. However, an amount of lift from the hull can be used advantageously so that, for a 50 pound overall lift, the least possible overall drag is encountered. The dotted line C-D is the writer's estimate of the best that can be done, with the 50 pound lift, in minimizing overall drag. The overall hull and centerboard lift-drag ratio of line C-D appears as 4.7, which is better than many catamarans.

Note that the best area of the single centerboard now is intermediate between 3 and 6 square feet for the 3 knot speed. Also, the best angle of attack for the centerboard is still 6 degrees while that of the hull is near 5 degrees. These are so close to being the same angle that a centerline installation of the flat board should be satisfactory. Since Fig 2 is drawn for only one hull, this area should be doubled to about 9 square feet for twin hulls.

If the reader plots the lift and drag characteristics of a good foil instead of a flat plate, using the same hull, an improved overall lift-drag ratio may result. However, the increased sensitiveness of the foil's correct angle of attack may cause adjustment trouble and a negative angle to the centerline may be required for optimum performance. All this has been seen in towing tank measurements before this confirming theory was worked out.

Whereas the above graphical analysis produced a prediction of 4.7 for the overall lift-drag ratio, a tank test on the model gave a ratio of 4.3. For those who insist on high accuracy in the calculation, the following should be noted:

Foil data in aeronautical text books is for high Reynold's Numbers where frictional resistance is quite small. At sail boat speeds, Reynolds' Numbers are low and therefore frictional resistances are high. For this reason, greater accuracy can be obtained if the aeronautical foil frictional resistances are calculated and subtracted from the drag values. Then the boat foil frictional resistances are calculated and reinserted into these values of drag. In the interest of simplicity, this has not been done in Fig. 2.

Most present day catamarans have centerboards which are much too small for optimum windward performance. The driving force of a model of a well known catamaran was increased 20 per cent, for the same sail force, and the speed increased nearly 10 per cent, on a course 40 degrees from the apparent wind, when larger, improved centerboards were installed. Full size hull speed was originally 5 knots, in this case.

AIRFLOW PATTERNS AROUND SAILS

BY LT.-COLONEL C. E. BOWDEN

During 1961, two friends and I made some experiments with sails in an endeavour to correlate the airflow patterns between full-scale and the large radio controlled models we use for our yacht research. The two friends are Mr. J. C. Hogg, and Mr. R. H. R. Curwen, with the kindly support of Dr. Lamont of America. My full-scale "X" One Design keel boat—L.O.A. 20 ft. 8 $\frac{3}{8}$ in., and a 1/3rd scale model "X" boat were used. Other radiomodels, all around 7 ft. 6 in. long were also employed.

The tests under discussion demonstrated that airflow patterns on models of this size show a very close similarity to full-scale, and that our models can be relied upon to provide a very close similarity in waterflow and wave making to full-scale, whilst manoeuvrability, and general seakeeping characteristics in reasonably scale seas in open water are a reliable guide. In order to obtain reliable airflow pattern results, over two hundred photographs were eventually taken, with wool tufted sails in action on radio models and full-scale craft. The photographs selected to illustrate this short article are therefore backed by corroborative evidence.

Measuring apparent wind and angle of attack

An electrical indicator was produced to check apparent wind speed and angle whilst sailing. The models are checked by a small visual indicator. Angle of heel was also measured during the operations.

It was found that in windward sailing, as close as normal racing practice in our Class demands, that the full-scale "X" boat was sailing at 26-28 degrees to the apparent wind. Our experimental six ton cruiser sailed best at 30 degrees.

Model sail accuracy

To be of value model sails must be sufficiently large for skilled sailmakers to reproduce curvatures accurately. Our sails have a luff height of between 8 ft. 6 in. and 9 ft. according to scale (young dinghy size) and the accuracy of the sails is assured through the fortunate cooperation of Mr. Bruce Banks, the expert sailmaker and racing helmsman. Bruce Banks has recently opened his own sailmaking establishment, and has also made our full-scale sails, whilst taking great personal care to reproduce similar characteristics between model and full-scale. I stress this point because in the past I have not been satisfied with my model sails, before Bruce Banks agreed to cooperate in our work. It should be remarked that the boom angle of the full-scale "X" boat was 8 degrees from the centre line of the hull in the

windward photographs shown, therefore the foot of the mainsail was flying at 18 degrees to the apparent wind.

Sail thrust measurements, angle of heel

When making the airflow photographs, some typical sail thrust tests were also made on the full-scale "X" boat in order to compare these with those made on the model sails in our special model sail testbed. We employed the Curwen sailing towing method to find the sail thrusts of the 184 sq. ft. of sail area on the X boat.

Over a considerable number of runs at different wind speeds up to 18 m.p.h. apparent wind, it was found that only $\frac{1}{4}$ to $\frac{1}{2}$ lb. effective thrust per sq. ft. of sail area is developed on the "X" boat's sails in windward sailing. The figures are a trifle low because the leeway resistance of the towed X boat, being towed by my boat under sail, was not taken into account. Nevertheless the figures are very near, and emphasise how important it is to use every available ounce of driving power in a hot one design class, if one wants to keep amongst the leaders. Also a very small increment in drive, by small improvements in cut and sheeting etc. can make the difference between guns and being an also ran.

Angles of heel were kept between 10 and 20 degrees according to wind strength, in the moderate wind speeds at which we tested the sails. It is known from tank tests here and in America that hull resistance varies little from the upright to 20 degrees of heel. After that the resistance rises rapidly. Even large radio models such as ours suffer from overheeling, and we therefore have a working table in which we use a mixture of lower wind speeds and less sail area according to the scale of the model in order to obtain correct heeling, when we deem that heeling is vitally important in comparative sailing with full-scale. Each model therefore has a normal scale rig and a special "heeling rig."

We have a specially designed open air model sail testbed to measure our model sails. All rigs are quickly transferable from model to sail-test bed. The bed has 5 tensiometers, carefully treated for low friction by knife edge bearings. The bed operates in the natural wind with unrestricted end spill and turbulence effects, which we believe to be most important. This is so because our bed has shown that even in an apparently steady wind there is a wide "band" of angles of attack constantly meeting sails. John Hogg, one of the afore-mentioned "team," produced a small instrument to measure this "band." Recordings are made on a revolving chart by an electrical spark pen to reduce friction losses. Although our investigations are not yet complete, it can be said that in a "steady" wind over a wide expanse

of water at 12 ft. height, Hogg has frequently recorded a "band width" of from 20 to 40 degrees swing in periods of 6 seconds. This means that a sail that is critical to angle of attack, as certain wing airfoils are known to be, is not suitable for sailing purposes. Some of the poor flow in lee shown in the accompanying photographs will make one think in terms of suitable leading edge entry and curvature of sails to accept a wide "band." A helmsman can deal with "feathering" to longer period shifts, but can not feather a keel boat to shifts in 6 second intervals or less.

The sail testbed can measure the side and the forward thrust components, the centre of pressure position and its movement fore and aft. The centre of effort height at different angles of heel can also be found.

Interpreting the airflow patterns

Due to limited space only a few typical photographs can be given. The captions are self explanatory. Nevertheless I will make a few general observations.

(1) Windward sailing (see cover photograph)

The airflow on the windward side of the mainsail is generally fair, with a vortex down trend at the foot of all sails. There is little evidence of the often discussed upward escape flow at the head, except when overheeled. There is a marked disturbance behind the mast when the max. camber height (or "flow") in the mainsail is situated well forward, which extends from the mast to nearly the half chord position. Fig. 1 shows a fully battened sail with max. camber height further aft. The flow is now good from luff to leach.

(2) The lee side

The lee side shows some alarmingly bad flow, not perhaps realised by all yachtsmen. This is particularly true of the "unslotted" single sail without jib (Fig. 4). It will be noted that even the airflow in lee of a "slotted" rig (Fig. 2) is only regular at the bottom half of the mainsail in lee, when there is a short overlapping jib or a non overlapping foresail. The flow in lee of the foresail itself is indifferent. A fully battened mainsail improves the flow in lee of the jib as well as extending a better flow further up the main itself where the gap is narrow at the juncture of foresail and mast.

(3) The long overlapping genoa

Fig. 3 shows how the long overlapping genoa on this radio controlled model improves its own lee side flow as well as the mainsail



Fig. 2. The "slotted" rig in lee. The soft mainsail has broken down airflow at the head. The foresail has indifferent lee flow. The narrowing gap of the foresail provides poor flow on the mainsail. The only flow that is fair and unstalled is the bottom half of the mainsail, where the wider slot is effective. A fully battened mainsail improves the jib flow, and the slot gap flow further up the mainsail.



Fig. 3. This radio controlled model with long overlapping genoa shows an improved airflow pattern in lee of the genoa itself, and also where the slotted gap narrows over the mainsail higher up.



Fig. 4. The lee side of this single mainsail without jib on the author's "X.O.D." boat, shows an entirely broken down airflow in lee over the whole sail, when sailing at the same angle as with jib in Figs. 1 and 2. A fully battened sail is similarly broken down in flow without jib slot.



Fig. 5. This automatic swinging slat, forming a crude "slot" ahead of the streamlined mast, improves the lee side airflow of this single sail. Note that the head of the sail has a broken down flow, where there is no slot.

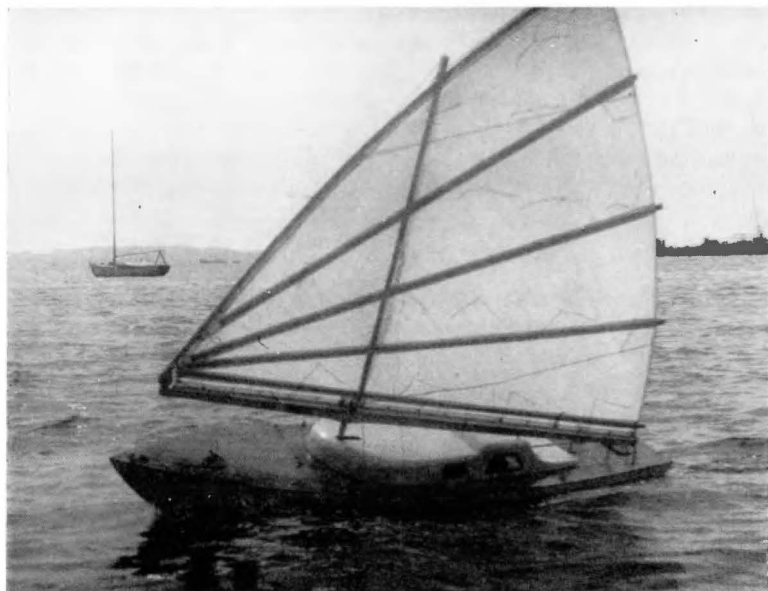


Fig. 6. The author's cantilever, fully rotating and folding delta rig (patented) at a certain very critical angle of attack when reaching, as shown on this large radio model, shows a reverse airflow in lee. The windward wool tufts can be seen through the transparent sail to be flowing aft, whilst the lee side tufts are flowing from leach to luff. When this reverse flow is obtained on the six ton cruiser "Tentative" with a similar rig, the waterspeed has been measured to rise by nearly 1 m.p.h.

flow. The latter has still a broken flow at the head where there is no slot effect.

(4) The single sail

The lee side of a single sail, without slot effect, is entirely broken down in flow whether a soft sail or a fully battened sail. See Fig. 4. I tried fitting a swinging slat to stops forming a crude slot on a single dinghy fully battened sail. Fig. 5 shows how the slot smooths out the flow, which is entirely broken down without the slot. The head is broken down where there is no slot effect.

(5) The Delta sail

A reverse flow was observed on my fully rotating, folding, delta sail. See Fig. 6. When the wool tufts flow *from leach to luff in lee*,

and correctly aft on the windward side, it was found on the full-scale cruiser "Tentative" that nearly one extra m.p.h. was recorded on the water speedometer in a moderate wind, when reaching at a very critical angle. As the same has been observed to a lesser degree on a normal rig, it might be worthwhile having a few wool tufts to observe through the sail, for the angle is very critical, and of course can only be used to advantage when the forward component of lift and drag assists reaching.

Further investigations

Why is a sail so poor in lee when slow speed double surface wings can have a reasonable flow on top of the cambered surface? It is hoped to find the reason during the forthcoming season, and at the same time measure where the maximum "flow" position of a mainsail provides the greatest drive.

A TARGET FOR RESEARCH

BY MAJ.-GEN. H. J. PARHAM

Hintlesham, Ipswich.

Research, to be effective, must start with a clear picture in the mind of the researcher. This is what Punch called a "blinding glimpse of the obvious." Yet it is not always easy to get this clear picture.

Now-a-days more and more thought is being given to sailing problems and it daily becomes clearer how close is the affinity between sailing and flying.

The basic problem in sailing is how to sail closer to windward. The basic problem in flying is how to fly with less power (in this article, to keep things simple, *gliding* is considered since all gliders have a standard power plant, gravity).

I suggest it is helpful to examine the problem in diagram form. Fig. 1 shows performance in the air and Fig. 2 shows it on the sea. In the flying case the "ideal" but unattainable line is the horizontal. In the sailing case it is the eye of the wind.

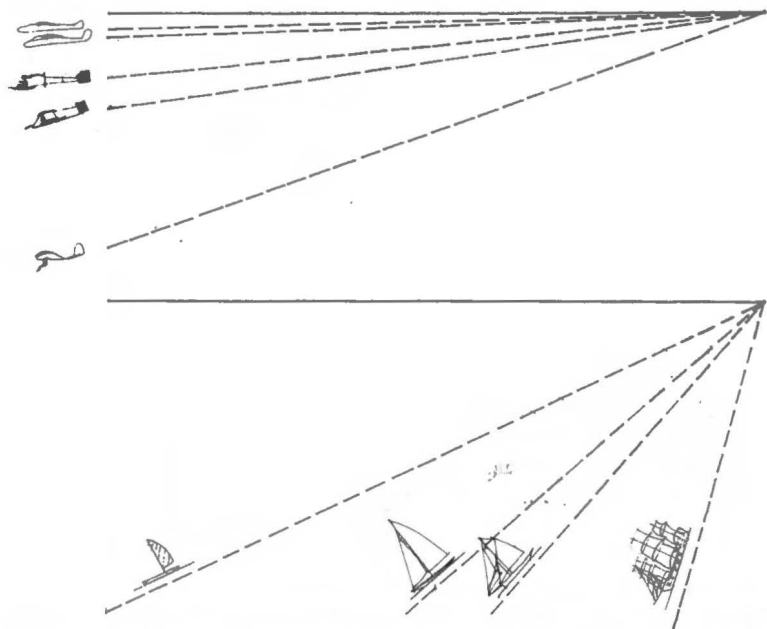
It at once becomes clear that what is wanted in both cases is a reduction in drag.

In the sailing craft drag is made up of sail drag, rigging and mast drag, air drag of hull and crew and (very large) the water drag of the hull. In the glider, drag is composed of wing drag (which includes the unavoidable drag through having to support the aircraft) and fuselage and tail unit drag.

The sailplane, by vast development, has reduced drag to about 1/40th of the total weight being earned.

Although our sails can produce a very sizeable force more or less at right angles to the wind the whole craft produces far too much air drag so that the total force available is in fact inclined aft more than it need be were the drag less.

This adverse backwards slope to the thrust . . . added as it is to the very high water drag of the hull . . . prevents really close sailing to windward.



Since only some revolutionary discovery of how to reduce *hull drag* could *greatly* affect windward sailing it follows that we are committed to a general "cleaning up" of a mass of minor sources of drag if we are to get any further improvement.

The faster and better our boats become the more important does this air drag become and the more worthwhile becomes any research on how to reduce it.

THE COURSE THEOREM

(*The Components of the Apparent Wind Angle*)

BY JOHN MORWOOD

In A.Y.R.S. No. 37 *Aerodynamics I* Edmond Bruce very cleverly showed the relationship between the three factors; (1) the angle of the apparent wind to the course in degrees, (2) the lift to drag ratio

of the hull to the course and (3) the lift to drag ratio of the sails and hull to the apparent wind. It is felt that the matter can be more simply stated as follows:—

"On any heading, the angle between the apparent wind direction and the course made good is equal to the sum of (1) the 'drag angle' of the hull force to the water flow and (2) the 'drag angle' of the aerodynamic force produced by the sails and hull to the wind flow." This statement may be called the "Course Theorem."

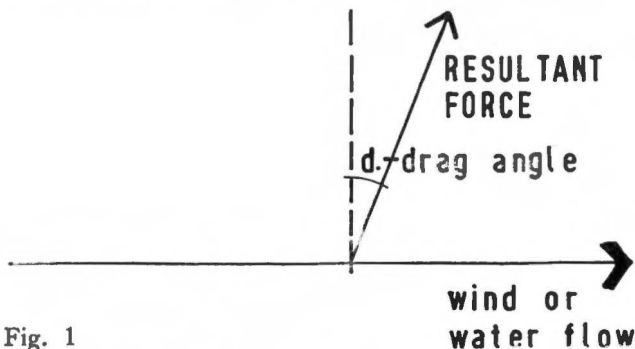


Fig. 1

Fig. 1 shows what is meant by the "drag angle." This angle is the angle aft of a right angle to a wind or water flow at which the force produced by an aerofoil or hydrofoil acts. This angle would be zero if there were no drag.

The proof. The diagram of Fig. 2 shows the two main forces acting on a sailing boat with the direction of the apparent wind and the course made good marked. The apparent wind AL blows on the sailing boat, both hull and sails, and creates a force acting along the line ORa, making a drag angle d. The angle NaOL is a right angle. Therefore the angle RaOL is $90^\circ - d$.

The boat sails along the course SC making an angle of leeway which creates a force ORw, which is equal in size and opposite in direction to ORa and this force acts at a drag angle D. The angle NwOS is a right angle and therefore the angle RwOS is $90^\circ - D$.

Now, the angle RaOL is equal to the angle AORw and is therefore $90^\circ - d$.

Thus, having proved that the angle RwOS is $90^\circ - D$ and AORw is $90^\circ - d$, the angle AOC must be D plus d and, of course, the angle AOC is the angle between the direction of the apparent wind and the course made good.

Inference : This theorem shows that if either the drag angle of the aerodynamic force produced by the sails and hull, or the drag

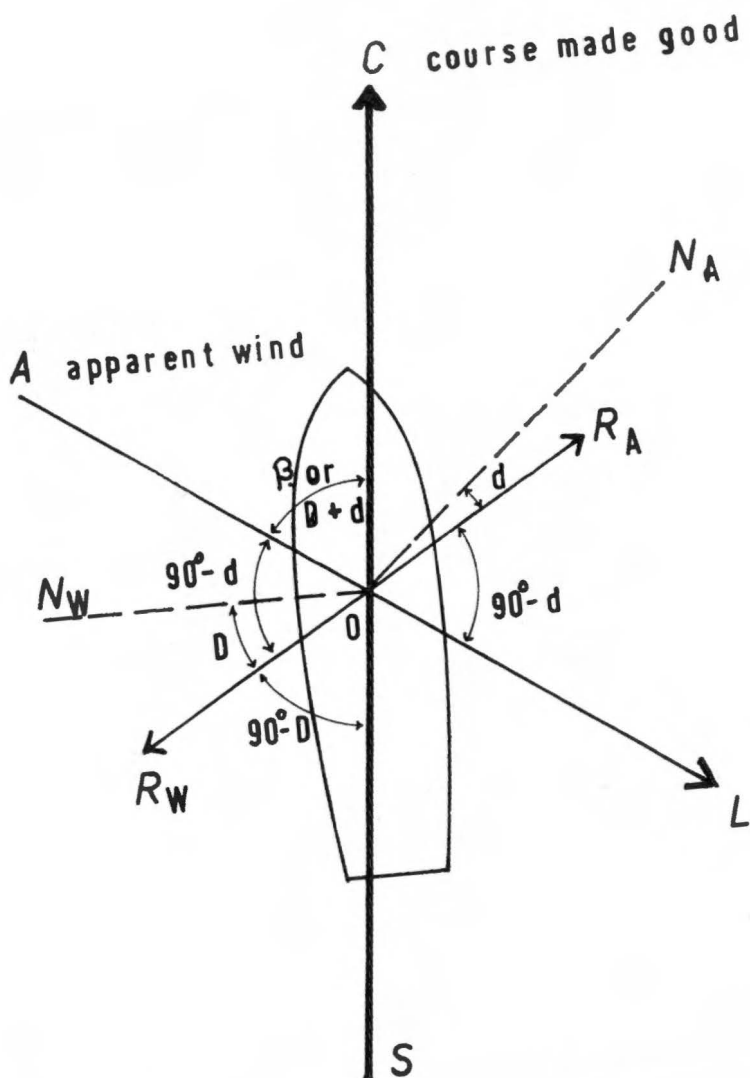


Fig. 2

angle produced by the hull in the water can be reduced by any amount, the minimum pointing of the yacht to windward can be reduced by that amount.

AN OPTIMUM COURSE INDICATOR

BY W. G. JOHNSTON

2 Owen Grove, Henleaze, Bristol

When a helmsman is sailing to a mark against a steady wind, he sets a favourable rig and then he finds an optimum angle at which to sail. In general, if he wishes to complete the passage as quickly as possible, he chooses the rig and angle which give him a maximum value of "speed made good to windward" (V_{mg}). This rig and angle also give him the quickest passage even if the mark is not directly to windward, since in this case the cross-wind component of the distance to the mark can be traversed without loss of extra time by using the cross-wind excursions essential to tacking. (If the mark is directly to windward, these cross-wind excursions must be made to cancel out and can be regarded as wasted). The helmsman must also attempt to choose the best points at which to tack, taking into account local conditions and the direction of the wind. The instrument to be described assists a helmsman in choosing optimum sailing conditions and optimum turning points for a windward passage by indicating to him on a dial the ship's speed and the direction of the true wind. With this information, he can estimate "speed made good to windward" and consider at what points he should come about.

The instrument comprises in one unit mounted at the bow (Fig. 1):

(a) A device for measuring the velocity and direction of the apparent wind.

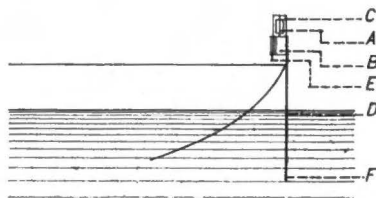


Fig. 1

(b) A device for measuring the ship's speed along the fore and aft axis, and

(c) A mechanism for deriving from these measurements the direction of the true wind.

The relationships between ship's speed, apparent wind, true wind and speed made good to windward are shown in Fig. 2. The vector V_T indicates by its length and direction the velocity of the

true wind. Then, if V_s similarly represents the ship's velocity, V_A will represent the velocity (speed and direction) of the apparent wind. The speed made good to windward is represented by V_{mg} which is the component of V_s in the direction of V_T .

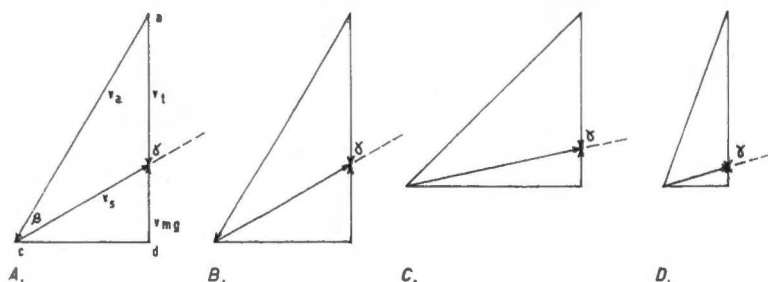


Fig. 2

It can be seen (Fig 2b) that any change of rig which increases the speed of the ship V_s for a given angle γ of heading brings an immediate increase of V_{mg} . However, the relationship between γ and V_{mg} is not so direct. In general, if γ is increased (Fig. 2c), V_s will increase because the ship runs freer but the proportion of V_s in the direction of V_T will get less. Conversely, if γ is made smaller (Fig. 2d) the proportion of V_s in the direction of V_T will increase but the speed of the ship V_s will diminish as it heads into the apparent wind. It is difficult for the helmsman to recognise optimum conditions without knowing his speed *and* the direction of the true wind.

The wind measuring device. This consists of a light cylinder ("a" in Fig. 1) which is pivoted at its bottom end with its axis vertical so that it can incline freely in any vertical plane. Horizontal wind velocities deflect it away from a "zero-velocity" position, to which it tends to return by virtue of a spring. The apparent wind speed exerts on the cylinder a force which is a predictable function of the speed. The spring is coupled to the cylinder in such a way that at equilibrium the angular deflection away from the vertical is proportional to the velocity of the apparent wind. The direction of the deflection away from the vertical indicates the direction of the apparent wind, rather like a weather vane. We can thus measure the speed and direction of the apparent wind.

The wind velocity measuring cylinder is mass-balanced and is stabilised against gusts and the ship's motion by a fluid damping system. It is mounted on an airtight container ("b" in Fig. 1) and it is protected by a cage "C."

The water speed measuring device. To the side of the container ("b") is fixed a rigid tube "d" with its bottom end immersed in the water. A second cylinder "f" of smaller diameter is pivoted at the bottom end of this tube. It is deflected by the water speed against a spring and the deflection is conveyed by a steel wire inside tube "d" to a lever pivoted into container "b."

The mechanism : The instrument feeds into container "b" the speed and direction of the apparent wind and also the ship's speed. Some simple moving parts convert this information into the direction of the true wind which is given on a pointer moving over a large dial "e." A second pointer gives the ship's speed.

The use of the instrument. The values of γ and V_s indicated by the instrument might be used by a helmsman as follows :—

(a) Using γ and ship's heading, he can fix the direction of the true wind with reference to his compass or a landmark. If he is navigating with a chart, he can then decide where best to tack, taking into account buoys, coastline and currents. Also he can immediately spot any change of wind direction, and if he sees that the wind is changing he will not set out on a long leg which could leave him in an unfavourable position after the wind has swung round.

(b) Using V_s he can adjust his rig for maximum speed on any particular heading.

(c) If he wants to go to windward as fast as possible, he can estimate V_{mg} (in order to make it a maximum) as follows. The relationship between V_{mg} and V_s and γ is given by the equation $V_{mg} = V_s \cos \gamma$. From this equation a table of numbers can be drawn up (rather like a multiplication table) with values of γ as read from the instrument, from say 20° to 60° along the top, and values of V_s as read from the instrument down the side. The helmsman can then see from a glance at this table the value of V_{mg} which corresponds to his indicated values of γ and V_s . The values of V_{mg} vary smoothly along the rows and down the columns so that intermediate values can be easily and accurately estimated.

A VENETIAN BLIND SAIL

BY JOHN LONG

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The boat used for the experiments was a rather old *Minisail* hull fitted with a 14 foot, 2 inch diameter freely rotating mast. The Venetian blind was 6 feet wide and approximately 10 feet high and had 2 inch wide slats. For the first experiment, it was erected partly reefed but not fully closed, giving a total area of approximately 45 square feet.

The sail was first erected before the mast but was found to be impossible to control and nearly took the boat up the beach. With the sail aft of the mast, it was then launched and was sailed fairly well until going about when, due to the lack of control sheets, the sail went head into the wind and proceeded very rapidly in *reverse*. It was then decided to rig it in a more fore and aft position, when con-



siderably more control was obtained and progress made in the right direction. The experiment had then to be called off due to a rudder which kept coming off which made steering very difficult.

Further experiments will be made fully rigged in a fore and aft position and with the rudder mountings modified.

General results indicate a strong case for trying this type of sail on larger hull, where more room is available for control sheets etc.

FURTHER NOTES ON THE BENT MAST IDEA

BY MAJ.-GENERAL H. J. PARHAM

I have been sailing now for some 15 years with a mast curved at *right angles to the airflow*. The essentials of this idea are that by curving the mast to about the same curve as the leach one greatly reduces the (very adverse) effect of "twist." Also one can almost eliminate the effect of mast interference which the famous Warner researches, in the early 1920's proved could produce a loss of 20 per cent in efficiency when close hauled.

Recent experiments using two such sails as wings of a model glider have greatly strengthened my belief in the efficiency of such a rig. I now have a model of 46 in. span which will glide, quite well, with an all-up weight of 1 lb. 2 ozs. which is high for a small model



Fig. 1



and shows that a wing section such as a soft sail can give about as good in Lift as a conventional high lift aerofoil. Drag of course must almost certainly be greater. A considerable improvement in gliding angle and in load carrying has recently been made by filling in the gap between the two "booms" with a loose piece of fabric which just bellies out in the wind to a gentle curve and stops end losses at the foot of the two wings. The effect is most marked and gives one to think!

The wing section is as shown on Fig. 1.

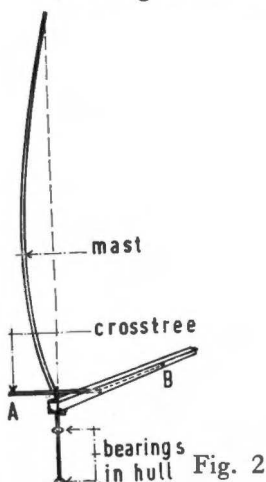


Fig. 2

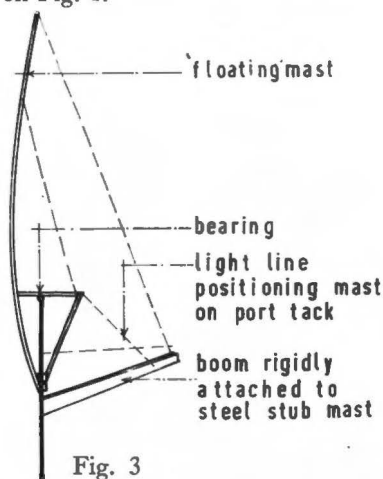


Fig. 3

Now as to the full sized rig. The basic requirements to be observed are as shown on Fig. 2. There are a variety of ways of meeting those and all have some objections . . . and corresponding assets.

The stressing of the mast is quite beyond me being far too complex but taken all round it seems that because the pull of the canvas is always parallel to the greatest depth of the mast section and because the outhaul at the clew need not be very terrific (because one is not

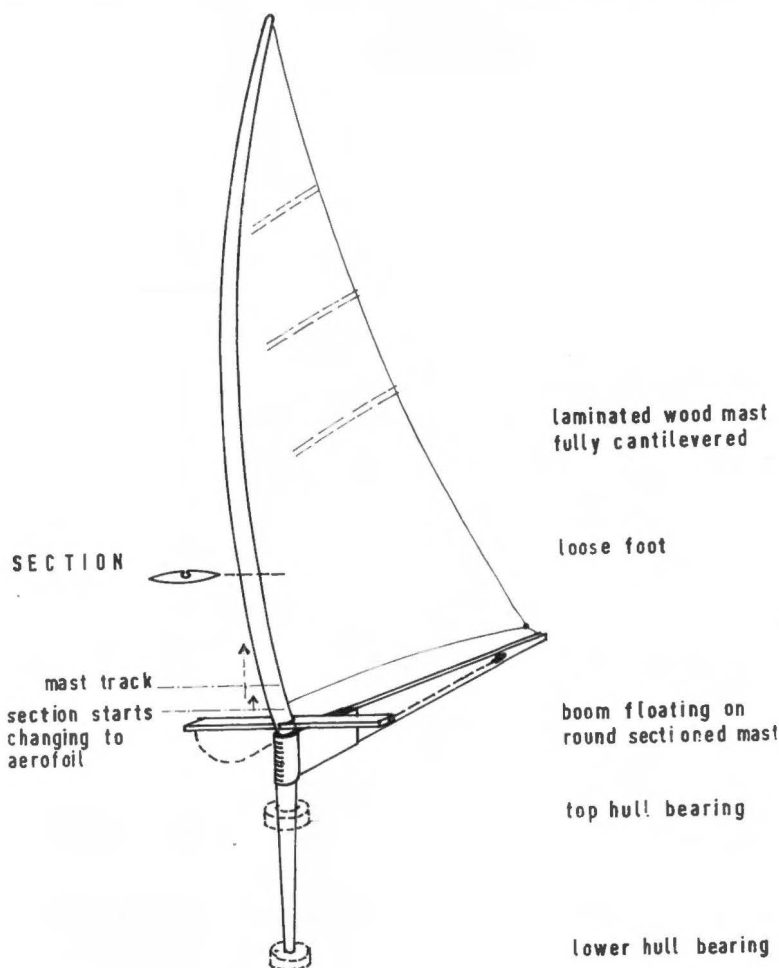


Fig. 4

attempting the impossible by trying to produce the infinite pull down of the leach which could alone stop it from falling off to leeward) the stresses on the mast are not very high.

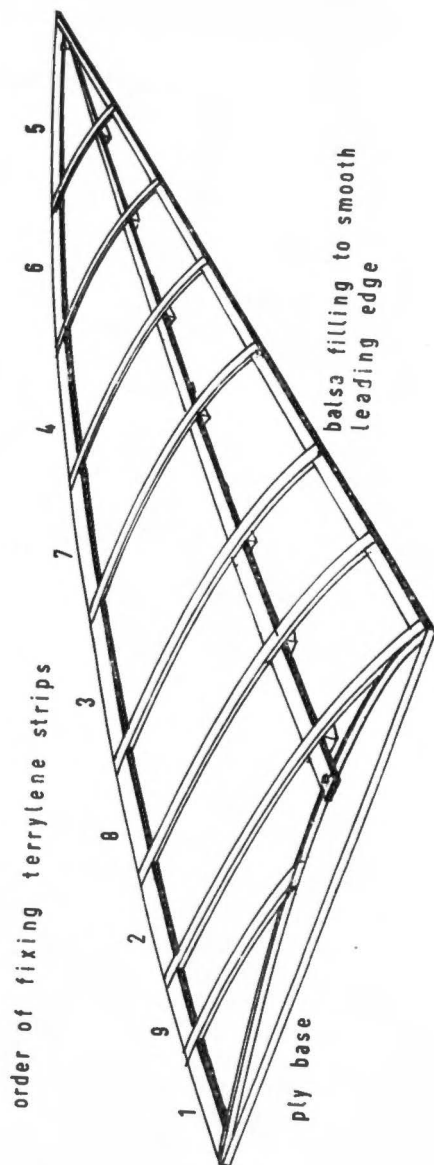


Fig. 3 shows the construction I have actually used—in sails of up to 80 sq. ft. only. Fig. 4 shows what I would *like* to try were I less old and idle than I am now.

I hope very much that some of the energetic and able young members of A.Y.R.S. will develop what I believe to be an extremely promising and already well tried idea.

A METHOD OF MAKING MODEL SAILS

BY MAJOR-GENERAL H. J. PARHAM

Hintlesham, Ipswich

I recently had to make a model sail (luff 6 ft., foot 3 ft.) for a test. The sail was of my "gulls-wing" design and set on a bent mast. Thus, there was a double curvature over the whole sail which involved more "cutting" than would be the case with a straight masted Bermudian sail. But the principle I used could be applied for any model sail.

A piece of plywood, the size of the sail, was mounted on a firm wood base and to it were screwed at each seam of the sailcloth a 1 inch wide lath so that the exact contour of the "aerofoil" was represented. See page 35.

Starting at the foot, one strip of terylene (Dacron) was lightly stuck to the wood with clear Bostick adhesive. This was done with every *alternate* strip. When these were all on, the intermediate strips were firmly stuck (with the same adhesive) to the Terylene strips already mounted. When dry, the whole sail was peeled off the woodwork.

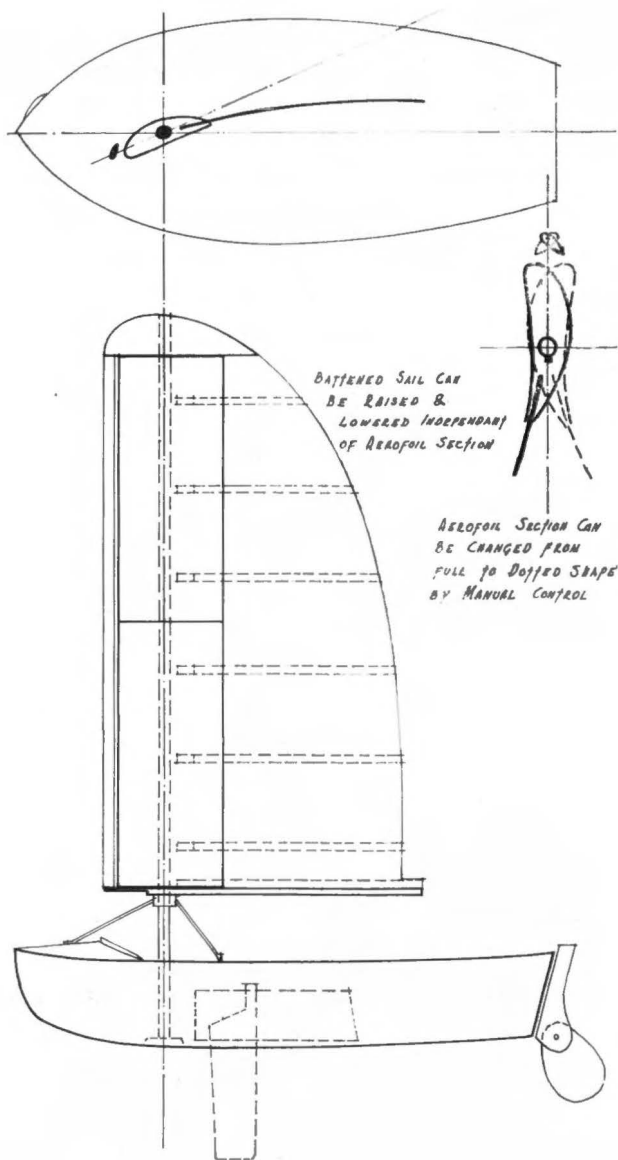
A REVERSIBLE CAMBER WING SAIL

BY DAVID GREENWOOD

Valmaseda, Alumway, Ridgeway, Downend, Fareham, Hants

Last year (1961) I constructed a rather crude variable camber wing sail and subsequently heard about and joined the A.Y.R.S. I have now nearly completed a much improved wingsail which has the great advantage that the leading edge can be changed over without recourse to the "up and over" method, by operating two controls mounted alongside the boom as shown on page 37.

The section of the front portion of the aerofoil is not far off U.S.A.T.S. 10 but the rear portion is much shorter. Provision for a slot is being made adjacent to the leading edge. I would add that the rear portion of the wingsail comprises a fully battened conventional sail without any belly.



The total area is near 70 sq. ft. of which the aerofoil portion comprises 27 sq. ft.

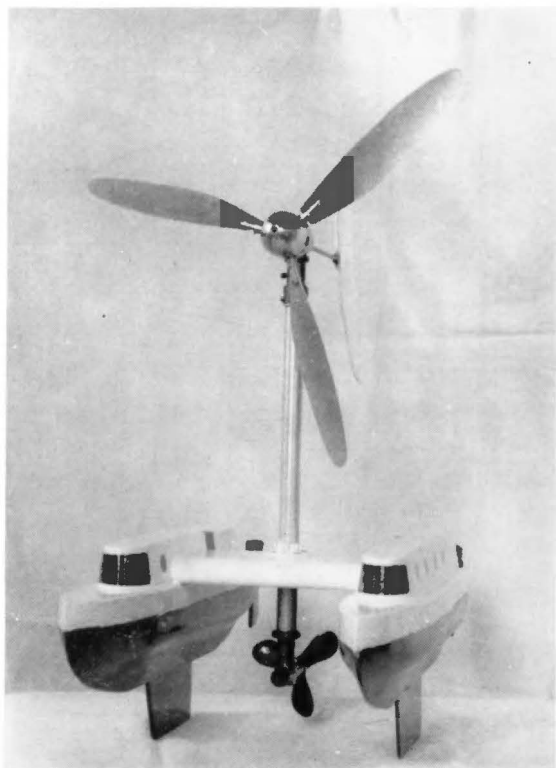
I am hoping to mount the wingsail on my 12 ft. 6 inch dinghy—non class and rather too sturdy perhaps for sensing the advantages of a wingsail, I will try to do this without stays so that the wingsail can revolve 360°.

THE STORY OF MY WINDMILL DRIVEN BOAT

BY W. ZALEWSKI

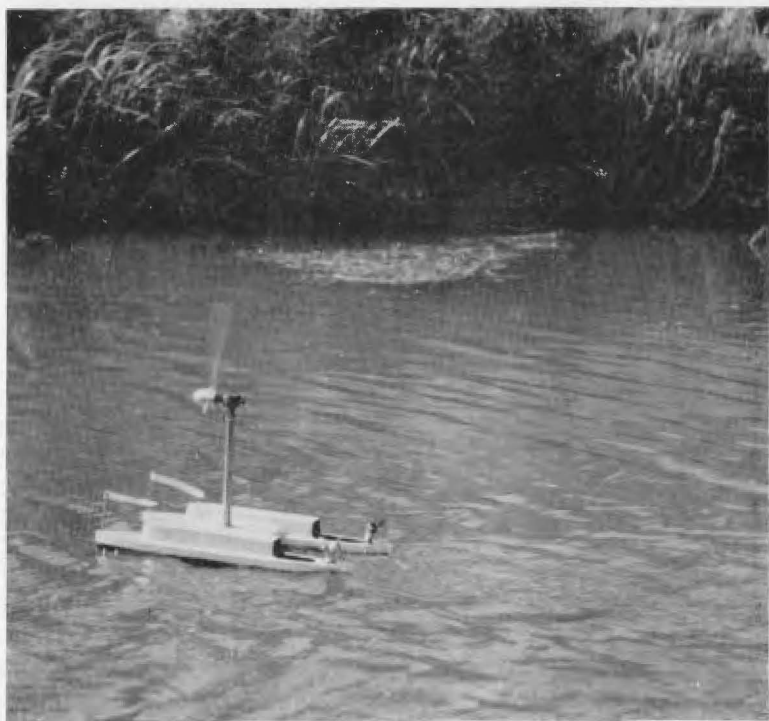
8 Goldborne Road, London, W.10

I have always been keenly interested in windmills, together with aviation, since 1908/9, studying all that I could find about them in German literature. The first World War absorbed me in designing



aeroplanes and propellers in Russia. On my return to Poland in 1918 there was nothing for me to do, so I worked on writing a full theory of windmills, based on the simple blade sections airscrew theory

of Drzewiecki, published in 1906, and others. At that time there was no possibility to complete the work by aerodynamical tests, so it was abandoned for work on aeroplane design. From my theoretical studies the following conclusions were drawn:



(1) To get the maximum power from the wind, the blades at the tips should have $CL/Cd = \text{maximum possible}$;

(2) The CL should be small.

(3) The circumferential speed should be as high as possible;

(4) For maximum efficiency, which means: maximum of relation;
useful power

$\frac{\text{useful power}}{\text{axial resist.} \times \text{wind speed}}$ the angle of inclination of the section to the

axis should be near 45° . So, for running the best arrangement should be (1). But for beating, the best would be (4). The propeller should be of variable pitch.

The idea to put a windmill on a stable barge or raft came to my mind in 1950, when looking from a prison window on the slow moving estuary of the River Dnieper near the Black Sea. There I had time to think, and there, I considered whether it would sail into the wind or not.

When in London I began to read about catamarans and their stability, I started to calculate the possibilities, and when I joined the A.Y.R.S. I found much useful material in their publications about the



dynamics of catamarans which excited my imagination and soon led me to the conclusion that the boat will have good performances when sailing into the wind.

In 1959 I began to make the model, designing the windmill approximately for the maximum power, with high circumferential speed and with slowing down gears 1:2 for water propeller. This model I tested first on my bath, choosing several types of propellers. The best and the largest I took with the model to the River Ouse and to the North Sea in June 1960. There I observed that when sailing into the wind the bow rises. This proved that the axial resistance was large. Though the model sailed well into the wind there were high stresses inside the gears, which would not be practical for a full scale boat.

In 1961 I made new windmill, mast and gears, designing all rather for max. efficiency, and several propellers to choose the best one. This model gave much better speed (gears 1:1). Till now only

a few tests have been made in the open air. I did not observe any difference in speed in running and in beating. Perhaps it was a little quicker in reaching. This model was exhibited on the A.Y.R.S. stand at the last Boat Show (Jan. 1962).

Further problems for me are: to make a new light hull for the model with smallest resistance; to find help for building the full scale boat; and more experiments in the open air.

SLOPING SAILS AND CENTREBOARDS

BY WILLIAM GARNETT

Hilton Hall, Huntingdon.

Some study has been given in the A.Y.R.S. to the use of sloping sails to reduce or abolish the heeling moment. The rigs reported on in A.Y.R.S. No. 14 were not found to be satisfactory, but as these were complicated affairs with several sails sloped to lee and to weather, some further analysis may be required.

The principle involved is that the heeling moment is reduced by shortening the moment arm between the lines of action of Sail force and Lateral Resistance (Hull force). One way of doing this is to slope the sail to weather or to lee so that the Sail force acts obliquely up or down and intersects the line of action of Weight at a lower point than with the sail upright. Similarly the effect of sloping the lee centreboard to weather or vice versa is to *raise* the point of intersection of the lines of action of Lateral Resistance and Weight.

Fig. 1a shows a section of a catamaran with a sail rigged with the foot out to lee and sloped up to weather. There is a single centreboard, also placed to lee and sloped to weather. The lines of action of weight (somewhat to weather owing to position of crew), of buoyancy (somewhat to lee owing to heeling), of sail force (obliquely upward owing to rake and slope of sail) and lateral resistance (obliquely upward owing to slope of board and hydrodynamic pressures on hulls) are all shown. The two last mentioned forces (S and LR) are resolved at X and Y respectively into vertical and horizontal components, thus forming a rectangle. Since the sides of this rectangle form a balancing pair of couples, they are in proportion to the size of the forces they represent. The heeling moment is provided by the couple between the horizontal sides, and this is balanced by the righting moment provided by the couple between the vertical sides (W and $B + S_v + LR_v$). The dotted line shows how the moment arm between S and LR would be lengthened if the sail and centreboard were placed to provide no vertical components of these forces; it also shows that the weight required to maintain the righting moment would be greater.

There are two further points which emerge from this figure. One is that weight is not balanced against buoyancy alone, but against the sum of all the vertical upward forces. Since we are getting vertical lift from both sail and centreboard it is clear that the old rule of "Sail forces equals Hull forces" does not apply. This rule, after all, is based on Archimedes, who only considered the two forces buoyancy and weight. The second point is that since buoyancy has been reduced (by 60%) wetted surface is also reduced and speed increased.

Fig. 1b shows the same balance of forces but equated in a different way. S and LR are resolved at their point of intersection (Z). Since their horizontal components are equal and opposite the resultant force is the sum of their vertical components. This force ($S_v + LR_v$) and buoyancy together balance the weight. Since their respective moment arms (p and q) about the line of action of weight are here equal, they also are equal.

In Fig. 2 the lines of action of S and LR are even more sharply sloped, so that they intersect on that of W. By analogy with Fig. 1b, S and LR are resolved into a vertical force ($S_v + LR_v$) which is directly opposed to W. There is therefore no heeling moment, no righting moment and therefore buoyancy also acts on this line. This "momentless state" which is reached when the lines of action S, LR and W all intersect at one point, is the ideal of stability at which combinations of sloping sails and centreboards are aimed, but it need not be reached except in an emergency, and then the total vertical upward force must exceed the weight before a capsizes can occur.

This analysis does not consider forward pitching moments, but in the interests of all round stability the lift obtained by sloping the sail to weather should be secondary to that obtained by the more usual expedient of raking the luff, or pivot line of balanced sails, aft. The maximum angle of combined rake and slope should not be much more than 35° or too much drive may be lost, and it should be possible to achieve the "momentless state" without letting the boom out beyond the "maximum angle" position.

Among other advantages of this "lee side system" are that less wind is spilled by sloping a sail to weather than at the same angle to lee, the sail suffers no interference on its low pressure side, and that the lift obtained from this combination of sail and board both placed to lee and sloped to weather may be more effective than that from twin hydrofoils, since it is a lot steadier and results in less leeway. The alternate use of these boards allows them to be asymmetrical foils with a built-in angle of attack, so that they may be used as twin hydrofoils on occasion. Methods of altering their slope, operating them

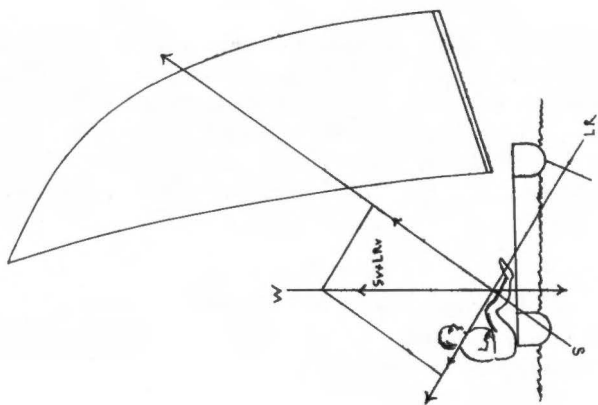


Fig 2

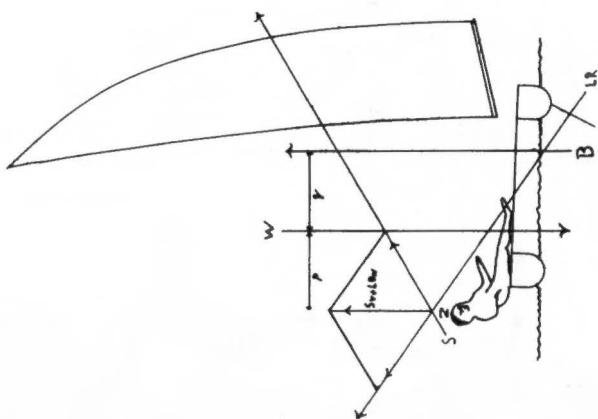


Fig 16

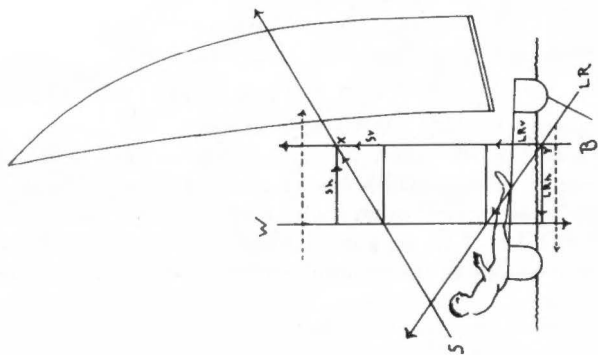


Fig 14

—and the sail—and other practical problems may be left to the ingenuity of the reader. My own Pintail (AYRS No. 37, p. 30) only goes part way towards a full leeside system and is too heavy a boat for her length. But her performance in rough weather in holding a 15-foot cat with 50 sq. ft. more sail area makes me confident of her relative performance in the “ideal conditions” so rare at sea.

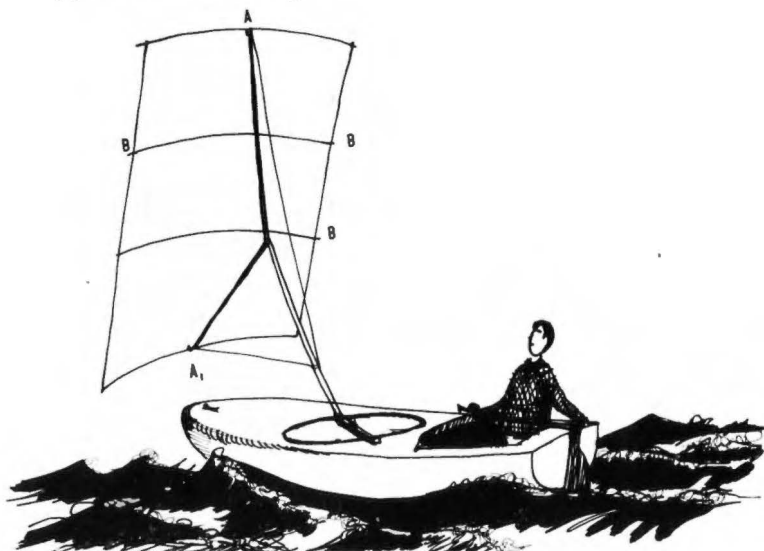
A NEW SAIL?

BY JOHN PHILLIPS,

17 Bal Lane, Mary Tavy, Tavistock, Devon

A.Y.R.S. members may be interested in this experimental sail which, if it works satisfactorily, will

(a) need no trimming,



(b) be equally efficient on all points of sailing,

(c) exert no heeling moment from wind pressure.

Advantage (c) is, perhaps, the most important.

A rough drawing of the sail in reaching position is shown in Fig. 1.

Very briefly the sail functions as follows :—

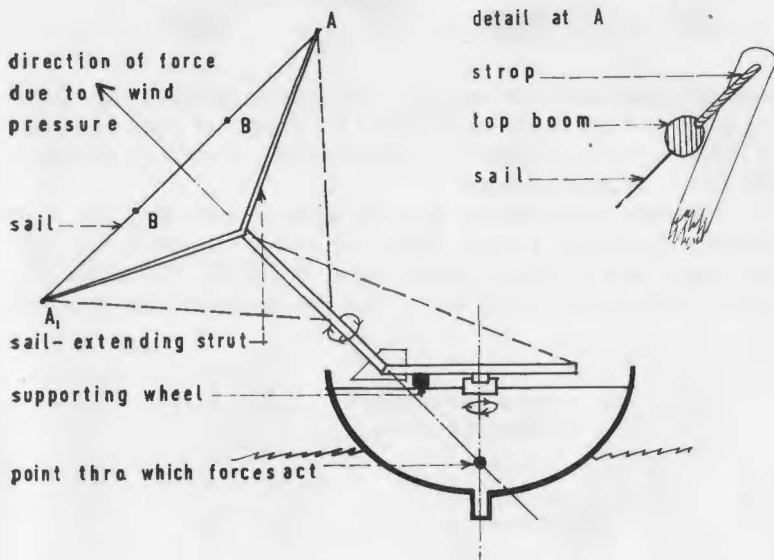
1. The foot of the mast is connected to a horizontal “spoke” which is free to rotate round a central point on the deck (Fig. 2).

2. The “mast” slopes at an angle of 45° . (The choice of angle is arbitrary but 45° is, I think, a good compromise). The sail lies in a plane at right-angles to the “mast.” Wind pressure, acting roughly

at right-angles to the sail, produces a force acting outwards along the mast through a point low down in the hull.

3. The mast, together with the sail-extending struts and sail, can rotate around the point where it is fixed into the "spoke" (Fig. 2).

4. The sail, rectangular in shape, can also rotate (through 180°) about A and A_1 (Fig. 1 and Fig. 2).



5. All sail trimming *must* be automatic. Rotation of the mast may be manual or automatic.

There are various ways of trimming the sails automatically. The simplest method I have devised is by means of guides fixed to the deck. I am not altogether satisfied with this arrangement.

Reefing is effected by partially closing the sail-extending struts and pulling the battens (B) to the top or bottom of the sail.

The sail is made self-steering simply by connecting the mast or "spoke" directly to the tiller.

In going about the sail swings round astern and is trimmed horizontally, luff forward, to reduce drag.

As the mast need only be short (a mast 10-15 feet long could give a sail area of 200-300 square feet) it should be easy to lower it when necessary.

I shall be interested to hear any comments, critical or otherwise, members may make.

LETTERS TO THE EDITOR

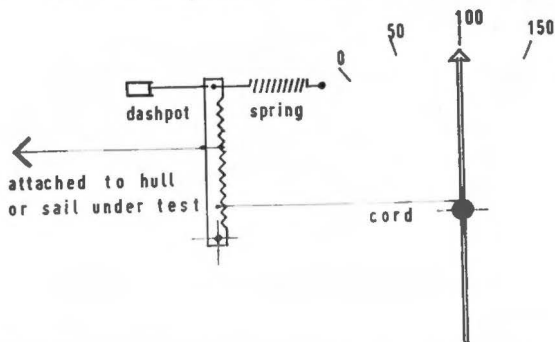
Dear Sir,

I wish to convert my Gmach fibreglass kayak to sail. To reduce weight, I will use an outrigger and not duplicate the hull. We get sudden severe gusts that come without warning so to give maximum



stability, I will use a lee outrigger. To reduce wave-making, I will try to design a foil to lift the float clear but capable of going horizontal to reduce draught in shallows. When reaching, it could be set nearer the vertical to reduce leeway.

Normally, foils have to have excessive area to allow for light winds. How about a pedal driven foil craft with exactly the right foil area to suit a normal human output of $\frac{3}{4}$ H.P.? With care, the weight could be remarkably low as there are no sails or mast to worry



about. If the user started half submerged, the hull could be dispensed with, too! Maybe, low speed foils filled with expanded plastic foam would give certain buoyancy. Its worth going into, I think.

I have an idea for wind tunnel and tank experiments that would enable comparisons to be made instantly of experimental rigs to any standard rig and read as a percentage.

A lever is hinged at one end. The other end has a spring and dashpot damper. The movement of the lever is indicated by a moving pointer calibrated from 0 to 150. This represents a percentage of force obtained as compared with a standard. The lever is notched and each notch is numbered for reference. The attachment to the hull or sail hooks into one or other of these notches. When wanting to compare a new rig with, say, a National 14, the latter is attached

to the notch which at a given wind speed gives a pointer reading of 100. Keeping the same wind speed, the other rig (or hull) is attached and the reading compared. The above arrangement is suggested for models. When full sized hulls are used, the unit could be on the hull itself where the person altering the sails could see it more easily. But with a large enough scale and pointer, this would be unnecessary.

JOHN MORE.

Tigh na Mana, Bettyhill, By Thusso, Scotland.

Dear A.Y.R.S.

Tahiti! All I can say is this—don't wait until it's too late.

Had a rough trip from Hawaii, twenty-two days and 3,000 miles around the Atom test zone—upwind and mostly close hauled.

In the Doldrum area we encountered dozens and dozens of vicious squalls—solid rain and screaming wind—all from dead ahead (S.E.).

Going long distances upwind is a form of insanity, but if you have to do it, take a trimaran! *Lodestar* has been great—not one moment of doubt.

We went as far as 180 miles per day close hauled, without really driving. Most of the sailing was done under jib and mizzen, in order to minimize the motion.

Although we are having crew problems, we expect to leave within a few days, and plan on reaching New Zealand around mid-September.

Regards,

ARTHUR PIVER.



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