the "pin" is on the counterweight assembly and the slot on that of the vane. If they were the other way round there would be no locking action at all since wind pressures on the vane would merely cause the pin to move in the slot.

To obtain adjustment of the vane angle in the broken condition, side adjusting screws on the top plate, as used for the Ballantyne gear, can be used. This is good since it is both precise and enables slightly differing adjustments for the two tacks. The alternative is to make the pin adjustable in a slot in its mounting arm. Two alternative forms are illustrated. The simple commercial type is a plain clamping screw, but with this it is difficult to obtain precise adjustments. The second is more complex, in which the pin position is adjusted by a screw thread feed adjustment which can be really precise. The latter in practice is worth the additional trouble to make, since to be able to adjust the vane angles critically can make all the difference between the boat "flying" on a course and just sailing there.

Sailing with the Fisher gear is so similar to that with a Lassel or a Ballantyne that only a brief resume is necessary.

When sailing on a close beat (see Fig. 5) particularly if a change of tack or a guy will be required before the course is completed, sail with the gear "broken". That is with the body in the fore and aft position and the locking lever freeing the pin and

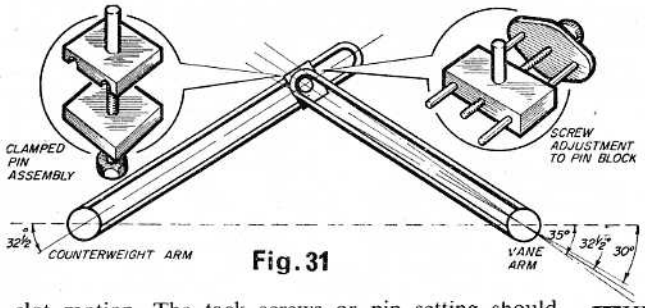

Fig. 31

slot motion. The tack screws or pin setting should have been adjusted in tuning up, before any racing was commenced. It is good practice always to sail close beats with the vane in the broken condition as this ensures that this adjustment is always available, and should there be a wind shift while on a course you are all set for a tack or, with the flick of the guy arm, a guy. All other courses should be sailed with the gear fixed, and the body turned to the appropriate angle. Avoid any temptation to adjust the tacking screws from their optimum setting for a close beat, to sail a course not so close. The settings for a close beat are critical and are worth preserving when once found. Nevertheless, experience may show that slight adjustments are required—for a close beat—in different wind strengths. If required, these are likely to be a slightly closer vane angle in light weather and a slightly greater angle in heavy weather. Quite apart from hull design the rake of the mast can give rise to these variations. It is worth while trying varying the rake of the mast to reduce as much as possible the need to vary the vane angle for different weather conditions since such adjustments and their restoration later can so easily lose adjustment, and know its optimum setting; one of the troubles about vane steering is that the approximate setting of a vane makes the boat behave so relatively well that too many don't bother to seek the most out of it.

Before leaving this gear a few ideas on dimensions will be helpful. While the pattern follows the Ballantyne gear in many details, the replacement of the gear linkage, with its relatively close spacing, by the pin and slot motion calls for a greater spacing between the side pintles on the main body. A minimum spacing of 2 in. between these side pintles is desirable and for 10 Rater and A class 2½ in. would be better. For gears on all but a 36 in. class boat the centre of gravity of the vane and counterweight should be 3½ in. to 4½ in. from the centre pintle, according to the size of the boat. Vane feather sizes will be discussed in a subsequent section. Full use should be made of the space between the side pintles for the pin and slot motion, since the larger it is the more precisely in general it can be adjjusted.

Balance is easily achieved since the vane and counterweight assemblies are so similar in size and construction and the vane and counterweight should be made the same weight, so that their centres of gravity can be equally spaced from the centre pintle. This leads one to point out that it is worth making a couple of vane feathers while you have the gear in pieces and the scales handy, since it is not really good enough to use any old feather if you expect to get the most out of your gear, whatever type it may be.

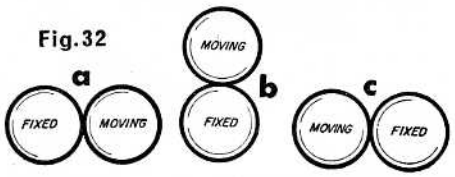

Fig. 32

THE fourth and last type of gear to be described is the moving carriage gear. This gear as distinct from the previous ones is of British origin and of a later date. In the author's opinion it has much to commend it. It has the following attributes: (1) It is easily balanced. (2) It gives positive helm to Lee and Weather. (3) It is positive in tacking. (4) Its angles of self tack can be adjusted precisely and independently for the two tacks. (5) Its guying action is as good as any. (6) It is robust. That is enough.

The whole principle of operation is entirely different from any of the others and since the author is aware that it presents difficulty to some potential users, it will be described from first principles. To an engineer it is a SUN and PLANET motion, so to start with let us place two pennies on the table side by side, heads facing the same way, in the position of the circles in Fig. 32(a). Holding the left hand one still, with a finger of the left hand carefully roll the right hand one round the stationary one to the position shown in Fig. 32(b) and then on to the position shown in Fig. 32(c) and notice the position of the head. By the time is has got to Fig. 32(b) the head is upsidedown, i.e., it has rotated 180 deg. while moving through 90 deg. relative to the stationary penny and by the position of Fig. 32(c) the head is upright once again, i.e., it has turned through 360

deg. while rolling 180 deg round the stationary penny. Turning now to Fig. 33 the pennies have been replaced by identical gears and the means of rotating the moving gear is supplied by mounting it on an arm, or carriage as we call it, pivoting round the shaft of the first gear. The latter gear is called the SUN wheel and the moving one the PLANET. Moving the carriage either clockwise or anticlockwise while holding the sun wheel will cause the moving gear, the planet, to behave just as the coin did. The gear will turn through twice the angle that the carriage moves through. Now we couple the sun wheel to a rudder which, for a start, is held central relative to the axis of the boat, and we mount a vane feather and counterweight on the planet gear, in line with the carriage and the gears and the rudder. This is illustrated in Fig. 34. Consider for a moment that the rudder is fixed in line with the skeg and we move the carriage through 15 deg. to one side. The vane will move through 30 deg. Just what we want for our self tack motion. If the carriage is moved 15 deg. in the other direction the vane moves 30 deg. in that direction. Now think of the carriage being temporarily secured in the 15 deg. position and free the rudder; any movement of the vane will be transmitted through the gears to the rudder as a positive drive either to LEE or WEATHER. That is just how the moving carriage gear works. To give the carriage the required movement it is coupled through a cord 'bridle" to the main boom, and to adjust the vane

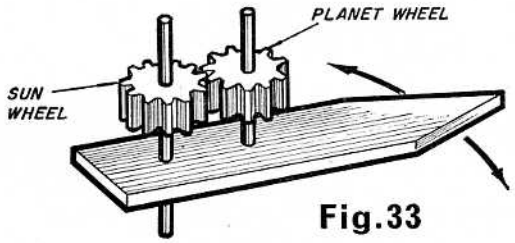

Fig.33

angle on the tacks adjustable stops are put on each side of the carriage to determine and limit its angular motion.

Fig. 35 shows the details of a practical design based on these principles. A moving carriage vane gear was first described by the author in the *Model Maker*, Febru ary 1961, and let it be said that there is nothing wrong with that design—the present one is merely a variation on the theme, just as one gets variations with the other forms of gears. Turning to the parts as coded in Fig. 35 "A" is the rudder post with quadrant for gybing just as with the previous types of gears described, "B" is the main pintle on which the gear is mounted, "C" is the carriage which fits on the main pintle. It consists of a tube "H" which is a reasonable fit on to the pintle and has in its top a conical bearing. Carefully spaced a pitch diameter of the gears away from the centre of the tube is the pintle "D" to carry the planet wheel "E". This wheel is fixed to a tube "K" with a top conical bearing. The scale is clamped to this tube to permit final adjustment for fore and aft alignment when the gear is fitted to the boat. The vane and counterweight assembly also fits on tube "K" with an adjustable clamp which permits it to be adjusted for correct frictional movement when the gear is being used in the fixed condition. The sun wheel "F" carries the arm "G". This combination is made a

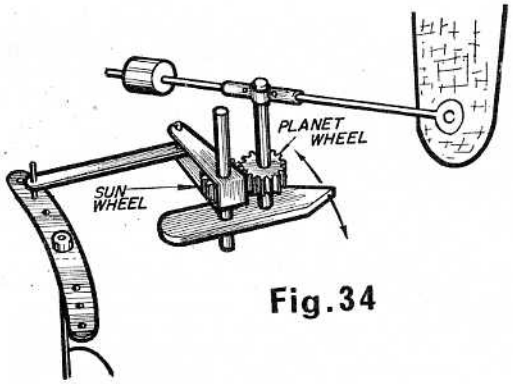

Fig.34

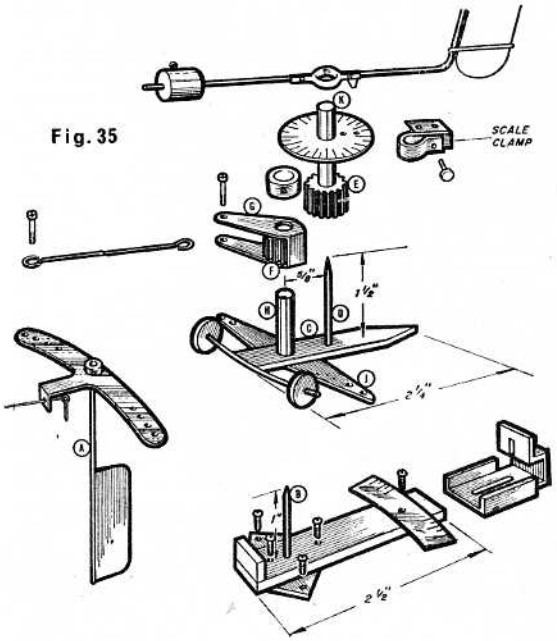

Fig. 35

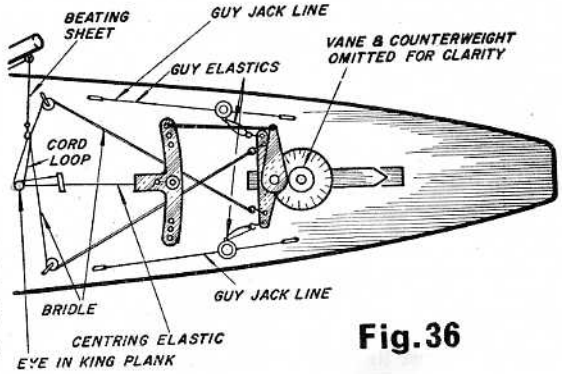

Fig.36

nice clearance fit on tube "H". The arm is designed at the gear end to cover the gear teeth so that it will prevent the tube, on which the planet wheel and vane are mounted, lifting off when in use. It also acts as a limiting stop. The sun wheel is in turn prevented from lifting off by the collar above, secured by a grub screw. The cross arm "J" used for giving the tacking motion is secured to the carriage at the pivoting point. The gear motion is transmitted to the rudder via a push pull rod attached to the arm on the sun wheel at one end to the quadrant at the other. The angle of movement of the carriage when in the "broken" or self tack condition is determined by the two stops which are on the threaded rod attached to the carriage. They "catch" on a stop on the main base. At the other end of the main base is a scale for observing the angle of the carriage—this is half the vane angle as will be apparent from the introductory remarks. The locking catch is also at the back end of the base in the form of a slider which, in the forward position, engages the tail pointer of the carriage. The vane and counterweight assembly will be clear from the figure. It has centrally a friction grip on the tube to enable it to be positioned at any angle while gripping enough not to change angle with wind forces. Fig. 36 is a plan view showing how the bridle of Terylene cord connects the beating sheet from the boom to the tacking bar on the gear. It also shows the guys which will be described in the operation of the gear.

Having now described the parts we turn to the alignment on a boat. The fact that a push pull rod is used to transmit the vane movement to the rudder permits much greater flexibility in positioning the vane gear relative to the rudder post compared with the pin and slot motion usual with other gears. Thus on 36 in. R and Marbleheads where the rudder may be very near the transom the gear may be mounted less than an inch away, while on a 10 R or A class the opportunity can be taken to place the gear well aft of the rudder post so clearing the vane from the slipstream of the mainsail. A gear using equal sized gear wheels has been illustrated and the author would recommend this 1:1 ratio, having experimented with different ratios up to 3:1 (the larger gear being the sun wheel and the smaller one the planet. He is however aware that others find satisfaction with a higher ratio than 1:1. When using the 1:1 it is recommended that the distance of the point of attachment of the push pull rod to the quadrant from the rudder post is one and a half times the length of the operating arm on the gear. This has practically the same effect as a $1\frac{1}{2}:1$ gear ratio with equal spacings for the push pull rod. If you have more than one position on the quadrant you can find what suits your boat and gear best. Having decided where you wish to place the gear, the length of push pull rod can be measured from the point on the quadrant you are going to use (with the quadrant and rudder neutral) to the pivot on the gear arm held at right angles to the centre line of the boat (if the alternative positions on the quadrant are on an arc from this point then you can effectively alter your ratios without any other adjustment). It will then be found that the range of angular movement of the gear arm will give adequate rudder movement, more than is available with a pin and slot motion. This angular movement is limited in one direction by the arm striking the back tube and in the other direction by the gear end of the arm stopping against the teeth of the planet wheel.

Having fitted the right length of push pull rod and secured the base of the gear to the deck with the locking catch in the locked position the scale should now be adjusted so that the 0 deg. marking is aft and the 180 deg. forward relative to the axis of the boat. With the rudder held central, unlock the catch and see that the vane moves to twice the angle as indicated on the carriage scale as the carriage is moved from the central position first to starboard and then to port. Adjust the carriage movement to 16 or 17 deg. on each side by turning the stops.

OUR attention can now be directed to the bridle which gives the tack motion, the guys and the centering line. First the bridle. This should be of nylon or terylene so as not to be affected in length by being wet or dry. It requires to have just a degree of slackness about it so that when the boom is moving over and pulling there is no binding at the eyes or pulleys. Three methods are illustrated. (a) in Fig. 36 where the beating sheet is hooked to a cord link to an eye on the centre line of the boat and the two halves of the bridle come from the top of the link. (b) Fig. 37a where a horse (possibly existing) is used and the two halves of the bridle are attached to the runner, and (c) Fig. 37b where a plain bridle is used and the length carefully adjusted, with the kicking strap to the boom tight, so that it has just the right amount of slack. The latter is the simplest, but has the disadvantage that it is so easy to adjust the kicking strap for some other purpose and then find that the bridle is binding. The author would therefore recommend (a) or (b).

The guys are simply light elastic bands connected at one end to the cross arm of the gear and at the other to bowsies on side jack lines, so positioned that there need be no pull on the elastic, i.e. it is out of action, or when moved forward there can be considerable pull, i.e. the guy is in action. Both are out of action on plain tacking.

With this type of gear the author recommends a centering line to a forward tail on the quadrant, so that if the wind fails the rudder is centralised immediately. With the earlier types of gears described it has been desirable to apply the centering action to the gear body because of the pin and slot linkage to the rudder, but that limitation does not apply to the push-pull arrangement. This centering elastic should be shirring elastic, nothing heavier, it only has to centre the rudder when the wind fails and anything stronger means that the vane has to continually waste steering power "fighting" this elastic.

Now to using the gear. Let us start with any plain course. In these cases the carriage is locked and the vane set to the angle for the course, see Fig. 5. Either the beating sheet or running sheet is used as appropriate. The gear will transmit positive lee or weather helm. Gybing lines should be set as described in an earlier section if the course is anywhere near a run.

For a close beat where a tack or a guy may be required the vane/counterweight assembly is set fore and aft over the scale (VANE aft) and the carriage released by sliding the lock back out of engagement. If the carriage tacking stops have been set as described earlier the gear is all set for port or starboard tacks with both guys slack, and for turning from one tack to the other. If one is sailing on the port tack, i.e. wind over the port side, and on turning the boat to