8 Using the sails to steer the boat

Self-steering

A boat can sometimes keep herself on course without help purely due to her inherent directional stability. Trimming the sails and giving the rudder the right degree of bias is all that is needed to keep her steady. There are few problems when close hauled but not many boats are so stable on all the other points of sailing. Nowadays, with such good self-steering systems on the market, it is unnecessary to aim for such extreme directional stability when designing a boat because it is only obtained at the cost of other design requirements such as behaviour or performance under sail and manoeuvrability.

Furthermore the balance of a boat under sail is governed by the strength of the wind and the state of the sea. When the wind changes the sails have to be retrimmed if the boat is to stay on the desired course.

Wind vane steering gears and automatic pilots are a good solution to the self-steering problem, of course, but they are expensive and can fail. An alternative method used in years gone by was to get the sails to steer the boat. Special sails that act more or less like a large wind vane can be used, such as 'Miranda' in figure 8.1, or just the sails that are a normal part of the boat's gear. Sails used for steering are generally connected directly to the tiller, but this is by no means always the case and they can sometimes be set so that the boat keeps herself on course. Twin headsails set in a vee forward are a good example of this.

Steering with sails

Little gear is needed to get the sails to steer the boat, two blocks, two small lines and some elastic strops are usually sufficient. Given a little experience it takes little time to trim and adjust the sails, once the right setting has been found. It is much easier if the fact that sails will be used for steering has been taken into account when deciding where to place the fittings on deck. A number of methods are shown in the following pages and from these a system suitable for every boat can be assembled. They are grouped according to the boat's course in relation to the apparent wind, specific systems being given for sailing close hauled, with a beam wind and down wind.

The genoa, staysail, mizzen, mainsail and spinnaker can all be used for steering. There are two ways of using the staysail. When it is set normally to leeward it both drives the boat forward and steers her. When it is backed it can be used when the wind is blowing from a wider range of directions, but it does not then contribute to boat speed.

How they work

It is difficult to explain how sails steer a boat but it is easier to visualise when the wind is free or abeam.' The sail must react both when the boat

8.2. *A storm jib can be used to steer the boat and is hanked to the windward shroud when the wind is abeam but to the backstay on a run. The system is shown here at its simplest. The turning moment delivered by the sail equals the turning moment that the tiller must deliver to counter weather helm. Only one tiller line is being used, and the balance is found by making the tiller line fast further forward or further aft on the tiller, or by adjusting the spar that extends the clew of the storm jib. The angle of the jib to the wind can also be altered so that the force delivered matches the steering force required at the tiller. The jib sets better when the boat luffs up and pulls on the tiller line, returning the boat to her course. If the wind blows harder weather helm increases, pressure on the jib also increases and the tiller is pulled to windward to counter the extra weather helm. The increase or decrease in the wind and the resultant change in tiller line tension do not always match the increase or decrease in weather helm. When they do not the tension of the tiller line has to be balanced not merely by the pressure on the tiller resulting from weather helm but also by a rubber shock-cord. A system can then be built up whereby the sail steers the boat in winds of greatly varying strengths.*

A further refinement to the system shown here is to fit a counterweight to the storm jib so that heeling does not affect it. Otherwise the sail would hang down when the boat heeled and the rudder would be deflected undesirably. The sail can also be overbalanced so that the rudder is automatically deflected further as she heels, and thus counters the increase in weather helm. Fitting a second tiller line builds up a wind vane gear similar to 'Miranda'. This is suitable for an emergency but a proper wind vane gear is of course preferable for permanent use. It is rare to have a special sail for steering because one of the boat's normal sails can generally be used for this purpose.

sheet is made fast to the windward side of the tiller. The system works in winds of widely varying strengths without requiring adjustment, and course correction is both positive and very quick to take effect. Naturally a staysail can be used instead of the genoa and works in the same way. Other sails can be used similarly for all the points of sailing between a beam reach and a dead run, and the various methods possible are shown in figures 8.7 and 8.8.

It is more difficult to explain how a sail steers on a close hauled course. Most boats steer

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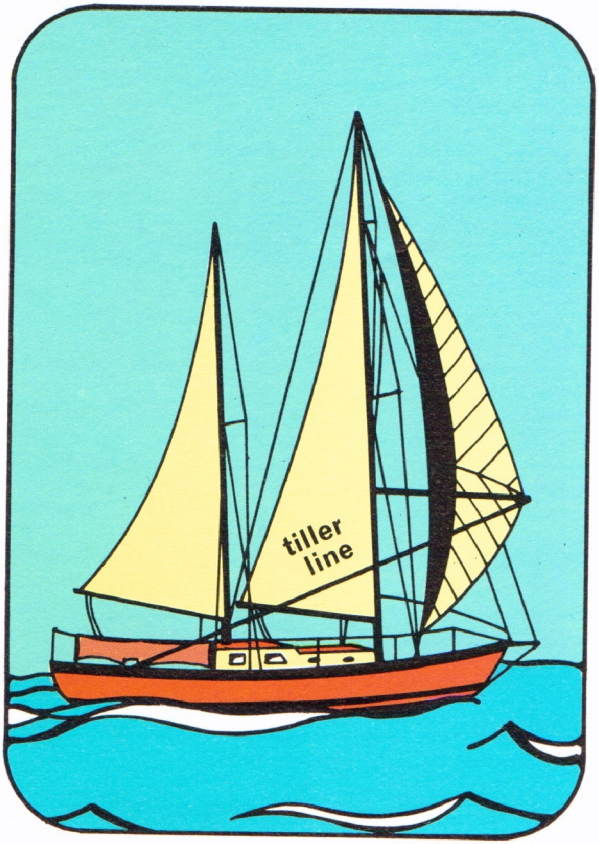


8.3. *If a boat will not stay on course as a result of trimming the sails and giving the rudder appropriate bias her balance can be improved by setting a special sail. With the wind abeam, when the boat has great weather helm and maximum steering force is required, a good deal of this griping force can be countered by setting a jib boomed out to windward, either close forward of the mast as shown here or hanked to the forestay. In the latter case a very long boom is needed to hold the clew of the jib far enough forward and to windward if the system is to be used with the wind abeam. Figures 8.4C and 8.8A show a rig for a dead run using the jib in this figure, while figure 8.8D shows such a jib steering the boat.*

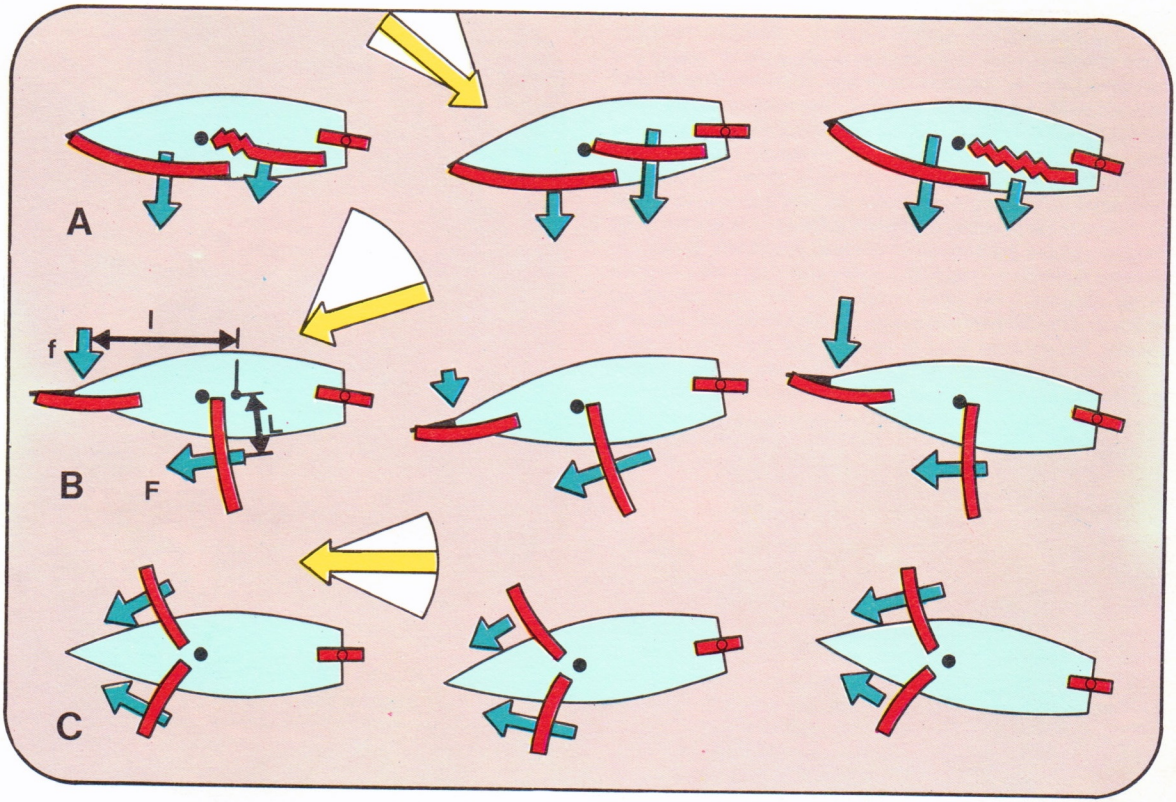
8.4. *The rigs shown here are all able to keep a boat on course. Some boats can steer themselves perfectly using these systems, or that in figure 8.3.* SPRAY, *in which Joshua Slocum sailed alone around the world, is a well-known example. She steered herself the whole way with her sails suitably trimmed and her rudder lashed. Slocum stepped a small mizzen on her afterdeck purely to improve her self-steering qualities.*

In cases when a wind vane gear just will not work altering the trim of the sails can help the boat to achieve a state where she can be steered by the vane.

Here the tiller is fixed, and it is simply due to the set of the sails that the boat stays on course. The aerodynamic forces on the rig have to balance the hydrodynamic forces on the underwater body.

One disadvantage of the systems drawn here is the relationship between course and wind strength. A new state of equilibrium has to be found every time the wind speed changes and, because the sails and the rudder are fixed, this can only be achieved by altering course. If the boat is to keep to her original course either the trim of the sails or the angle of the rudder has to be altered.

A To obtain directional stability on a close hauled course the genoa is hardened in too much and the mainsheet is slackened slightly. Most boats will stay on course when their



sails are trimmed like this and their rudders are fixed. When the boat bears away the mainsail fills and the lift force increases. Because the genoa had been hardened in too far the lift force produced was reduced in its partially stalled state and bearing away accentuates this. The air flow on the lee side of the sail becomes very turbulent, the sail stalls completely and the lift force is reduced even further. Pressure forward decreases, pressure aft increases and the boat is turned back to her original course. On the other hand when the boat luffs up the mainsail starts to shake and practically all lift force is lost, while the genoa sets perfectly at the optimum angle of incidence and the lift force increases. Pressure aft decreases, pressure forward increases, and the boat bears away back to her old course.

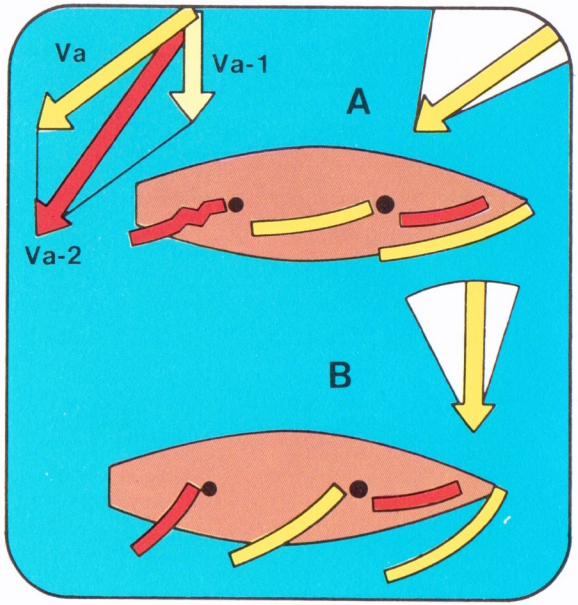
In gusty weather light sensitive boats can luff too far in a gust and the genoa will start to shake. The boat will come to a halt head to wind, or may even go about. Some other form of self-steering is required for this type of boat.

B The system used by SPRAY *and other boats is practicable on a reach. A small jib is sheeted hard amidships and the mainsail drives the boat forward. When the boat luffs the pressure on the jib increases and the mainsail becomes less efficient, but the opposite occurs when the boat bears away. This continues until a state of equilibrium, $F \times L = f \times l$, is reached and the aerodynamic forces balance the hydrodynamic forces.*

C Twin headsails set well forward in a vee will keep the boat on course on a dead run. The jib sheets may be attached to the tiller but this is not necessary if the vee is sufficiently acute.

All the systems shown will be less dependent on the wind strength if one of the sails is connected to the helm with a tiller line.

8.5. *A two-masted boat has more sails to set, and this increases the alternatives when trimming her to sail a steady course and also when using special sails to steer her. A shows how the staysail and mizzen are trimmed for stability. They work in just the same way as the sloop's sails in figure 8.4A, the mizzen being eased out too far and the staysail hardened in too much. The genoa and mainsail are trimmed to provide propulsive force. The boat can sometimes sail a steady course when the wind is abeam, as seen at B. This was the principle used aboard* SPRAY. *The mizzen is set too far out and the staysail is trimmed practically amidships. Because the mizzen is right aft it is very sensitive to the alteration in the apparent wind which results from the stern yawing, as shown at A. As the boat bears away the stern swings to windward, causing the apparent wind to increase and blow from a more favourable angle. The lift force produced by the mizzen increases and tries to push the stern away. Setting the mizzen too far out increases this effect because the difference in lift force produced is then greater. Va = apparent wind on course. Va1 = wind resulting from the stern swinging. Va2 = new apparent wind. When the boat luffs the lift force produced by the mizzen is reduced.*



8.6. *Sails steering the boat when the wind is forward of the beam. The arrows indicate the wind direction that matches the way the sails are trimmed in the sketches, while the arcs show the range of wind direction through which the relevant systems can be used. To keep the sketches as simple as possible the sheet is shown leading direct to the tiller, although this is less likely in practice.*

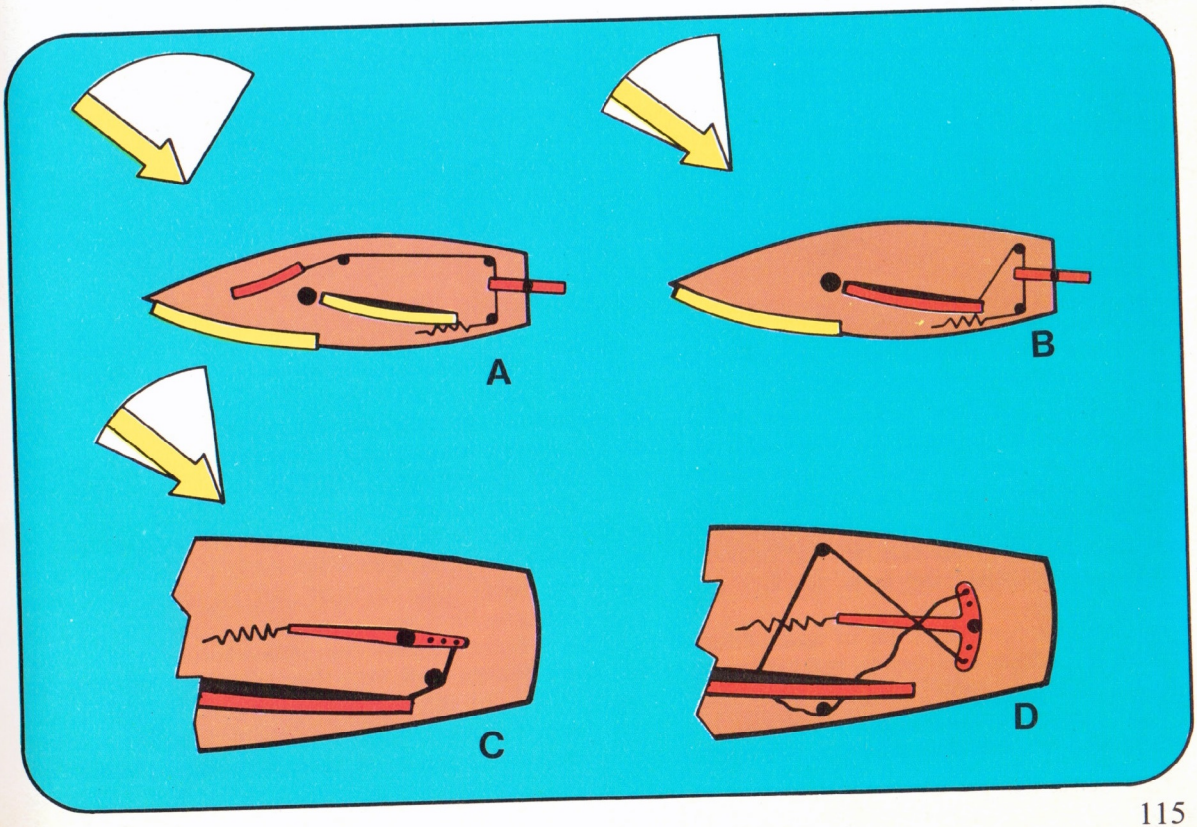
A A staysail set aback is steering the boat, with the sheet attached to weather of the tiller. The staysail, operating like a large wind vane, corrects well and positively when the boat goes off course and when wind speed alters. Alterations in apparent wind speed resulting from altering course improve the effectiveness of this system. A jib set aback provides satisfactory steering power in light weather too, the only disadvantage being a reduction in speed because the jib is backed. This method can be used on virtually all points of sailing except dead before the wind, and because the jib operates the same way whatever the course no problem arises when a wind direction is reached when the sheet would have to be changed to the other side of the tiller as is the case with other systems.

B The mainsail steers the boat. This is the best method with the wind forward of the beam. When the boat is pointing high the mainsail only reacts positively to an alteration in wind strength, corrections of deviation from course being left to the boat's inherent stability. The mainsail will also bring the boat back on course when the wind becomes more free. The sheet can be made fast on the lee side of the tiller balanced by elastic when close hauled and the mainsail will then act like a large wind vane, operating as in figure 8.4A, but weather helm will not then be corrected automatically. The trim of the sails determines how well the mainsail will steer when the boat is on the wind, and this will decide whether the sheet is made fast to windward or to leeward of the tiller.

The mizzen or a genoa can also be used when the wind is forward of the beam but these methods are not included here because they are not always reliable.

C The tiller here extends aft of the stock to provide alternative points to which the sheet can be made fast. A rubber strop centralises the tiller continuously, which is more convenient when beating because the tension is adjusted to suit both port and starboard tacks and need not be touched.

D Braine gear. Here the mainsheet is made fast to the tiller in such a way that, if the boat tacks accidentally, she will automatically be put about again on to the original tack. Alternatively the gear can be set so that the boat will sail on either tack, and she can therefore be put about without the need to adjust the lines on the new tack.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themselves anyway on this point of sailing, and the sail is used to transmit the change in wind strength to the rudder so that the necessary correction is made to counter the variation in weather helm. Figure 8.6 shows various possibilities that can be used when close hauled. A staysail set aback as in figure 8.3 will also correct effectively when wind strength changes and when the boat goes off course, acting in the same way as just described for the genoa when the wind is free. If the mainsail is used to steer only changes in wind strength are corrected, while the boat's inherent directional stability is relied on to correct a deviation from course. When the mainsheet is not hardened in fully on a close hauled course the mainsail will behave as described in figure 8.4A. Bearing away will increase the pull on the mainsheet and so the sheet has to be attached to the leeward side of the rudder. On the other hand if the sheet is attached to windward and the mainsail is hardened in slightly too much the effect is reversed, bearing away causes the angle of incidence to increase, the sail stalls completely and the lift force is reduced, whereas luffing up sets the sail at the optimum angle of incidence and the lift force increases. If the boat luffs too far the lift force will again decrease. In practice making the sheet fast to windward enables deviations from course to be corrected, even when pointing high on the wind. The aerodynamic forces on the rig resulting from going off course appear to override any possible wrong rudder reactions caused by the mainsheet.

The sheet is normally used as the tiller line, but naturally any line can be used provided that tension alters when the boat deviates from her course.

Various combinations of sails, tiller lines, rubber strops and tiller can be used, and a steering system using sails can always be assembled for a boat by going out sailing and observing how the tension of the sheets alters when she bears away and luffs up.

The system in use

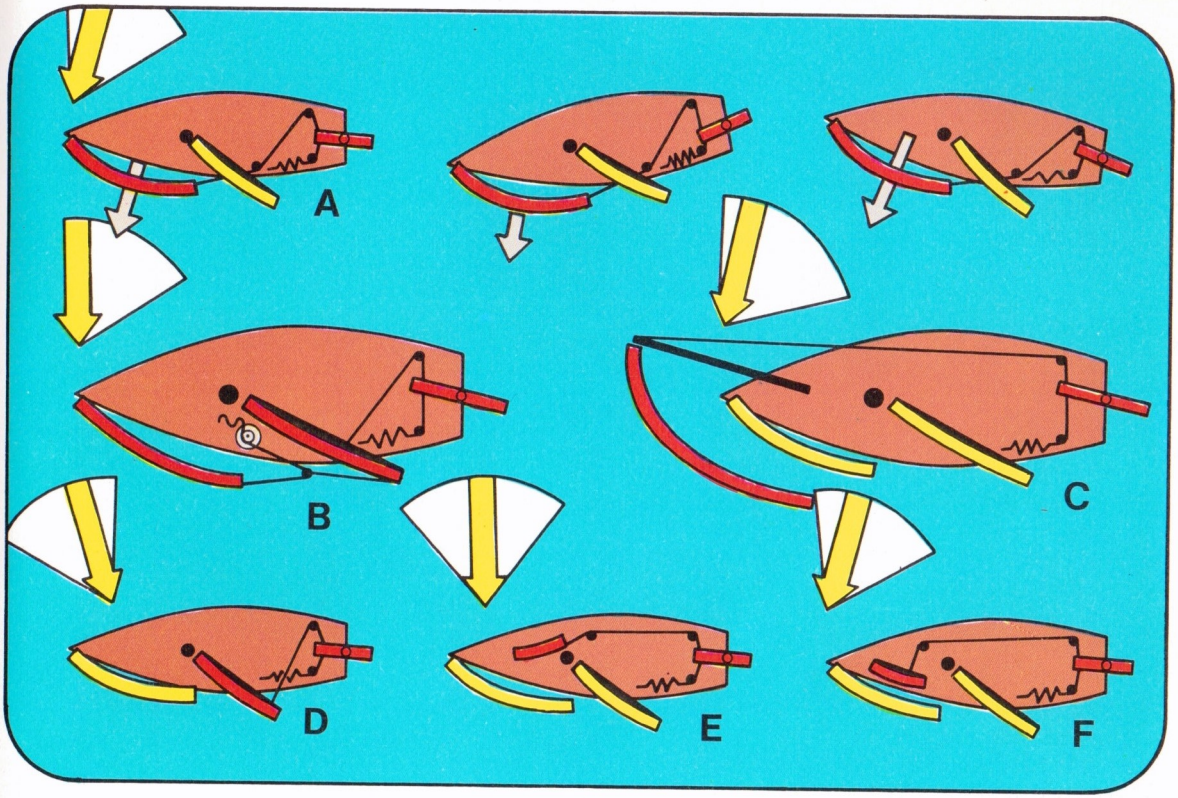
An automatic pilot or a wind vane gear is naturally easier to use and requires less work, but this does not alter the fact that sailing boats making long passages should be able to use their sails for steering. Anyone who sails on a tight budget finds steering with sails a very attractive alternative to a wind vane gear.

At the start much patience and ingenuity is needed before a satisfactory method of using sails for steering is found, but the time spent is very worth while, particularly when sailing alone or with a small crew. It is much more pleasant to spend a few hours thinking out the self-steering system and getting the sails to do the work than to sit eternally locked to the helm. As already said, on the second occasion it takes little time to get the sails to steer the boat if you can remember the setting used before. Do not lose heart if the system did not work the first time because a solution can always be found.

Tiller lines and elastic

The tiller line, and sometimes the sheet itself are made fast to one side of the tiller. The pull exerted by this line is opposed by the boat's inherent weather helm. Sometimes weather helm is able to counteract the pull on the tiller line but, more often, the help of an elastic rubber strop is required to achieve a balance. If the pull on the tiller line is reduced when the boat goes off course the elastic pulls the tiller over, and vice versa, thus bringing her back on course.

It is largely the pull of the elastic that determines how well the system works, and the quality of this rubber shock cord is vital. If the rubber does not stretch easily the tiller line will not be able to pull hard enough to move the rudder, but if the rubber is too stretchy the tiller will move



8.7. *There are various ways of getting the boat to steer herself when the wind is abaft the beam. The most practicable methods are amongst those shown here and in every case the sheet is made fast to the windward side of the tiller.*

A *The genoa steers the boat, and the way it works is described fully in the text. Luffing up increases the lift force produced while bearing away reduces the lift force. This system is used when the wind is abaft the beam.*

B *Genoa and mainsail keep the boat on course. It is difficult to steer with sails when the wind is abeam, but by combining the pull of the mainsail and genoa sheets as shown here the sails can control the boat on a beam reach.*

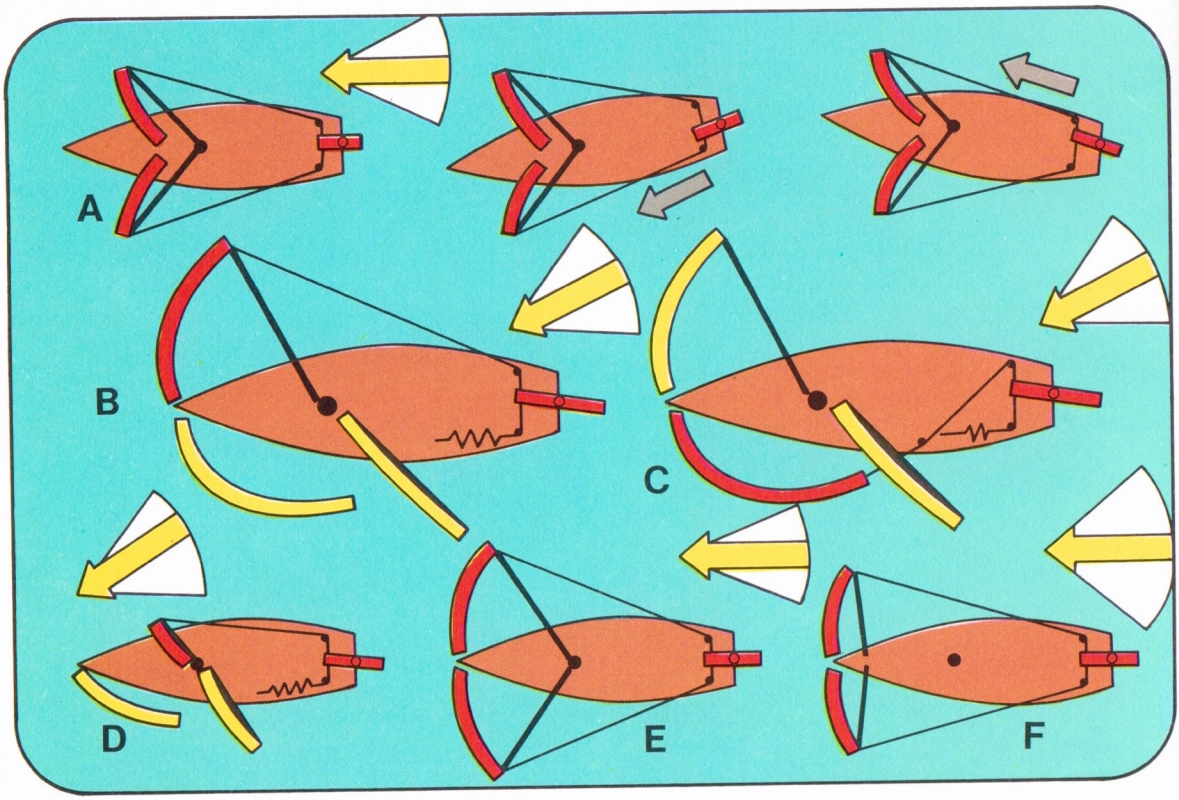
It is hardly surprising that B is effective with a beam wind because it is a combination of a system that works well with the wind forward of the beam and a system that is effective when the wind is abaft the beam.

C *A reaching or running spinnaker steers the boat here. In light weather a reaching spinnaker can be effective, the guy being sheeted directly to the windward side of the tiller. The principle is the same as A, and this method is effective right round to a dead run.*

D *The mainsail can keep the boat on course from high on the wind to a close reach. The way it operates has been described in figure 8.6.*

E *A staysail set aback operates as described in figure 8.6A.*

F *The staysail steers the boat in the same way as A. When the jib is set on a boom there are many ways of reducing the pull on the sheet to match it to the steering force required, and this explains why a boomed staysail is so often used to steer larger boats.*



too far and oversteering will occur, the boat snaking either side of her course. The rubber must also stretch as evenly as possible. The shock cord, often used to lash sails and so on, is not very suitable when under load because it resists stretch initially and then extends more easily once a certain degree of load has been reached. It also has a limited life. Rubber strops such as those used for underwater weapons, catapults and so on stretch and retract much more evenly, and are thus better suited to the demands of self-steering gear.

Even more important than using good rubber is to keep friction as low as possible. The rudder itself and the sheaves over which the tiller lines run must move absolutely freely. Keep the number of blocks to a minimum when leading the lines to the tiller, and ensure that the sheaves are large enough and turn easily.

Tiller or wheel

When using a sail to steer it is preferable to have a tiller rather than a wheel, quite apart from the fact that it is easier to make steering lines fast to a tiller. If the boat has a wheel the tiller lines are often attached to the emergency tiller and, sometimes, the wheel can be uncoupled from the

8.8. *Twin headsails can be used downwind to get the boat to steer herself and no elastic is required because both sheets are led to the tiller. If the wind is not absolutely dead aft the boat can be steered as described in figure 8.7.*

A *Twin headsails set in a vee work as described in figure 8.4C. The luff runs from the top of the mast to a point close forward of the mast. The clews are held out by booms attached to the mast, a method which provides great stability and which is easy to handle. The only disadvantage is that the arc through which the booms can swing is restricted by the standing rigging and this is why this method is only suitable for running dead before the wind.*

B *Genoa to windward. A second genoa boomed out to windward can steer the boat remarkably well on a broad reach. No extra equipment is needed and the mainsail need not be lowered. Twin headsails are preferable for longer periods, but the method shown here can be recommended for shorter spells and less work is required to set it up.*

C *Genoa to leeward. If the wind is too far aft to set the sails as in figure 8.7A booming out a genoa to windward balances the rig again, while the genoa to leeward can steer the boat.*

D *Jib to windward. A small jib hoisted up the leading side of the mast and boomed out to windward steers effectively and works in just the same way as the staysail set aback in figure 8.7E.*

E *Twin headsails, hanked to the forestay, are held out here by booms attached to the mast. This is a simple method but very long booms are needed and, again, their freedom of movement is restricted by the mast's standing rigging.*

F *Twin headsails are again hanked to the forestay but, because the booms are attached to the foredeck, the arc through which they can swing is increased and consequently this method can be used through a wider range of wind directions. The booms can be shorter than those attached to the mast and in strong winds the clews can be allowed to move forward to give the stability provided by A.*

rudder stock so that the inertia resulting from turning the wheel at the same time as the rudder does not affect the system adversely. If this is impossible the tiller line can be made fast to a drum connected to the wheel.

Atoms and Aries wind vane gears, among others, manufacture a drum for use with their wind vanes, and these can obviously also be used when steering with sails.

Steering power

The steering power required is not very great, but the pull exerted by a sheet can be extremely high and far exceed the steering power needed. Only in smaller boats can the sheet be made fast directly to the tiller. The various fittings and rubber strops would be disproportionately heavy if they were to be adequate to deal with the very great pull exerted in larger boats. The sketches that set out the various methods all show the sheet leading directly to the tiller where it can be made fast with, say, a clove hitch. Figures 8.10 and 8.9C

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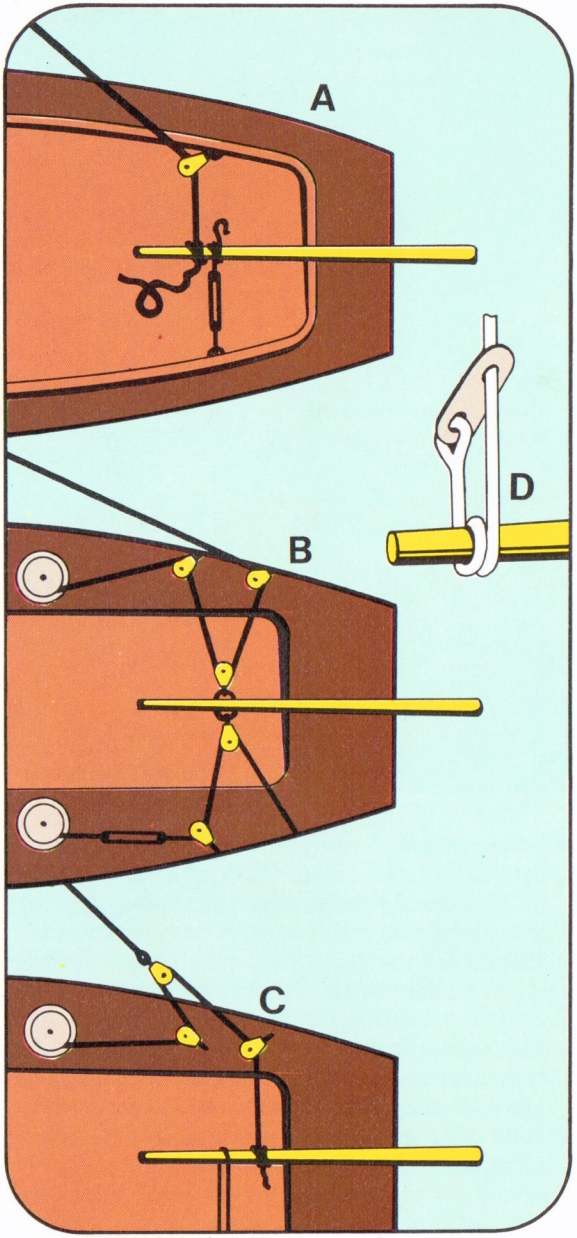


8.9. *Various methods of making the sheet (or tiller line) fast to the tiller.*

A The sheet leads direct to the helm where it is made fast with a clove hitch. This is only possible with small boats when there is little pull on the sheet. In larger boats the pull has to be reduced before making the sheet fast to the tiller.

B The sheet leads through a block on the tiller to a winch and this enables the tension of both the sheet and the elastic to be regulated exactly. This is a particularly popular method for twin headsails.

C The sheet is connected to the helm with a block and tackle which halves the pull on the sheet, making adjustment with the winch easy.

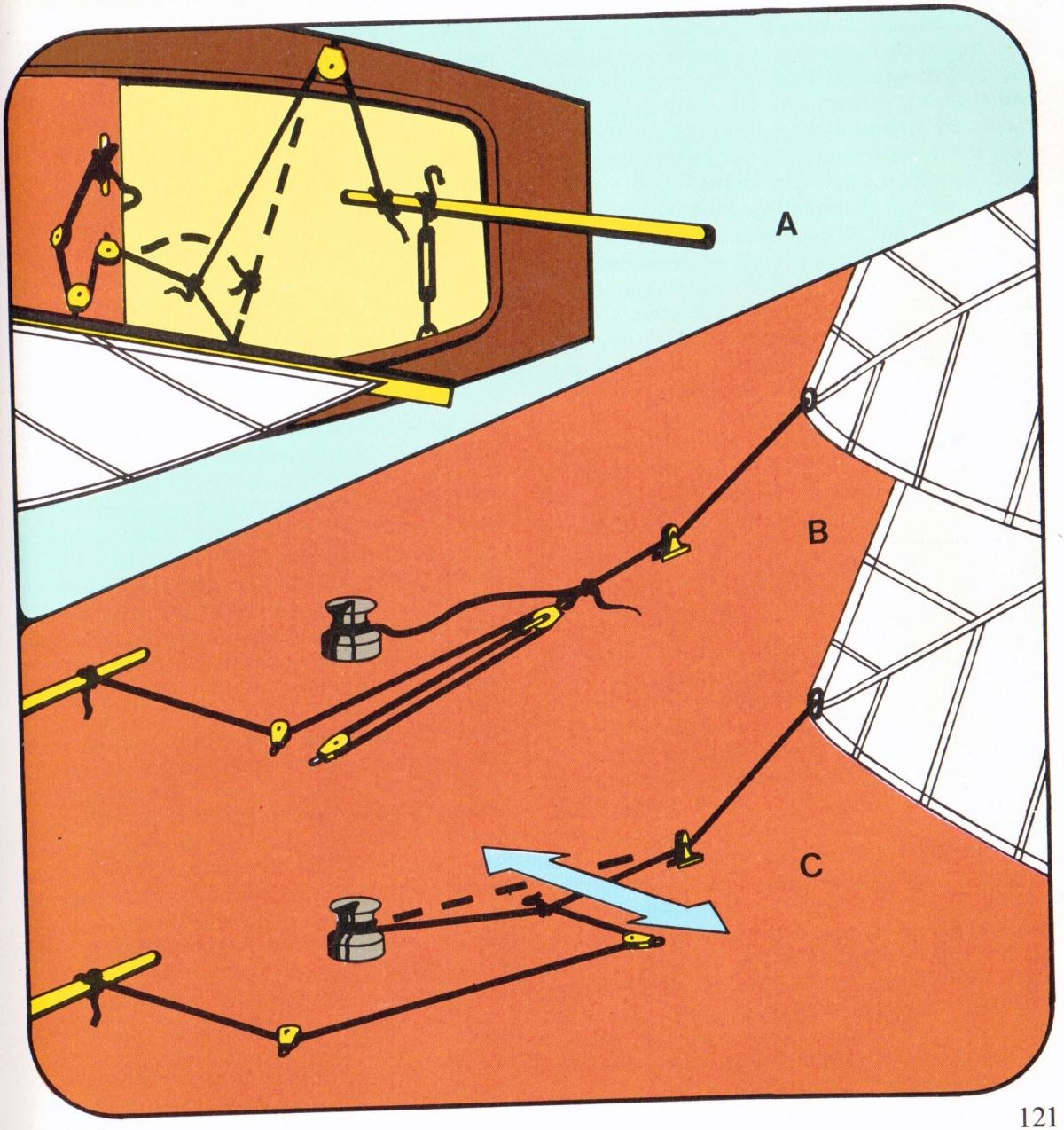
D A simple method of regulating the tension in either sheet or elastic.

8.10. *Various methods of making the tiller line fast to the sheet.*

A The tiller line can be made fast to the standing part of the mainsheet tackle. If the mainsheet is under great tension the tiller line pulls the standing part slightly out of line, and only a small part of the tension of the sheet is transmitted to the tiller line and therefore to the helm. When the wind is abeam or in light weather the sheet is uncleated and the tiller line takes over. Naturally the running part of the mainsheet tackle can also be used as a tiller line. If the mainsheet tackle has two running parts yet another method is possible, one part being made fast to the tiller while the other part regulates sheet tension. The sheeting tackle of jibs set on booms can also be used in this way.

B The running part of a tackle is used as the tiller line. The tackle is itself attached to the sheet. The pull on the sheet can be reduced as many times as the number of sheaves incorporated.

C If there is sufficient room between the genoa fairlead and the winch the tiller line can be attached directly to the sheet and will pull it out of line. When the pull on the sheet increases it will tend to straighten and vice versa, and this movement is transmitted to the helm by the tiller line.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show how a tiller line can be attached to a sheet so that only a part of the sheet's pull is used to steer the boat. If a special tiller line like this is used the self-steering system can be disconnected immediately without touching the sails, and this is an important safety factor, for example if the boat finds herself on a collision course.

It is worth recommending that rudder movement should be limited when the sails are steering so as to reduce the possibility of oversteering. A maximum deflection of 5°–10° to port and starboard should be satisfactory on a reach. Rudder deflection can be restricted by attaching two lines to the tiller to limit its travel, or by using pegs either side. Two pieces of strong rubber are better than two lines because shocks transmitted to the rudder are avoided. This is valid when fixing the rudder too. If the rudder and the fittings that hold it fast are very heavy it is preferable to use very strong elastic either side of the tiller to restrain it.

Adjustment

Sheet (tiller line) tension depends on the wind strength. It is not only when the boat goes off course that sheet tension alters but also when the wind increases in strength, and self-steering gear therefore has to be adjusted to every change of wind. This is partly countered by a boat's inherent weather helm. When the wind blows more strongly, the pull on the tiller line becomes greater but weather helm also always increases and the helm has to be deflected further if the boat is to stay on course. It is possible to find a setting that provides directional stability over a great range of wind speeds by experimenting with the point where the steering line is made fast to the tiller, with the elasticity of the rubber strops, and with the degree of tension on both tiller line and rubber strop. If the boat keeps luffing up when the wind blows harder the tension of tiller line and rubber strop should both be increased, but if she tends to bear away slacken them slightly. Unless a balance between weather helm, wind strength and the pull of the sheet is found continual alterations have to be made to the rubber strop tension.

In light weather the rubber strop should be eased off with the tiller slightly to leeward so that an increase in wind speed will automatically result in the tiller being pulled to windward by the extra tension on the sheet. This is required to counter the increase in weather helm, the pull of the tiller line being balanced by pressure on the rudder and the pull of the rubber strop which is now stretched.

Altering the position where the rubber strop is attached to the tiller among other things affects the reaction of the elastic. Heavy rubber made fast close to the rudder stock will have the same effect as rubber that gives more easily made fast to the forward end of the tiller. The latter is better from the point of view of adjustment, and there is less load on the point where it is attached. This is equally true of the tiller line, and a light pull that moves the line a greater distance is preferable. What is possible depends on the way in which the changes in tiller line tension are transmitted to the sheet.

In some cases no rubber strop is needed, the pull of the tiller line being countered only by pressure on the rudder, but this is really only possible when increases and decreases in wind strength, and the consequent changes in tiller line tension, are balanced by the change in weather helm, and thus the pressure on the rudder. In most boats the pressure on the helm has to be augmented by a rubber strop if a system is to be set up that does not require resetting every time the wind strength alters.

Choice

The systems that use the mainsail give the best

results close hauled (figure 8.6) and the mainsail can be used to steer the boat until the apparent wind's direction is just forward of the beam. When the wind is abaft the beam a genoa or staysail do the job well (figure 8.7A). The genoa can still be used on a run provided that the rig is balanced by setting a jib to windward (figure 8.8C). A small sail set to windward, as in figure 8.8D and 8.3, also gives good results. For long stretches dead before the wind the mainsail can be lowered and replaced by twin headsails (figures 8.8A, E and F).

For general use a staysail set aback as in figure 8.6A and figure 8.7E can steer the boat on practically all points of sailing.

Advantages and disadvantages

Using sails to steer the boat poses problems for single-handed sailors when changing sails or reefing because, obviously, they cannot operate at that moment whereas wind vanes and automatic pilots continue to keep the boat on course. Gusty winds also cause a lot of work because the sails have to be adjusted both to the wind direction and, to a lesser degree, to wind strength. Changing course therefore takes a long time whereas with automatic pilots and wind vanes, all that is often needed is to turn a knob or to pull a line from the protection of the cabin. When sails are steering it takes time to find the correct tension for the rubber strop and tiller line before the boat settles on her new course.

Steering with sails, or knowing how to adapt the rig to steer the boat, is important when making long ocean passages, whatever the boat, and can be used as a reserve self-steering system should other methods fail. The loss of speed that may result when sails are steering—and this is by no means always the case—is a small price to pay for the extra comfort, particularly when this comfort costs so little money.