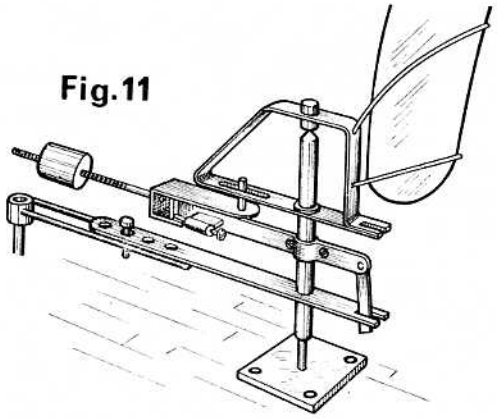
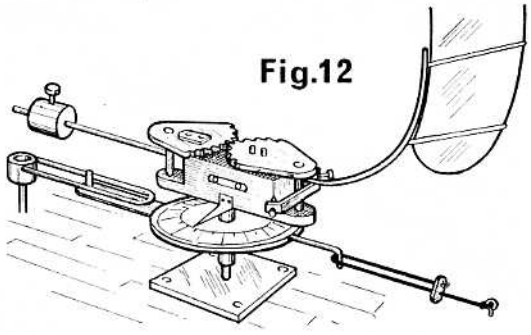


Fig. 12 shows a basic Ballantyne gear where the characteristic is the tacking motion being given by two equal sized gears set equidistant about the main vane pintle. This gear is readily balanced in both the 'fixed' and 'broken' conditions. Like the Lassel it gives positive lee helm when 'broken' and weather helm is entirely dependent on the angle of the heel of the boat when beating and the fact that both the feather and the counterweight are on the leeward side of the main pintle in this condition. Because there is no additional locking action of a toggle linkage it pays to have the feather and counterweight on the heavy side with this type of gear and have the mast position set for neutral helm on the beat. Should the mast be back from this position which would demand some weather helm there is a prospect that due to the speed of the boat through the water the pressure on the rudder may take control over the gear with the effect that the boat is driven up into irons when the boat becomes more upright and the gear is even less effective. This gear by its nature gives less trouble in failing to tack when the boat is put about.

The Fisher gear, Fig. 13, has a similar configuration to the Ballantyne except that the tack motion is obtained by a pin and slot linkage which is so proportioned that a degree of locking takes place in the 'broken' condition. This gear again is easily balanced for the 'fixed' and 'broken' condition. Because of the slight locking action it is suitable to apply a small amount of weather helm and since this is of some advantage, as will be discussed in the following section, the mast can be set back from the truly neutral position. Observation shows that at the present time there are probably more of this type of gear is use than any other, perhaps because many have been produced commercially and it is also the easiest tacking gear to make for oneself.



The fourth type of self-tacking gear — the moving carriage — is illustrated in Fig. 14. It is the most complicated and probably has too many parts to make it a commercial proposition at a price that can be afforded, although it should not be beyond many model yachtsmen with some metal model-making experience.

The self-tack motion is controlled by lines from the main boom and therefore is very reliable. As long as there is wind in the mainsail it gives positive weather and lee helm. It is very easily balanced. These are its attractive points. In addition, insofar as guying is ever a reliable or unreliable manoeuvre, its action in this respect is as satisfactory as any. The tacking action is attained by a sun and planet motion of two gears which may be equal or have some other ratio which will be discussed in giving constructional details later.

What does Automatic Steering do for you ?

We have now covered general sail trimming and sailing practice, we have also given some brief idea of the various types of steering systems that have been used and in particular, various kinds of Vane gears. It now seems time to ask the question at the head of this section and answer it, particularly as so many people are not conscious of the right answer.

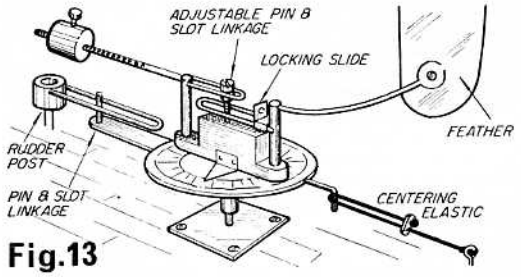


Fig.13

The answer so many would give is that it makes the boat go where you trim it, nominally from A to B. This may be the skipper's hope. The right answer, and one that must really be absorbed, to avoid frequent frustration, is that a yacht with sails and automatic steering correctly set on a straight course will sail at a constant angle to the wind. If the wind is constant in direction, then a fine course should be sailed and the boat should go just where you want it. It is seldom that we have true winds on our model yachting ponds and lakes and therefore the courses sailed will deviate according to the "flukes" in the wind. Very often these show a sufficiently constant pattern that use can be made of them and this all adds to the interest of model yacht racing, although such conditions usually favour the local skippers. Readers of Francis Chichester's single handed voyages when he has used vane steering will be aware that he records on more than one occasion waking after a "kip" to find he was on his way home again because of a 180 deg. wind shift, and that in mid Atlantic. Racing skippers are also not inexperienced in this phenomenon. We mention this because they supposedly know what they are doing. The less experienced think that their steering gear is not working properly and this is our reason for stressing just what automatic can do for you, and in a sense what it cannot.

Braine and self-tacking vane steering gears, besides steering on a defined course relative to the wind (which if the sails are correctly set should give optimum speed and therefore the fastest time from "A" to "B") are able to do three other things. (1) Guy. (2) Gybe; and (3) Tack by pole or hand without carrying out any adjustments. We see that four new terms have been mentioned and a little explanation would not be out of place. The first is the self-tacking vane. The Lassel, Ballantyne, Fisher and moving carriage gears briefly described in the last issue are all self-tacking. If you look at the steering compass (Fig. 5 in the February issue) you will see that when on a close port tack the vane feather makes an angle of 30 odd degrees to starboard relative to the axis of the boat. When on the starboard tack the feather requires to be at a similar angle, but on the port side. The non-self-tacking gear, Fig. 10, would require this movement of the feather to be carried out manually when the boat came to the bank and you wished to change it on to the opposite tack. Fig. 15 shows two boats in these positions just before coming to the bank and just after leaving. The self-tacking vane gear enables the feather to do this change of approximately 65 deg. automatically as the boat is "tacked" (turned on to the new or opposite tack) by pole or by hand. We thus see that we have not only defined (1) self-tacking gear but also tacking (4).

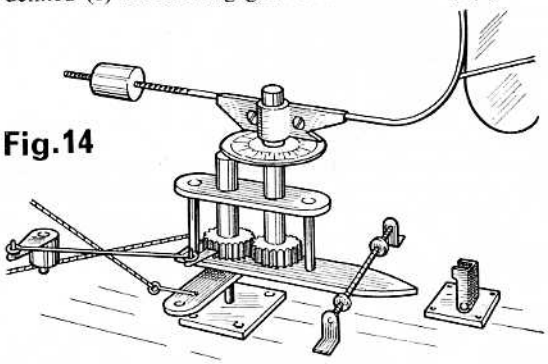


Fig.14

Now for (2) Guying. Guying is the ability to make the boat intentionally change tack when away from the side of the lake. Where this takes place not far from the side from which it has left it is called a "short guy" and when a long way away, frequently nearly the other side of the lake, it is a "long guy". How these are affected as well as those between will be dealt with later when we discuss the types of vane gears in more detail, but here the purpose of guying will be explained. Guying has two uses, the first is in racing where on the majority of waters it must be considered a vital necessity. Fig. 16 shows a fairly ideally proportioned lake for racing and the course taken by a boat with the wind in the direction shown. From this it will be seen that if a plain tack was made from position "X", the course followed would be the dotted one to "Y" and then after changing tack once again to "Z", whereas by quickly setting a short guy at "X" the course would be that of the solid line to "W" over the finishing line after a relatively few yards. If the course had brought the boat to "X1" then a longer guy to "W1" would still be better than to "Y1" and "Z1". The other use of the guy is when sailing alone on a largish water and the wind is fairly straight down the length of it,

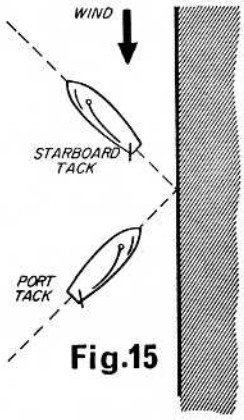


Fig.15

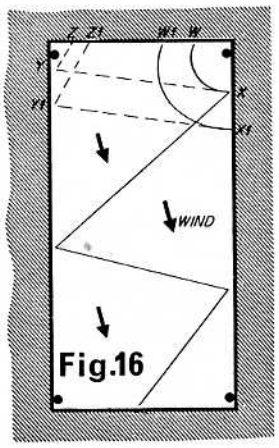


Fig.16

effective long guys save a lot of walking or running round the water and add considerably to the enjoyment. The long guy also comes to its own in racing where the water is wide such as the Round Pond, Kensington Gardens, London. It is recognised here that when the wind "is down the pond" guying is the quicker way to get to the finishing line than tacking as would be done on a narrower water.

Now we come to the third term, Gybing. It would be more correct to say the facility that the gear gives is the return or correcting gybe. These conditions arise with the wind behind the boat, i.e., on the run, with the main boom well out over the side of the boat. If, due to over-steering or a fluke puff of wind, the boom and main sail are blown to the opposite side, it is said to have gybed. Unless the wind was previously dead behind the boat there will be a deviation of course as shown in Fig. 17. What we want our automatic steering gear to do is to turn the boat back again to course and get the sail back on to its proper side and driving again, i.e., it is a return or correcting gybe. This then is what our gear can do for us, as we shall see when describing the gears in more detail.

How the Vane Steering Gear Works

As was said in the earlier brief section on the different types of vane gears, the balanced non-self-tacking gear can be used for all "plain" courses. Because of the simplicity of this gear we will use it to describe how the gear works on all straightforward courses. Fig. 18a and b show a side view (in section) and a plan view of the gear simply shown earlier as Fig. 10. Now is the time to describe the parts in more detail. (a) is the rudder post which is surmounted by a simple quadrant (b) with a slotted "tail" and a forward projection used for a balancing weight, a matter which will be discussed under

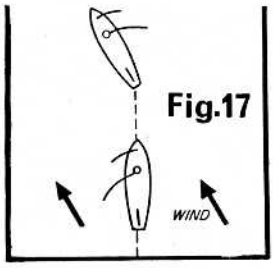


Fig.17

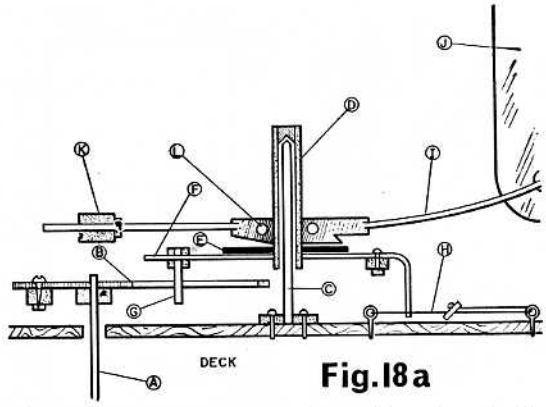


Fig.18a

balance later on. Note that the tail projects backwards almost to the pintle (c) on which the vane swings. (d) is a tube with a point bearing in the top and mounting the scale (e). A forward arm (f) carries the pin (g) which engages in the slot of the quadrant tail. It is useful to be able to adjust the pin position and this accounts for the three holes shown. A short arm projects aft. The small downward bent portion has a small hole through which the light centring elastic (h) passes. Finally we have the vane arm (i) carrying the feather (j) at one end and the counterbalance weight (k) at the other. This arm fits over

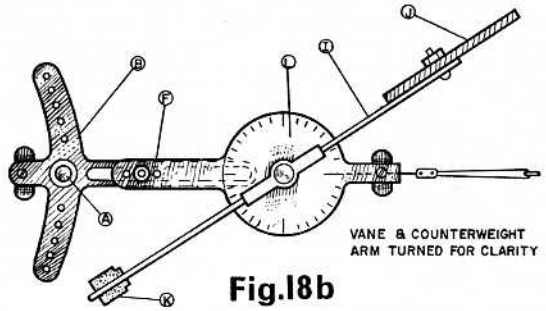


Fig.18b

the tube (d) on which it can be turned either clockwise or anticlockwise through a full 360 deg. Screws (l) enable it to be made friction tight so that it can be turned by hand to a chosen scale position; it will be too stiff for the wind on the feather to do so.

The simple gear described by Mr. Draper in the November 1964 *M.M.* shows how the pin and slot motion can be replaced by gears which give a constant angular motion between the vane and rudder movement. The restriction of the tooth by tooth adjustment can be overcome by the friction drive of the vane arm as described above.

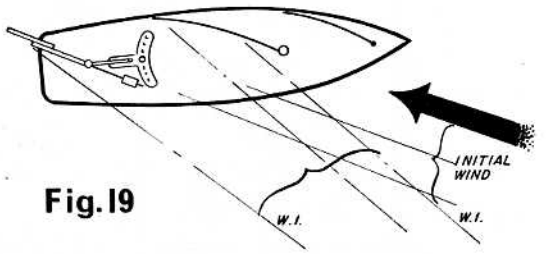


Fig.19

Fig. 19 enables us to take the first simple step in understanding the vane action. It shows a boat with sails and vane set approximately for a close beat on the starboard tack. The vane is shown "flying" like a weathercock in the wind; this, as we shall see later, is not strictly accurate, but for the first step it facilitates the simple explanation. Consider that the boat is sailing happily on the course shown, sails full and drawing and the rudder neutral. A wind shift comes along so that the wind now comes from W1, shown dotted. It now strikes the starboard face of the feather which will turn clockwise. Through the pin and slot—or gear—motion the rudder will turn anticlockwise and the boat be steered so that it resumes a course at the original angle to the wind. Note that this is what we said an automatic gear does. As the boat turns from its original direction to its new one the wind pressure on the vane eases until the feather is once again flying in the wind and we have equilibrium. If the wind had moved the other way the wind would have struck the feather on the port side and the movements would have been, vane: anticlockwise and rudder: clockwise. The course would again have been corrected to the same angle to the new wind. If now it was not the wind that shifted but rather that the boat fell away from the wind, the gear will try to steer the boat back on course relative to the wind. This condition arises when the sails are not set at the optimum angle for the course being dictated by the vane angle setting. Similarly if the sails are too tightly set the boat sails up into the wind on the sails and the vane tries to hold it off, not really sailing at all. This emphasises that to sail well the sail and vane angles must be in harmony. Now turn to the sailing compass, Fig 5, and apply the above wind of course shifts and see that each time the vane always moves the rudder the right way to correct the course.

Before considering the self-tacking gear and the question of balance, we must consider WINDS, real and apparent.

Winds, Real and Apparent

The real or true wind is that indicated by a weather cock in a high unobstructed position. To appreciate more readily an apparent wind when we come to it, it is worth pointing out that the true wind is observed from a stationary point. It will be clear from this that when you are at the pond side trimming your boat it is the true wind you feel in your face or on your side or behind you. The feather of your vane gear, which flies like a weathercock, is on a moving point when the boat is sailing and operates to the apparent wind. To appreciate the difference between true and apparent winds carry out the following experiment. Stand in an open space, holding a small flag, and turn so that the wind is coming directly to one's side. The flag will flutter directly across from, say, left to right. Now walk briskly or run forward. The flag now feels the apparent wind and no longer flies directly across but as if the wind is coming from somewhere in front. This is a product of your motion and that of the true wind. The effect on the feather of a boat in motion is just the same. The effect can be resolved by "triangles of forces", in which, if the wind speed is reversed and plotted at the appropriate angle relative to the boat speed plotted in its actual direction, the line joining the outer ends of these lines will be in the direction of the apparent wind and of a length proportional to its strength.