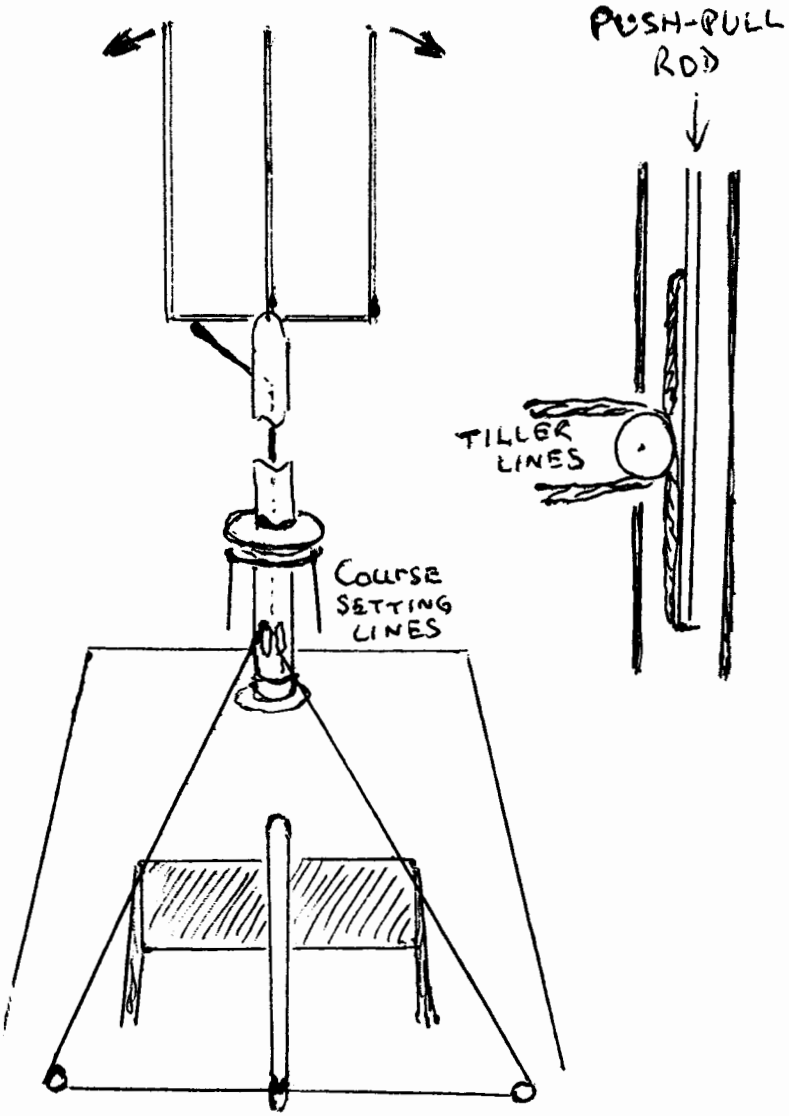



*Triplane Gear*

*System I*

This is the simplest. The vane is mounted about 4 in. away from the centre of a 2 in. pipe, giving some 30 degrees of movement on either side of vertical. The vane counterbalance would need to be offset to take the weight of the push-pull rod. The joint at the top of the push-pull rod would need a swivel.

*System II*

This is the same as No. 1 but with a biplane rig.

*System III*

With this system, the vane is mounted over the supporting pipe. An extension is used on one side to work the push-pull rod and, because this would need to be counterbalanced, it seems logical to use either a biplane or triplane rig. The push-pull rod would need a bend in the top of about 30 degrees and a slot would need to be cut in the top of the 2 in. pipe.

The swivel for course-setting would, with this system, have to be placed at the lower end of the push-pull rod.

*Tiller actuating mechanisms.*

The invention of the above vane mechanisms is easy. It is far harder to devise ways for the push-pull rod to work the tiller because aft decks will vary from boat to boat. Running line gears are more flexible because the lines can be led through blocks to the tiller. The simplest solution is to have the rod work a bell crank whose free end will move from side to side across the boat. It can then work a backwards extension of the tiller, a "Paddle", an auxiliary rudder or lines can run from it to the tiller. In the drawing, lines are taken from the push-pull rod and pass through blocks.

The M.N.O.P. Gear has a push-pull rod which works an auxiliary rudder mounted at the bottom of the supporting tube. This system has worked well but, surely, it is not right for a yacht with a counter because the supporting tube will be dipped in the water in a seaway. It also seems a waste to add a rudder when the yacht already has one.

*Instantaneous disengagement*

With running line gears, this is achieved by using jamb cleats on the tiller. With the "side crank" gears, described above, it can be got from a "latch" by which the crank or auxiliary tiller is connected to the main tiller.

*Below decks mounting*

With all the gears shown above and many others in this book, there is some inducement to run the supporting tube through the deck and have the crank or other connection to the tiller below it. This

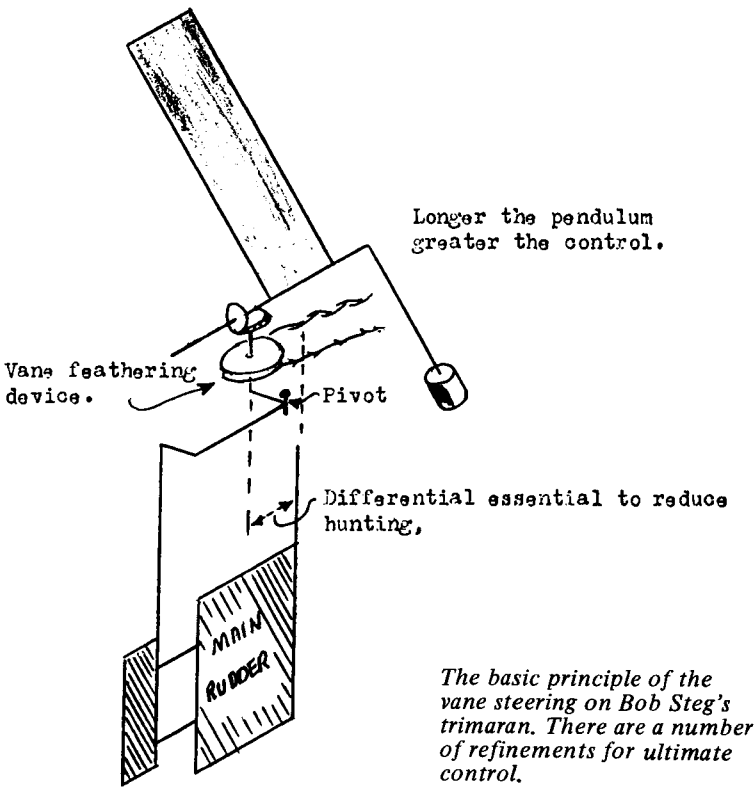
would make the gear less susceptible to damage from seas but could make it hard to inspect or deal with.

## FOUND IN THE NEW ZEALAND MAGAZINE "SEA SPRAY"

Bob Steg, a sales representative from America, and his wife arrived in Auckland in November, 1968 on their Jim Brown-designed trimaran, *"OFF SOUNDINGS"*, 38 ft. long.

They left San Francisco on May 18 and sailed via Honolulu, Penrhyn, Pago Pago, Tonga and Fiji. Even though they shortened sail at night, the Stegs found themselves averaging about 150 miles a day with the vane steering doing the donkey-work most of the time.

The "third man" has the vane moving around a horizontal axis and acting through bevel gears on a trim tab attached to the main rudder. Bob prefers it to the vertically pivoted vane type because of the greater sensitivity in light airs which, of course, is advantageous down wind. The drawing shows the basic principles of the design.




*The basic principle of the vane steering on Bob Steg's trimaran. There are a number of refinements for ultimate control.*

## THE MUDIE GEAR

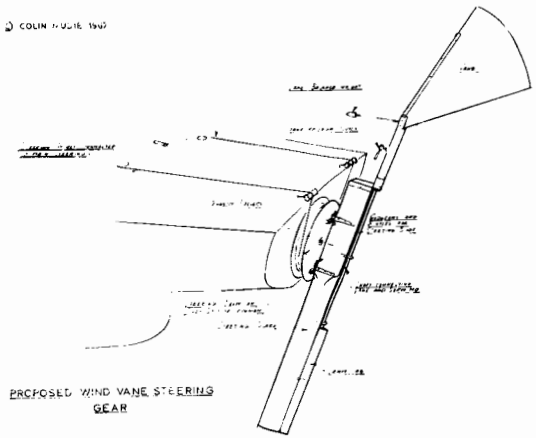
*Devised by Colin Mudie*

Bywater Lodge, Pierside, Lymington, Hants, England.

Mention was made earlier in this book of *"SOPRANINO"*, a 20 ft. sloop which crossed the Atlantic in 1952, using a simplified Braine gear. The crew was Colin Mudie and Pat Allam. Since then, Colin Mudie has been designing yachts, gear and gadgets. For instance, he designed the self-steering gear for David Lewis' *"REHU MOANA"* (a running line type) which worked satisfactorily during his circumnavigation.

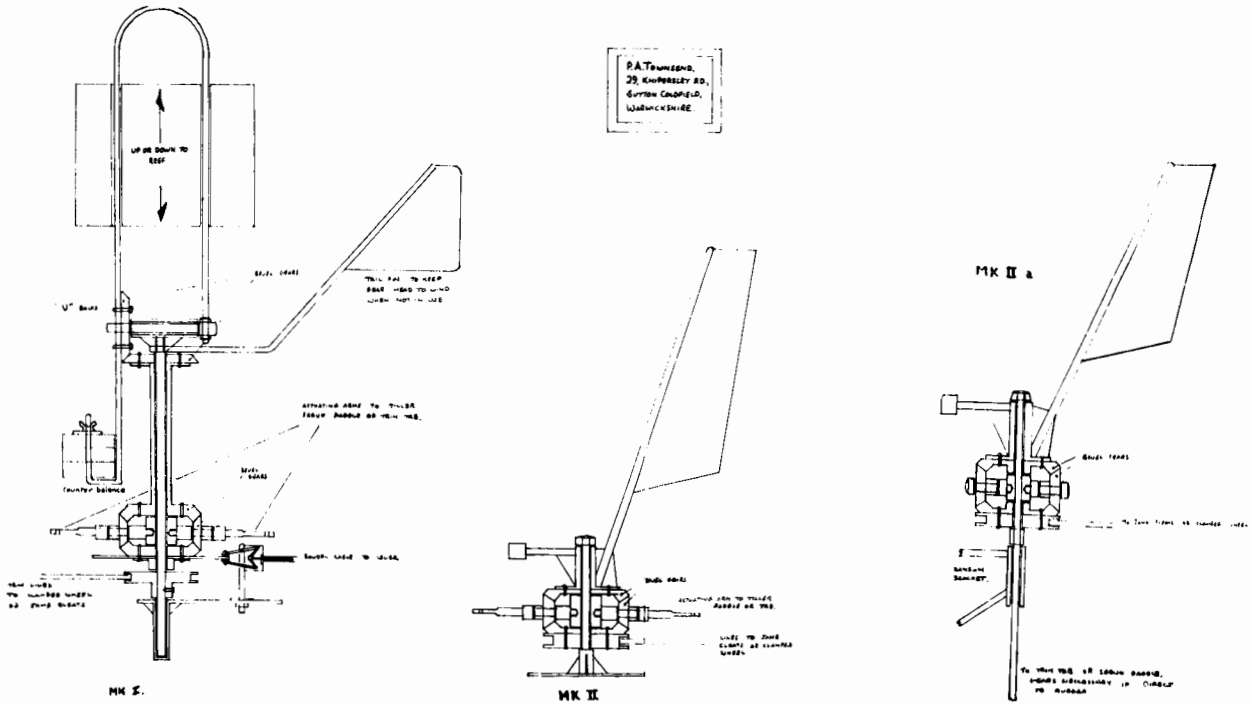
We were impressed with both the simplicity of the gear and the ease with which it could be removed for racing or for storms or to prevent weathering at moorings.

The drawing is almost self explanatory. A small vane works a trim tab on a "paddle" directly. The paddle is mounted on a drum by means of rudder pintles and the drum steers the boat through lines to the tiller. Because the only connection of the paddle to the boat is by the rudder pintles, it can simply be taken off. The vane can then be removed for storage.



PROPOSED WIND VANE STEERING GEAR

If one wanted to improve the gear a bit, the paddle could be attached to the drum in such a way that it could not turn on the pintles, the tab could be made larger and rotation of the vane reversed in direction on its way to the tab. The whole force on the paddle and tab would then be used to steer the boat in the same "sense" as the rudder. (See article on the Gunning gear). However, it is doubtful if many people would want to complicate an otherwise extremely simple gear for the amount of extra power to be achieved in this way.




*A "Differential Gear" by P. A. Townsend.*

## A DIFFERENTIAL GEAR

*Devised by P. A. Townsend*

Highburgh House, Packhorse Road, Gerrards Cross, Bucks.

In an early edition of *SELF STEERING,* we suggested using the differential gear from the back axle of a motor car to reverse the direction of rotation from the vane to the rudder, while giving continuous and fine course-setting. We dropped the idea from the last few editions but find that P.A. Townsend has used it with success.

A.Y.R.S. members will know that Mr. Townsend is designing a small yacht without sails in which he hopes to row the Atlantic. Naturally, self-steering is as valuable for a rowing boat in the ocean as for a sailing boat. With a following wind, the rower can relax while the boat maintains course.

*The Gear*

The drawing is self explanatory. The rotation of the horizontally pivoted vane is converted to vertical rotation by bevel gears. This, in turn is fed into the differential gear which actuates the tiller, servo rudder or trim tab through the side arms. The bottom gear of the differential is attached to a disc which can rotate freely, thus rendering the gear inoperative. A brake is placed around the disc, however, and if this is used, the vane will steer the boat, this being the course-setting.

The idea of raising and lowering the vane to alter power is new to us. It might well be excellent.

## VERTICALLY PIVOTED VANES

It seems obvious from this book that the place of the vertically pivoted vane is restricted to where the limited power available can be multiplied by some device or mechanism. In general, therefore, we have not included gears with this axis of rotation except where they are well established.

Two new gears with a vertical pivot are also included, firstly that by S.L. Seaton because the vane uses a flat system, though the light wind steering is not too good and that by Derek Fawcett who, by a pantographing linkage derives as much power from his vertically pivoted vane as we can get from a horizontally pivoted one.

## SELF-STEERING A 26-TON KETCH

*By S. L. Seaton, B.S., D.Sc., Assoc. Inst. Phys., Fellow New York Acad. Sc., Member A.Y.R.S.*

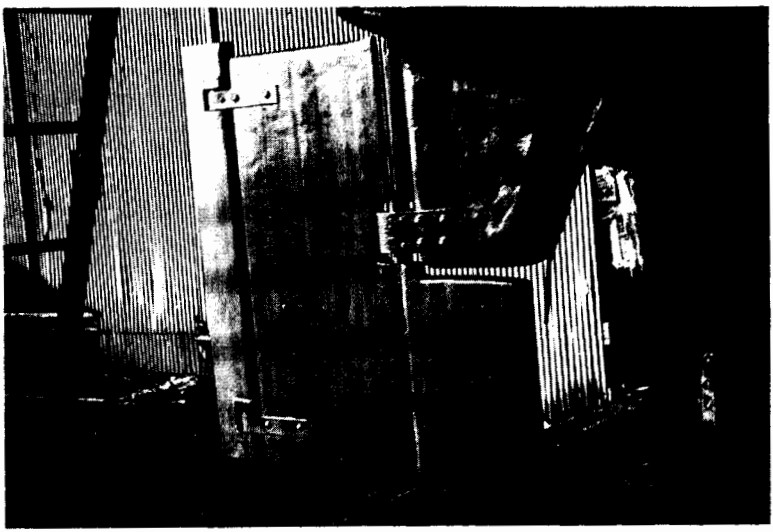
460, Windmill Point, Hampton, Va. 23364, U.S.A.

For ocean cruising we required a crew of seven, two on a watch plus the captain navigator. We use the "Whaler's Watch" system with three watches – six hours on and twelve off – which we advocate as very comfortable. My wife and I thus found it necessary to collect five competent souls to cruise with us, and this was always difficult.

The A.Y.R.S. publications, especially No. 13, stimulated us to try for a wind-vane self-steerer, which if it worked, could reduce our crew requirements from seven to four.

The boat is 44 ft. on deck with an outboard rudder well balanced, and is steered easily with a tiller. It has a substantial bumpkin aft, which seemed suitable for mounting the wind vane.

After considerable study it was decided to use a "trim-tab" on the trailing edge of the rudder (see Fig. 1) and carry the motion of the wind vane forward to the rudder post via a reversed linkage, then down through a shaft running in bearings clamped to the rudder post, thence aft via a differential rolling linkage, (see Fig. 2) to the trim-tab. The design was perfected so that as the rudder was moved by the trim-tab the latter came more and more in line with the rudder; resulting



*Trim Tab on the Rudder*

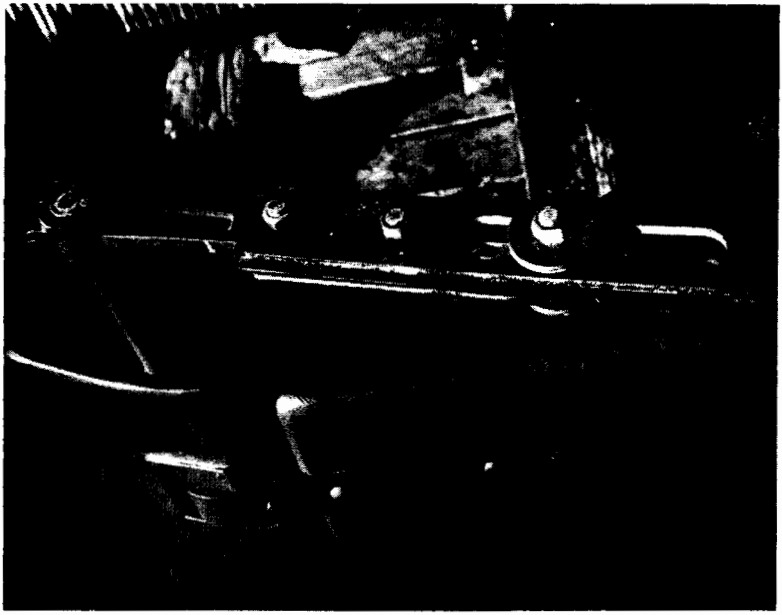


*Fig. 2. Trim-tab and differential linkage*

in a stable system. The linkage ratio is one-to-one, but is adjustable. The trim-tab area is 20% of the rudder area – which is quite ample. The tab is supported on the rudder by two bearings of *lignum vitae* with bronze thrust washers above and below each bearing working against stainless steel plates on the trim-tab to avoid wearing the tab. The whole device is substantial, for we have already encountered one hurricane and see no reason to believe that another may not find us.

Our first trials used a 30 degree "V" type wind-vane which controlled the course poorly; giving about plus and minus 25 degree wander. Consultations with aerodynamicists caused us to try next a "high-lift" airfoil – which worked even worse!

The linkages and the trim-tab behaved splendidly.

The problem was clearly to devise a wind vane having more torque at small angles of attack. Being at heart (as well as professionally) an experimental physicist, we turned to Balsa wood, glue and an electric fan. The results were astonishing, and are set forth in Figure 3. It seems that the trick is to develop a trailing-edge flair of some sort. We adopted the 60 degree slotted flap as used in aircraft during take-off and landing. The prototype is shown in Figure 4.

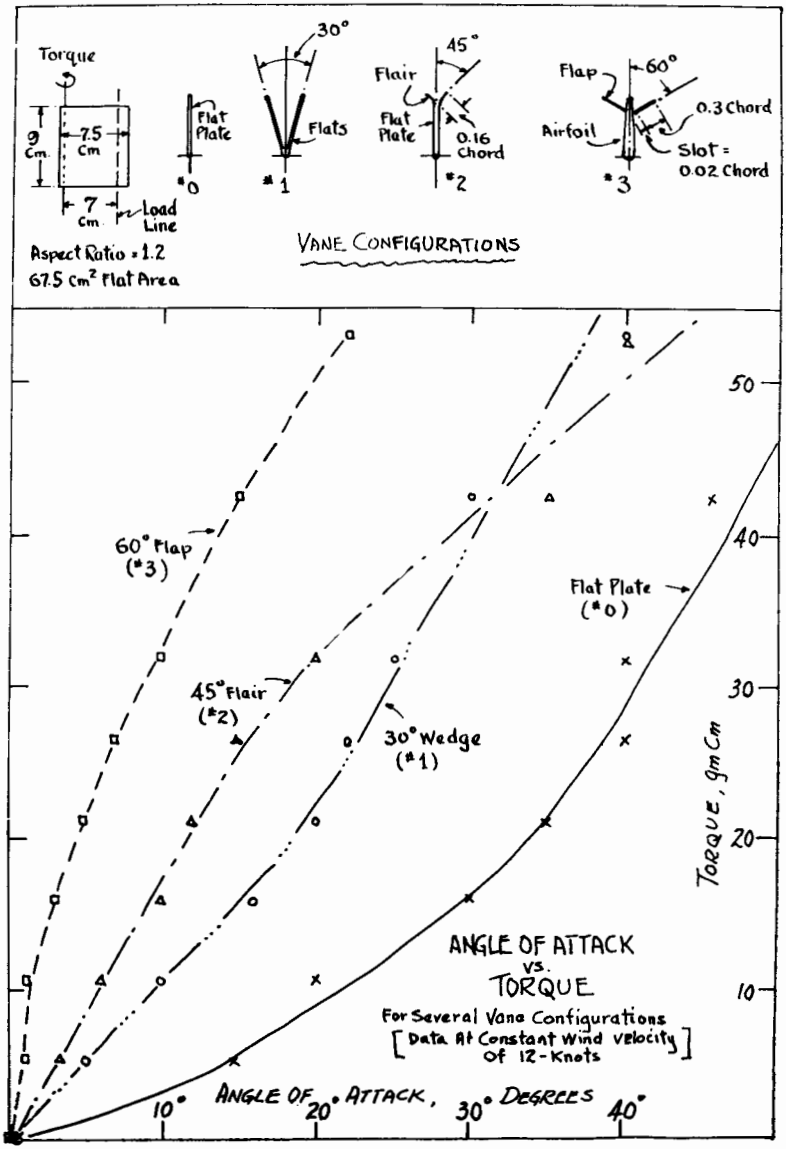



*Fig. 3. Shows the extra power from 60 degree "flair"*

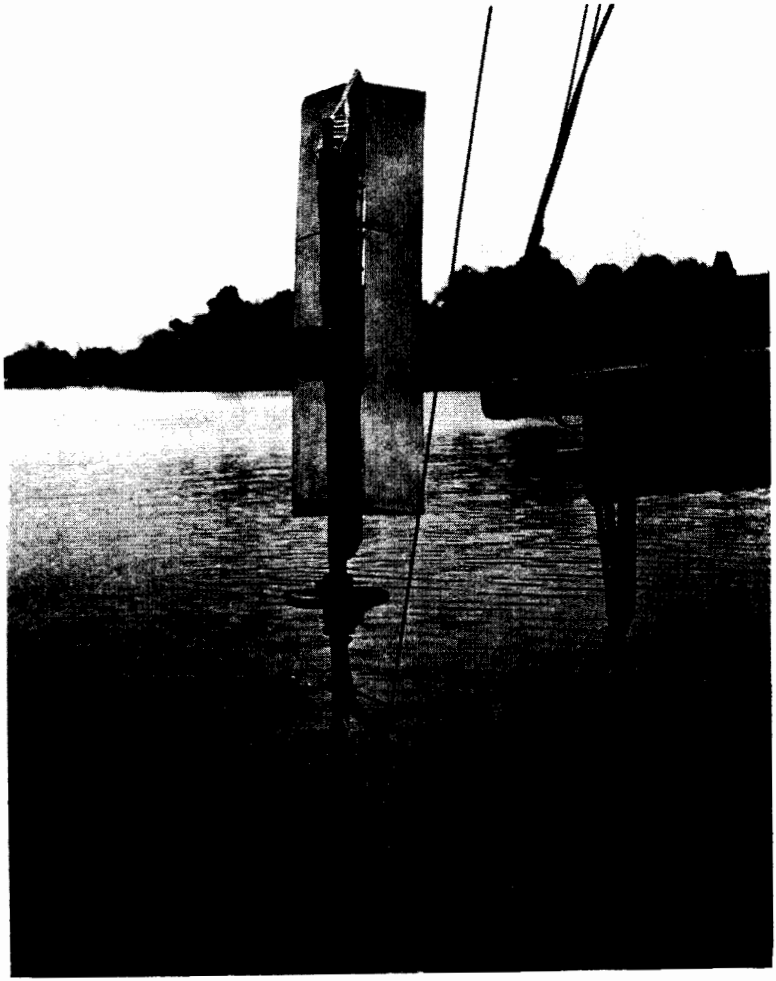


*Fig.* 4. *The wind vane in action*

This design gave us plus or minus 3 degree control with winds above 10 knots and hull speed above 2 knots. At lesser speeds the control gradually weakens and hand steering must be used.

The boat will not work quite as close to the wind with the self-steerer as with a helmsman. This is caused by directed wind flow from the mizzen so that the vane does not see the proper wind direction. Otherwise, the device is a profound success. All forces and motions are quiet and without strain. The rudder, vane and tab just seem

to float to and fro while the boat holds course as though by magic. We do, however, snap loose snubbing lines to the tiller so as to keep strong waves from putting the rudder hard against the stops.

Being conservative, we carried a full crew out to Bermuda and back for the first ocean test of the self-steerer, and it was a good thing we did, for we discovered two interferences in the mechanism. These have been correct. We now feel confident that we can cruise the boat comfortably with four people and have a much easier time of it than before.

For hand steering it is necessary to lock the trim-tab in line with the rudder, otherwise if the tab is cocked even a fraction it takes a strong man's full strength to hold against the effect of the tab in fast going.

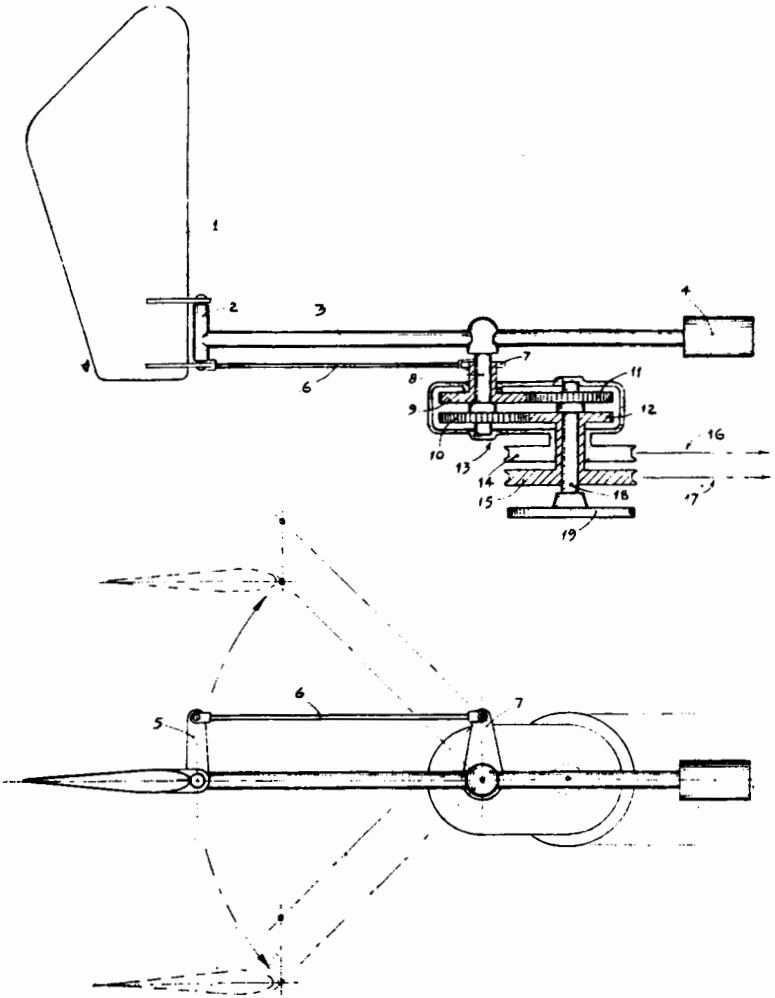
The author is pleased to acknowledge the assistance of Mr. Horace Pabst and Mr. Richard Nobles for valuable discussion and suggestions, and for expertly executed machine work.

Dear John Morwood,

You may remember that, when I joined the A.Y.R.S. in May this year, I told you that I was interested in the "Self Steering Problem". I have now finalised my design and have just filed a provisional patent.

My invention is very similar in principle to the A.Y.R.S. horizontally pivoted vane, in that the gear is capable of extracting considerably more power from the wind than is a conventional weather vane.

I have enclosed a sketch illustrating diagramatically the basic principle of operation. You will note that the gear resembles a conventional, vertically-pivoted wind vane. The only difference is that I have pivoted the vane at its leading edge onto the end of a horizontal lever arm, and have connected it with a parallel motion linkage system to a lever pivoted on the vertical shaft carrying the assembly. When the vane is set weather-cocked into wind, the vane is lined up with its horizontal lever arm, as shown in the sketch. On a wind shift to one side or other of the vane, the linkage system carrying it deflects in the manner shown by the dotted lines, maintaining the vane at a constant angle of incidence to the wind. For a wind change of 5 degrees for example, the vane assembly might deflect up to 70 degrees before coming into equilibrium. In this case the gear would be capable of absorbing 14 times more energy from the wind than would a conventional "weather vane" of the same proportions.




*Derek Fawcett's pantographing vane*

In order to effect continuous control of course setting, I have mounted the vane and its linkage onto a "moving carriage" gearbox, similar in design to that proposed by Tom Herbert for his horizontally pivoted wind vane gear. The only modification I have made to his moving carriage gearbox is that the course setting drum (14) and the tiller actuating drum (15) are both situated underneath the gearbox. I have done this because I felt it highly desirable to allow the system

complete freedom for continuous rotation when the wind vane control is disengaged by releasing the course setting drum.

The vane and its associated linkage system is very slightly more complex than the A.Y.R.S. horizontal vane, but has a compensating advantage in that its output is a rotation about a vertical axis. This in turn somewhat simplifies the transmission of motion to the yacht's tiller.

The main advantage of the system I feel – apart from its ability to absorb more energy from the wind – is that the vane is held perpendicular to the yacht's deck. The vane will thus tend to remain more effective when the yacht is heavily heeled.

My main objective, when devising the system, was to produce a wind vane steering system that was compact, for easy stowage, and capable of generating sufficient torque to actuate the yacht's rudder directly without the emcumberance of water power assistance.

So far, I have not been able to build a full scale prototype – in the main because my home workshop facilities are extremely limited. I have, however, built a small model of the system and this seems to function very well.

I hope that the above is of interest to you and, if you have any criticisms or queries, I will be very pleased to hear them. I look forward very much to hearing from you.

Yours sincerely,

**Derek Fawcett.**

14, Upperhill Rise, Rickmansworth, Herts, dated 10th July 1969.

**Letter from John Morwood to Derek Fawcett. Dated 17th July 1969.**

Dear Mr. Fawcett,

Many thanks for your letter and diagram of your self-steering gear. This looks extremely interesting and would, as you say, get far more power from the wind than the vertically pivoted vane. Your combination of this with Tom Herbert's "moving carriage" gear looks as if you have an extremely attractive gear altogether.

I have one suggestion to make and that is that you might consider adjusting this gear, so that it would be set with the vane to windward of the pivot on the weather bow of the yacht. This could be of advantage.

Yours sincerely,

**John Morwood.**

Dear John Morwood,

Many thanks for your letter and most useful suggestion with regard to improving the power output of my "parallel motion" wind vane steering gear.

I have calculated that setting the vane to windward, as you suggest, will increase its power output by up to 30%. It would be necessary to limit the motion of the vane to plus or minus 60 degrees from its central datum, in order that it will swing back immediately the apparent wind direction changes to the opposite side. My decision to set the wind vane downward I think was coloured by my original desire to design a self-steering gear that required no "water power assistance" and could be set by allowing the vane to weather cock. However, 30% increased power output is very attractive, and it may well be worthwhile sacrificing the ability to weather cock for easy course setting.

Regarding your other suggestions of setting the gear on the yacht's weather bow, I would agree that this position would place the vane in clear wind when reaching or beating to windward However, I tend to feel that any advantage gained thereby may be lost in transmitting the motion of the gear through a longer path back to the rudder. I favour mounting the gear on a bumpkin over the stern of the yacht where it is most handy and of course ideally placed for running downwind.

I am still hoping to build a full size prototype this season (although time is running short) and as soon as I have any useful results I will drop you a line.

Once again, thank you for your most astute and useful ideas.

Yours sincerely,

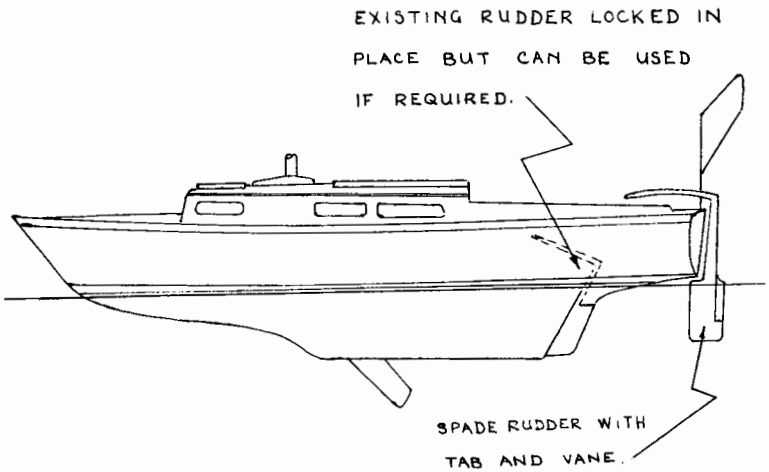
**Derek Fawcett**

Dear Sir,

For the past two years I have been using a *HASLER TAB* rig on my 27 ft. light displacement sloop in the Bahamas and here. Colonel Hasler wanted me to get the pendulum vane but I felt that sailing in shallow coral waters a spare rudder would be very handy.

As I designed the new rudder it is similar to the current spade rudders and in an outboard position.

"DOWNWIND"




With the new rudder the boat handles better under all conditions. The self steering rig works very well and I would not like to cruise again without one.

*"DOWNWIND"* now has a new owner and we are seeking a larger boat to sail from here through the West Indies and perhaps on from there. We shall fit self steering to the new boat.

Our thinking on our new boat has been greatly influenced by the A.Y.R.S. and the new issue of Self Steering is most useful.

Yours sincerely,

**Gregory Maue, Jr.**

36, Stephen Drive, Pleasantville, New York.

## SELF STEERING

*Notes by Jock Burrough*

A meeting was held in London on 3rd December 1968 under the chairmanship of John Morwood to discuss the problems of self steering and to suggest the answers.

*Horizontal versus Vertical Pivoted Vane.* The contention that the Horizontally pivoted vane produces many times more work than the vertically pivoted vane was not denied. With the centre of effort 2 to 3 times further from the axis in the Horizontally pivoted vane and the apparent wind angle to the chord of the vane being brought to zero when the vane had turned through 90 degrees, there was an advantage in effort of some 60 times.

Peter Ellison claimed that the vertical vane was more sensitive to wind change but gave nothing to substantiate his claim.

*Slope to the axis of the Vane – does this give more stability?* Max Gunning thought not as the vessel would be pitching through many degrees and a few degrees to the vane slope would make little difference. Noel Bevan who used the Gunning Gear on *MYTH* in the 1968 Single Handed Trans Atlantic Race with no troubles said that overweighting of the vane counter balance was good and steadied the corrections. His vane moved 5 to 10 degrees at the most. Jumbo Edwards has an aerofoil shaped vane set horizontally and he had experienced no vibration.

*Pivot Loading.* Pivot loading on the vane must be kept low. The advantage was with the horizontal vane.

*Pendulum as in Hasler and Gunning Gears.* The contention that the pendulum acting as a water operated servo gave a factor of about 17 in available power was not questioned.

*Should the gear be capable of putting the vessel about?* A reserve of power is required both for putting about and also to maintain course while sail changing.

*Position of the Vane.* The vane must be high enough to avoid damage by following seas and also to clear foul wind. A mast head vane would be affected by rolling and pitching. A pair of vanes on each weather quarter was suggested but not received with much enthusiasm.

*Is a Pendulum necessary?* Depends very much on the individual characteristics of the vessel. Even in a hard mouthed vessel a large