SMALL CRUISER NAVIGATION
R. M. Tetley

With fifty years' experience and very many sea miles behind him, R. M. Tetley has much invaluable advice to offer on the techniques of navigating small cruisers where space for charts and navigational instruments is at a premium and time for navigation is limited, particularly if the navigator is also the helmsman.

The author's practical solution to the problem is to design a chart board incorporating a pantograph which he uses with specially prepared A3 size charts to enable the navigator to take bearings and plot a course or fix a position from the cockpit – without having to leave the helm. Precise instructions coupled with clear illustrations will enable the practical sailor to make the chart board and appreciate its benefits.

The book covers planning and preparing coastal passages, chartwork, sailing in confined waters, navigating in bad visibility, night sailing and practical guidance on basic methods of navigation. Whilst an accurate compass, good charts, a log and a chronometer provide the bare essentials, the author's assessment of electronic navigational aids is very helpful in pointing out the value and shortcomings of various devices.

Whether you decide to make use of the chart board and pantograph design, or simply follow the practical and sound advice on coastal navigation, this book will be of great benefit to the small-cruiser skipper in providing guidance for safe and enjoyable cruising.

The Author

Born in 1919, R. M. Tetley was educated at the Dragon School, Oxford, then Haileybury and Sandhurst. He served an apprenticeship as a Boatbuilder/Shipwright and studied Naval Architecture but after World War II, finding restrictions on boating materials too severe to start business, he became a mechanical engineer. He later returned to tools in a boatyard in the South West until an accident forced him to leave, after which he became a civil servant working for the Royal Navy. He has many years of experience at sea behind him and has written numerous articles on sailing matters. Now retired and living in Cornwall, he devotes most of his time to writing.

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Equipment and Methods

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To Peg with my love and grateful thanks for her understanding and for putting up with me during a trying and difficult time G.

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1
Overcoming Time and Space Problems

Whether it be a 40,000 ton liner, a nuclear submarine, the Plymouth to Roscoff Ferry or a 22ft mini-cruiser, the navigator's primary problems are the same: where am I? What course or courses do I have to steer to get to where I want to be? The parallel does not quite end there because the basic equipment is the same despite all the modern electronic navigational aids available; it consists of a chart or charts, a compass, a log and a watch or clock. Here the parallel ends because aboard the first three types of vessel the space available to the navigator is greater than the whole deck area of a 22ft mini-cruiser, aboard which it is not possible to spread out a full-size chart with ease or comfort.

And so we come to the first of the very small cruiser navigator's problems – space, allied to which is time. Because this type of boat sails closer inshore than do her bigger sisters, there is usually less time available for the navigator to obtain a positive fix of his position, and to decide upon his next course of action. If you doubt this, try taking a round of angles, working out your position and any new course that may be necessary while you are steering the boat in a lumpy sea with a gusting wind and handling chart and instruments as well. Under these conditions time becomes very important. Remember also that you have only one hand with which to work on the chart, which is probably inconveniently folded so that the next mark on your course is on the underside. The chart will have to be refolded, and the crease smoothed out. In addition there are parallel rulers, one-handed dividers, pencils and so on to be controlled. No, a life on the ocean wave for the mini-cruiser navigator is by no means easy, and time is of the essence. Added to this problem is the fact that the resultant fix and subsequent course may well be somewhat inaccurate since working like this does not lend itself to accuracy which is of prime importance in any form of navigation, particularly in such areas as the Little Russel Channel in the Channel Islands or the Thames Estuary.

Space is the second major problem in sailing small cruisers offshore. There is nowhere aboard such a boat where a full-size chart can be spread out satisfactorily. As a result, the navigator has to fold his chart – at best a bad practice which creases the chart and can be a thundering nuisance on some later occasion when one really does want to plot a course quickly and accurately on the part which is creased. For years I have struggled with this problem of space and, in an effort to solve it, have tried out many ideas – some my own, others from people faced with the same enigma. My most recent ideas appear to have struck gold in that they have resulted in my being able to carry a chart on my knees and work on it one-handed without everything sliding off onto the cockpit floor. But the achievement of this solution has entailed a great deal of hard work on both charts and equipment.

Having established that the main problems of a small boat navigator are those of time and space, I think that it may not come amiss here to examine in very broad detail how these may be overcome, and to look at some of the background which has led up to my present thinking. My original equipment, some fifty years ago aboard a 12ft dinghy, was an old Imray, Laurie, Norrie & Wilson chart of the River Blackwater in Essex and an old 1914–18 war army prismatic compass: I had yet to learn the importance of a reliable watch. Having, in my school Officer Training Corps, learnt something of map and compass work on land, I translated my knowledge to river pilotage, and with considerable help from my father began to understand something of the yacht and small boat navigator's work. Service in the army gave me additional experience of map and compass work and I was able to expand my knowledge of navigation through having to cover long distances over large areas of almost featureless desert on my own, and having to cross this type of country at night without lights. All this is very similar to having to find one's way over the sea; map and compass course again.

Since the end of the war, I have sailed aboard many boats and was navigator on a number of them. Some were nice roomy boats with a real navigator's 'office'. Some were smaller and one had to

be satisfied with a folding chart table over the navigator's bunk, or the saloon table. Smaller still and one had to fold the chart and use it on one's knees as best one could – a pursuit found to be pretty hopeless and not conducive to good results. With this experience behind me I began to bend my thought processes around this problem of space and in the fullness of time came to realise that, aboard very small cruisers, time was part of the same problem.

My first attempts to solve these two problems were directed towards creating space in some way. I very soon learnt that the old adage about quarts into pint pots was only too true. It is absolutely impossible to spread a chart anywhere aboard a small boat, where the maximum available space is only a foot or so more than the length of the chart – if that. My first attempt was to cut the charts in half and fold them round a sheet of thin plywood, but this had drawbacks; the piece of the chart which went round the edge of the ply was always, or so it seemed, just that bit which I needed for plotting a fix or Estimated Position. Also, it did not solve the problem of one-handed navigation when, as frequently happened, I was also the helmsman – navigators *per se* being a luxury known only aboard larger boats. Gradually I came to realise that not only were there the problems of time and space to be solved, but the solution had to be one which included simplicity. The simpler the equipment and methods, the easier the navigator's task would be.

At about this time I really came to appreciate, to a much greater extent than before, the qualities of the special yachting charts published by Stanford Maritime Ltd and Imray, Laurie, Norrie & Wilson Ltd, but not before I had tried my hand at reproducing charts to a suitable scale and size. Not being a hydrographic or cartographic draughtsman I found this to be too time-consuming and gave up. And then I came upon part of the answer; I would take the relevant yachting charts and cut them to a size which was suitable for use on a special chart board to be used on my knees. I decided upon dimensions which I thought were about right and started work. But the size was *not* right, it was still too large. Eventually I decided upon a standard A3 sheet which also had the advantage that, since I use traces of charts to make a record of courses sailed etc, it fitted standard-sized sheets of tracing film. The A3 size suits *me* very well; others may prefer the old Half Imperial size which is nearly as good.

I had solved the problem of space, but that of time remained. I was still trying to steer and navigate simultaneously, using one-handed dividers and a parallel rule. It was some time before I hit upon the idea of adding a pantograph to the chart board. This pantograph had to cover the entire area of the chart in use, and the straight edge had to be adjustable to all angles. Mark I was a failure. I had not been accurate enough in making it, and the locked straight edge wandered through two or three degrees between the top left-hand and bottom right-hand corners of the chart board. Mark II was an improvement, but was still inaccurate down the left-hand side, and was subjected to too much strain at the top left-hand corner. I overcame this by making a longer chart board which gave a wide margin on the left-hand side. This was Mark III, and a description of it, and of the Mark V pantograph, is given in the next chapter.

While I was experimenting with chart boards and pantographs, I was also getting suggestions and tips regarding permanent additions to charts which could result in a saving of time. From a Junior Offshore Group (JOG) navigator I learnt to draw compass roses round Marine Radio and some coastal aero beacons. This done, I found that all that was necessary, having obtained a bearing on a beacon, was to draw the back bearing from it. The saving of time which resulted from doing this was well worth that spent drawing the compass roses. A continuation of this was to draw compass roses round useful lighthouses, lightships and Lanbys. It should be obvious that these compass roses must be drawn accurately, and the method I have used is to fix the chart on the drawing board, having positioned it accurately with a T square and set square. To set up, place the set square against the T square with its vertical edge facing the left-hand edge of the drawing board. Move the chart, carefully so as not to disturb the T and set squares, until the vertical side of the latter corresponds exactly with True North on an existing compass rose or the left-hand margin of the chart. Fix the chart to the drawing board without moving anything. It is now correctly orientated to True North on the board.

Take a pair of pencil bows and draw a circle using beacon, lighthouse or whatever as centre. This circle should have a radius of about 5cm, or whatever is suitable to prevent interlocking with another rose. With a protractor, mark in Magnetic North and

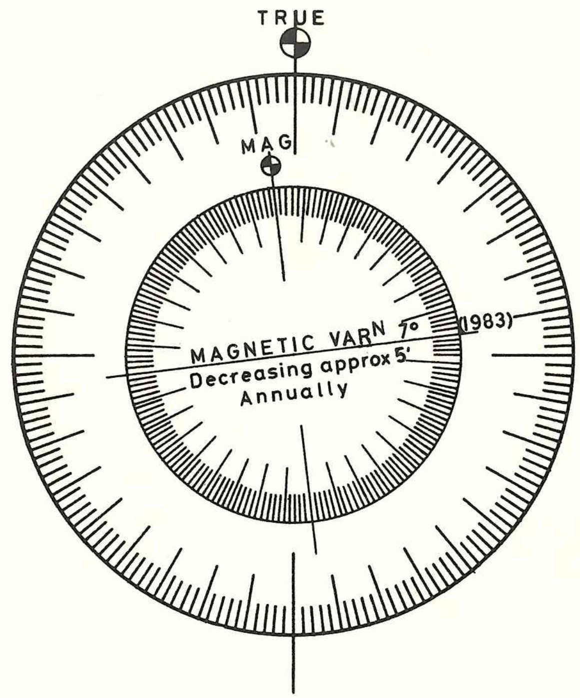

Fig 1

draw in this line. Mark in and draw the East–West line at 90° from the Magnetic North–South line. Draw another circle with a radius of 35mm and a third with a radius of 32mm. The outer circumference will give the length of the 2° graduations, and the inner that of the 10° graduations. With the protractor mark off all the 10° divisions, and draw these in in Indian ink. Do likewise for the 2° graduations, and except for adding the figures for the 10° divisions, the compass rose is complete, see Fig 1.

If it should be felt to be helpful, a True North compass rose could be drawn outside the magnetic rose, but I have found that this clutters up the chart too much and in any case a very simple addition or subtraction sum will convert a Magnetic bearing to a True one. Since Magnetic Variation only changes at the rate of about 5–8′ annually, and accurate steering aboard a small boat is seldom better than about 3°, a chart marked in this way will last for a number of years. If it is necessary to make any alterations to the charts as a result of the Admiralty Notices to Mariners, these

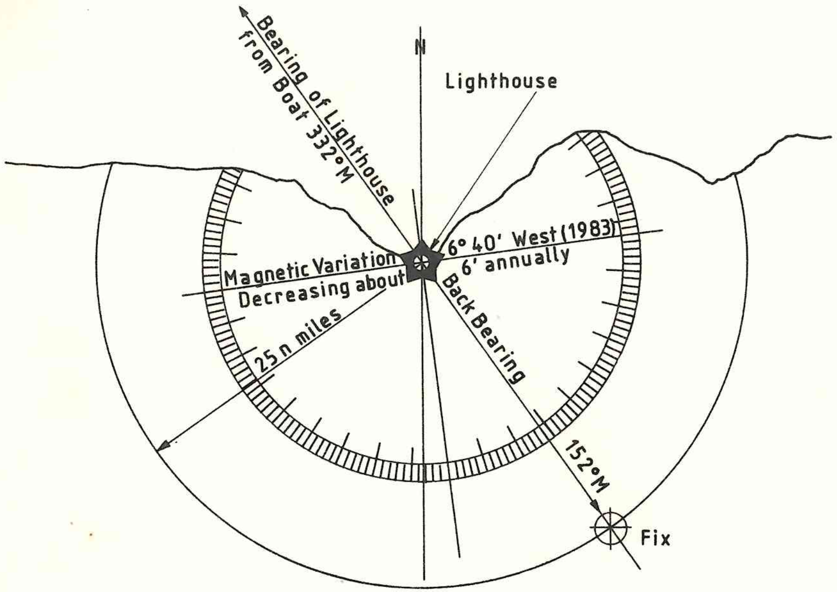

Fig 2

can be done on the Fablon covering of the chart in a self-etching mauve ink. By doing this the chart will only cease to be of use when it has worn out or faded.

In addition to the compass roses round lighthouses and lightships, I add a circle, or segment thereof, showing the maximum range of visibility of the light, allowing for my own height of eye. At night, when a known light lifts over the horizon, all that is necessary is to take a bearing on it, convert this to a back bearing (which will be explained later), mark it off on the maximum visibility radius, and lo, we have a fix, see Fig 2. There may be those who query the necessity of the outer True North compass rose, thinking that the inner Magnetic North ring should suffice. True bearings are sometimes needed, and it is occasionally necessary to convert from Magnetic to True; a dual rose saves a deal of time when this is a matter of urgency.

All the charts can now be cut to the standard A3, or Half Imperial size, irrespective of scale, since they are to be used in conjunction with the Mark V chart board. As each one is cut, a new top or bottom or vertical margin scale must be made for it since each chartlet has to be a complete unit in itself. Fig 3 shows

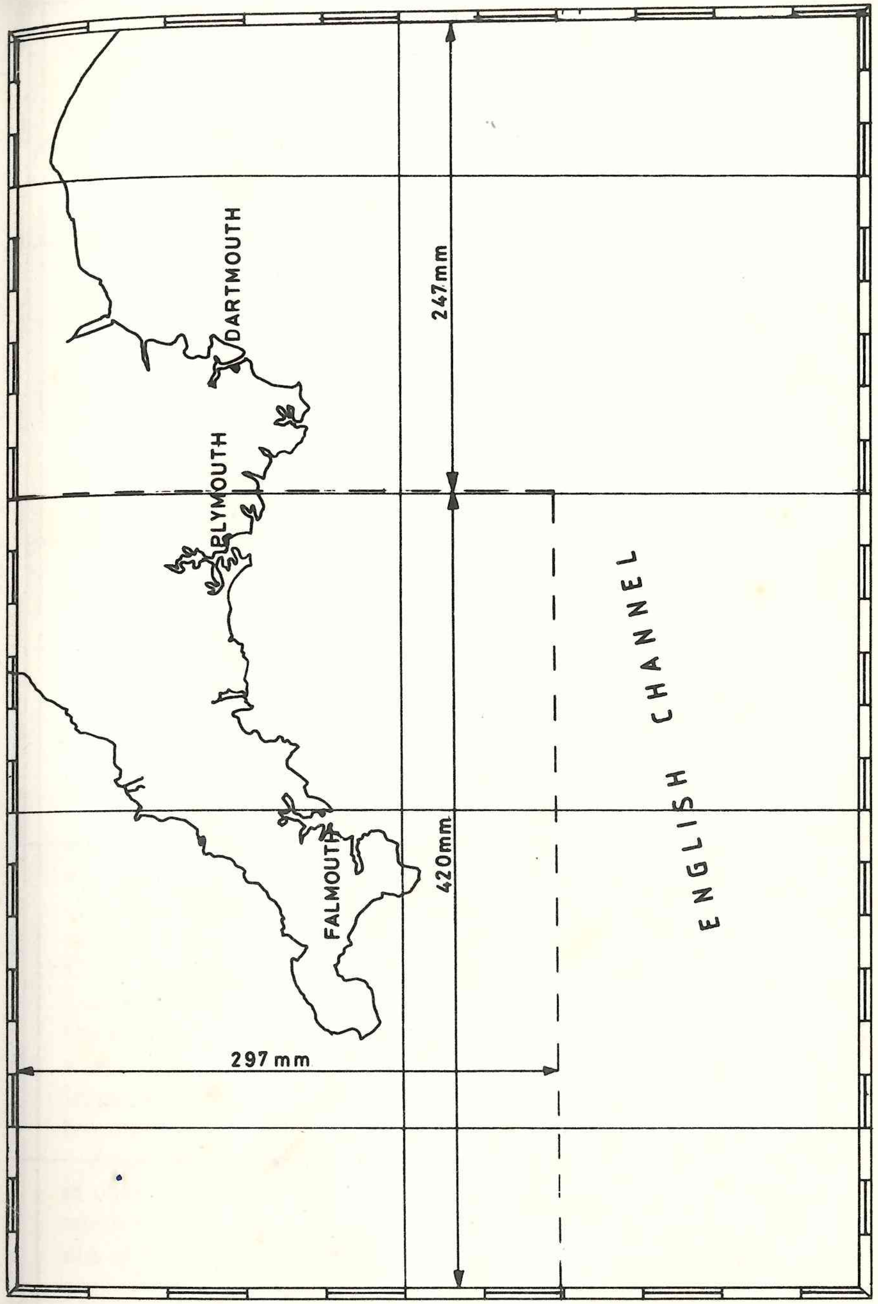

Fig 3

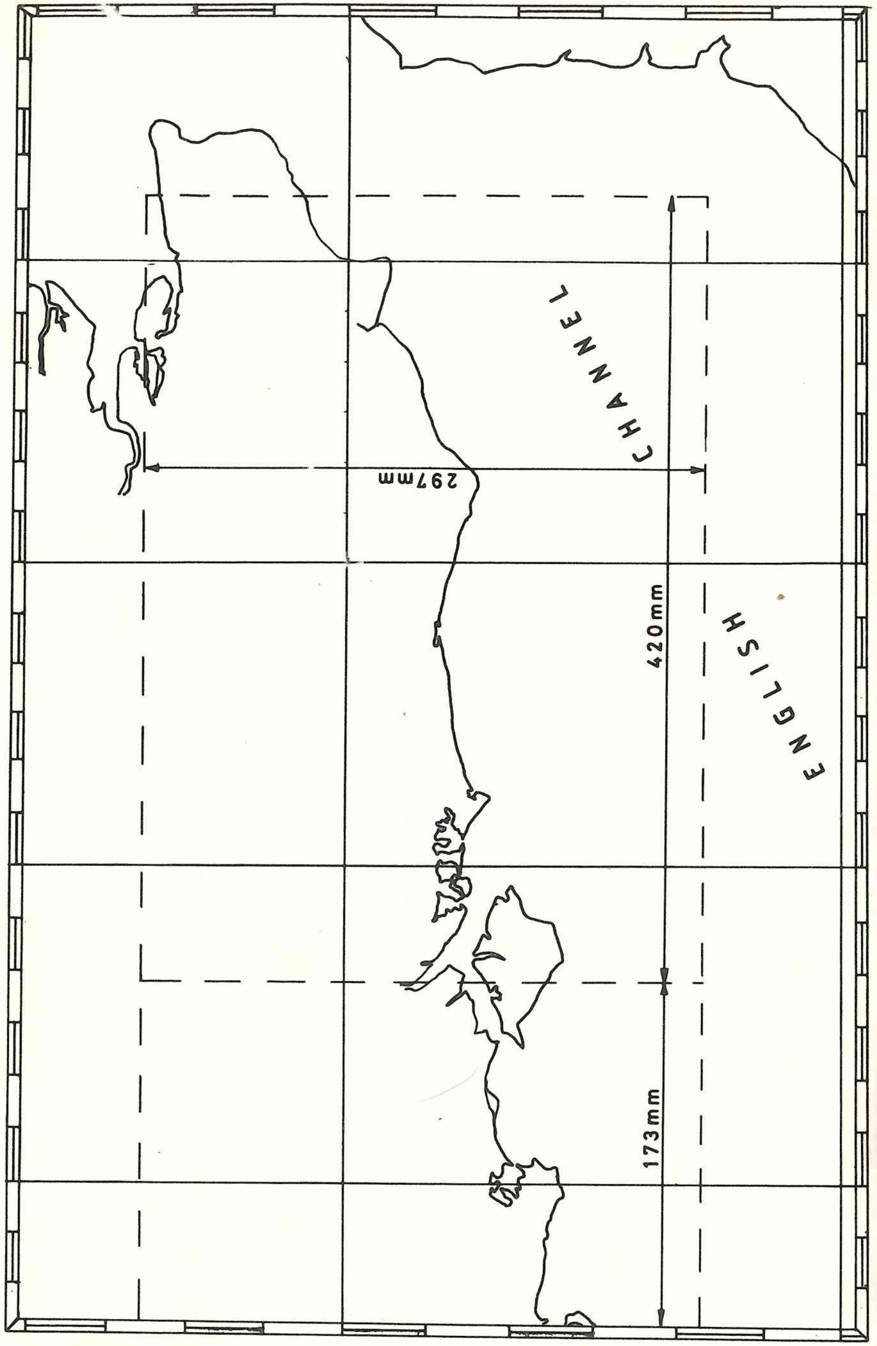

Fig 4

how the charts are dissected. Each portion is cut exactly to the required dimensions (420×297mm for A3, and 813×381mm for Half Imperial). No charts that I have met are exact multiples of the ISO 'A' Series so some of the A3 size charts have to be made up from adjacent sheets. This can produce problems, since such charts are not always to the same scale. If they are, draw a line on the next chart which coincides *exactly* with the edge of the previous one. This line *must* be True North and South – or True East and West if the charts are being prepared to cover the East or West coasts. Measure across the width of the remainder of the previous chart, and then measure across the new chart the balance needed to make up the correct A3 dimensions, see Figs 3 and 4. After the new chart portion has been cut and the new margin scale added, the two sections should make up one A3 size chart with no hiccups or misalignments where the two pieces join. When the two portions have been joined together, the cut line should be virtually invisible. As mentioned above, the trouble comes when the two adjacent charts are not to the same scale. The best way to deal with this is to end the first set of A3 charts with one which is smaller than the rest and start a new set to the new scale.

There are areas where the coast makes a change of direction of sufficient magnitude to produce problems. One of these is in the area of the Straits of Dover, another is round Land's End. Because my main chart folio begins at 50° 50′N, and 6° 35′W, I have no problems with the latter, but the Straits of Dover – although outside my normal cruising area – did present problems. I overcame these by having two cut lines, one East and West through the parallel of 51° 40′N and the other North and South along the meridian of 2° 34′W. This chart is cut from Admiralty Chart Number 1958 and is the only Admiralty Chart in my South Coast folio of passage-making charts. The next chart starts just to the north of Ramsgate, and covers the Thames Estuary. Should I want to go into one of the East Coast rivers, I change over to Imray's 'Y' Series or Stanford's Number C1. All these charts are trimmed to the A3 size for the East Coast folio.

At this stage I can almost hear readers asking how the two pieces of chart are joined together to make one A3 chart. The method I use involves waterproofing the charts at the same time with the aid of transparent Fablon. The method is simple, but requires care if the finished product is to be accurate. One sheet of the

Fablon is cut some 15mm larger all round than the chart. Since an A3 size sheet is 420×297mm and I like to have a plain white left-hand margin 150mm wide, if we now add 15mm all round we have the size to which to cut the Fablon: namely 600×327mm. A second sheet of Fablon is cut exactly the same size as the chart plus margin, ie 570×297mm. I use an old Imperial size drawing board to which is fixed a sheet of white cartridge paper. On this are drawn two rectangles corresponding exactly to the size of the Fablon sheets. Using double-sided adhesive tape, the smaller sheet of Fablon is fixed down on the drawing board over the larger rectangle, *sticky side up*. The chart is now put VERY CAREFULLY over the smaller rectangle, *face upwards*. Of course, where two parts of a chart have to be joined together, one part is fixed first, followed by the second after the mating edges have been very carefully married so that the joint is perfect. The chart is not laid flat on to the Fablon, but is rolled on so as to eliminate any air bubbles. These are worked out with a firm soft cloth which is also used to remove unwanted wrinkles.

When the chart has been fixed down onto the backing, add the 150mm wide strip of white paper on the left-hand side, not forgetting to add a margin scale to the edge of the chart should this be required. This done, the next job is to trim the Fablon exactly to the correct size (570×297mm). For this I find that a sharp model-maker's knife is ideal, used in conjunction with a steel straight edge. I place the chart face up on a sheet of thin chipboard, and press down very hard on the steel straight edge when cutting. When trimmed, the edges are absolutely true, which besides looking neat makes the next part of the job a great deal easier. The second, larger, sheet of Fablon (600×327mm) is now very carefully rolled on to the face of the chart, sticky side down, at the same time working out the wrinkles and air bubbles and keeping the edges along the lines of the larger rectangle. A vitally important factor in applying this second sheet of Fablon is that it is a once-only job, because if the Fablon is pulled away from the chart, it will take part of the printed surface with it since the adhesive is very strong.

After successfully sticking the second sheet of Fablon down onto the chart, the corners of the former are cut away, each one at an angle of 45° as in Fig 5(i). The edges of the Fablon are folded over to the back so that their ends form a perfect mitre seam, Fig 5(ii).

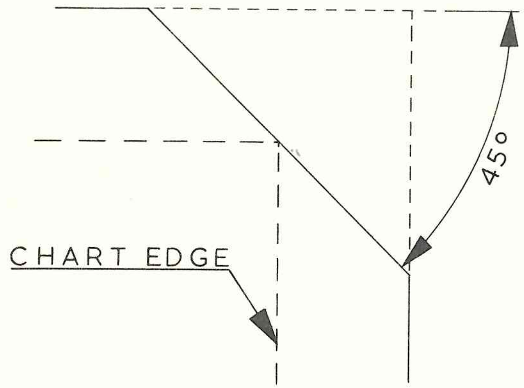

Fig 5(i)

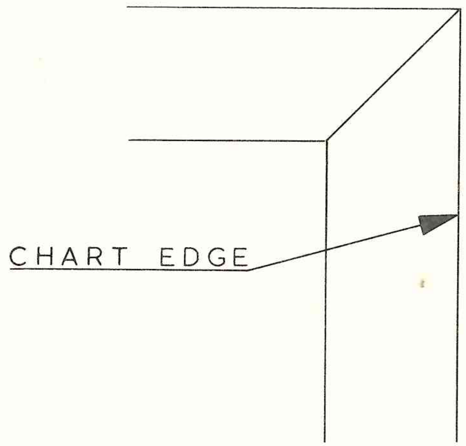

Fig 5(ii)

The waterproofing of the sheet is now complete. The need for care in every part of this operation cannot be too strongly stressed since the accuracy of the finished article is of paramount importance.

Before leaving the subject of waterproofing charts, I want to say something about those charts which are folded when bought. Many yachting charts and all Admiralty Charts are flat or rolled when purchased, but others can only be bought folded. If one tries to stick Fablon or other self-adhesive transparent film onto a folded chart, the chances are that air will become trapped in the region of the folds, and in some way unknown to me moisture finds its way in and eventually turns that part of the chart brown and spoils it. The most effective method I have found for dealing with this is to iron out the creases before commencing the waterproofing operation; this is my method of doing it. I take a sheet of plywood and lay it on a table, and on to it I put one thickness of an old cotton sheet. I lay the chart *face down* on the board, and place a piece of damp blotting paper over the area of a crease, then proceed to press it with a hot iron using lots of pressure. I lift the blotting paper periodically to check on progress, and when all trace of the fold has disappeared I move on to the next crease. It is MOST IMPORTANT that the blotting paper should be damp, not wet, since wetness could well distort the face of the chart. I personally do this ironing just before putting the chart on to the Fablon backing, while some people iron out the creases before cutting the chart; both methods seem equally effective. Treating the charts in this way stops air pockets forming, and so prevents moisture from spoiling them.

Let us now look at charts in some detail. We can then work out the pros and cons of each type, of which there are three published in the United Kingdom. Admiralty Charts by the Hydrographic Office, Stanford's Coloured Charts for Coastal Navigators by Barnacle Marine Ltd and Imray, Laurie, Norrie & Wilson's 'C' and 'Y' series charts. Apart from being used for passage planning, I think that most small boat owners would agree that the majority of Admiralty Charts contain too much information, most of which is of interest to big ships only. This is not to decry them – far from it, they are the finest charts in the world – but they are just too much for the very small boat man who wants to obtain his information quickly. The Hydrographic Department are now producing charts for yachtsmen, and when they have produced a complete series I shall probably be among the first to get a set. The Admiralty Harbour Charts are of great value and, now that many of the smaller harbours are being included, it is worth making up a Harbour Chart folio for a cruising area.

I use a full-size set of Admiralty Charts to a small scale for doing all the 'dirty' work of passage planning in the early preparatory stages of a cruise so that I can draw, erase and redraw to my heart's content without making a mess of my actual navigating charts, and when I have finished planning I can erase all the markings and clean the surface with breadcrumbs, ready for use the next time.

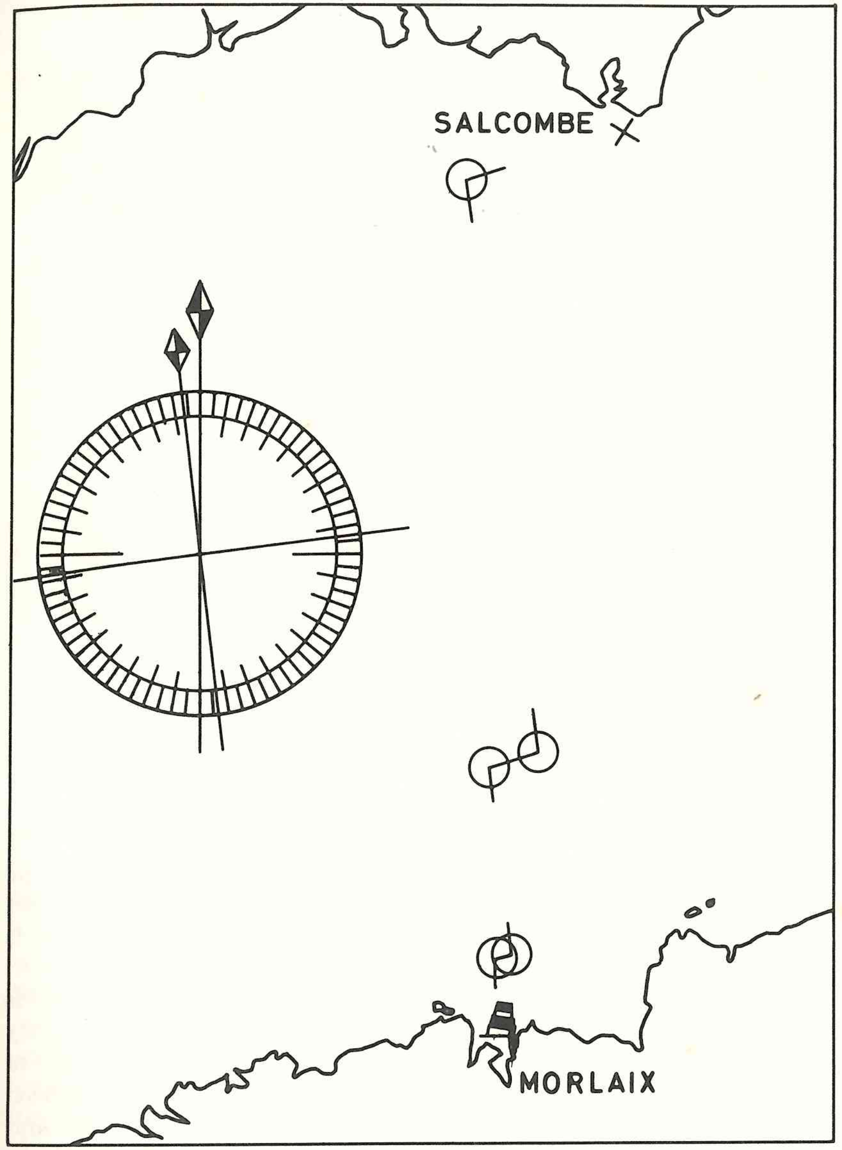

Fig 6

As an example of what I mean, when planning a windward passage from, say, Salcombe to Morlaix in North Brittany, I can work out a preliminary scheme of tacks along the plotted course, modifying where necessary, and when I am satisfied with the results I transfer the final details to traces which I can use as masters for my passage charts. This involves marking down each point at which I propose to tack, and where I intend changing from equal tacks to a long leg and a short, should this become necessary. See Fig 6, where each tack is marked, and the geographical position is entered in my navigation notebook.

Although outside my normal cruising area, there is one large-scale Admiralty Chart which I do have, and this is of the Straits of Dover. Such are the problems attendant upon crossing the traffic lanes in this area that I have found it vital to plot my actual course over the ground at frequent intervals so as to be able to make course corrections to allow for the vagaries of wind and tide which can affect the actual course sailed. Failure to obey traffic lane regulations could cost thousands of pounds and, I would add, there is no appeal against the findings of the court which imposes the fine.

My passage-making charts are all kept in folios which relate to particular cruising areas, and are a mixture of Stanford's and Imray's charts. In actual fact I have a complete set of each for the South Coast but, in the light of experience, and as a result of personal preference, I have found that a mixture provides the best coverage. It is interesting that, in my South Coast folio, each type is equally represented. I think that this shows what an excellent standard both publishers have achieved, especially so when it is realised that the second-string folio is virtually as good as the first. Both Imray and Stanford have published their coloured charts for yachtsmen for a long time, and as the years have passed they have benefited from previous experience so that the quality of their charts improves steadily year by year. The colouring is used to differentiate between land, drying mud or sand, and water, and to show the underwater contours which are most likely to be of interest to yachtsmen. Some Admiralty Charts are coloured, but as I have said before their accent is on big ships. The Harbour Plans are all coloured, and are of value to large and small alike. I think that I now have a complete set of the South Coast Harbour Plans; in many, nothing larger than a small trawler could enter,

but for the small boat cruising man they are invaluable. Both Stanford and Imray produce Harbour Plans as insets on their main charts, and on their passage-making charts they frequently give large-scale inserts of difficult routes. One item I like on the Stanford charts is the harbour information which is printed on the backs of the sheets. Had it not been for the large-scale inserts and the added information on the back of Stanford's Coloured Chart No 13, I do not think that I would ever have undertaken the entrances of the rivers Erme and Avon in Devonshire.

We now come to some rather special charts, at least as far as sailing men on this side of the Channel are concerned; these are the *Cartes Guides de Navigation Cotière* (CGNC) published by Éditions Cartographiques Maritimes. They give complete coverage of the French Channel, Atlantic and Mediterranean coasts, and as far as I have been able to find out are all to the same scale of 1:50,000. They may seem a bit strange to our eyes, being used to the British style of chart, but as one grows accustomed to the presentation their value becomes apparent. As I understand it, movements are afoot to standardise conventional signs on charts throughout the world, but I have a feeling that it may be some time before this comes to pass.

The signs on the CGNC charts are more or less self-explanatory, and one idea in particular which I like very much is the way in which lighthouse information is imparted. There is no need to stare, possibly in bad light, trying to decipher the small print giving the characteristic signal and range of a lighthouse. This is shown as an arc of a circle which is divided up into white and coloured spaces representing the colour and duration of the flash, and the duration of dark. Round the circumference of this arc is printed, in large clear letters, the maximum range of the light's visibility. For every harbour there is shown the safe course or courses for entry, as well as the safest course through a difficult passage. Although printed on thinner paper than British charts the CGNC charts are waterproofed, but can still be drawn on. Although, in spite of their thinness, they are claimed to be tear-resistant – a big advance on their predecessors of ten years ago which were very flimsy and tore all too easily – they need more careful handling than the British ones if they are to last any length of time; in addition to their coastal charts, Éditions Cartographiques Maritimes publish very good Tidal Charts for the English Channel, Radio Signal Charts for all three French coasts and, above all, some really excellent maps and charts of the French Inland Waterways. There is a series of fourteen of these entitled *Cartes Guides Fluviales*, and for anyone contemplating an inland voyage through France they are ideal. I would add that they are printed in French, German and English, while the *Cartes Guides Cotières* give their information in four languages.

2
Chart Board and Pantograph Construction

The Mark V chart board itself (shown in finished form in Fig 7) is, in essence, a sheet of plywood 600×300×12mm thick. My first chart boards were made from marine-grade plywood, but only because I had some handy in the workshop. The Mark V board is made from WBP grade, and is, in fact, 13mm thick, but in every way I have found it to be perfectly adequate. My early boards were made from $\frac{3}{8}$in material but I found that this bent under certain circumstances. Consequently I have made my present board from the thicker ply which, after thorough testing, has proved to be rigid enough and the added weight has given better stability when balanced on my knees. In addition to the plywood, the Mark V board has an all-round edging of 12·5mm wide iroko (this could be mahogany); again, I happened to have some handy.

The plywood is cut, planed and sandpapered to the required dimensions, as is the edging. Two lengths of the edging are cut measuring 625mm, and another two to a length of 325mm. Mitres are cut and fitted at all the ends, and the edging is then glued and pinned to the plywood as shown in Fig 7. Use a good quality resin glue such as Cascamite or Aerolite 300, in conjunction with *brass* panel pins. Steel ones react with the acid hardeners which cause stains in the timber; in addition, should moisture penetrate the wood the pins could rust and again cause unsightly stains. For these reasons it really is not worth saving the odd penny by buying the slightly cheaper steel panel pins.

When the glue fixing the edging has set, the whole board should be sanded down, greater care being taken on the working face of the board since, when using thin paper charts such as the CGNC, grain in the timber could cause problems when working on the

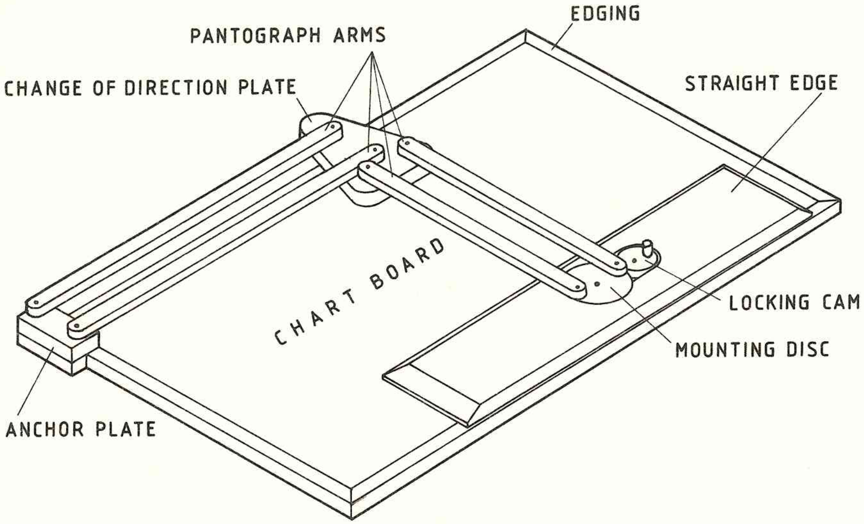

Fig 7

chart. On my present board I rubbed down first with medium two sandpaper, but one could just as easily use a medium-grit garnet paper. Because different people prefer different finishes it is a matter of preference whether the board is finished with paint or with varnish. Mine is painted a very pale duck-egg green. I first applied two coats of metallic pink primer, giving a light dry rub-down between coats using a fine-grade sandpaper. The primer was followed by four coats of white undercoat with a wet rub-down between coats using a fine-grit wet-and-dry paper. Because I had previously found that a full gloss finish was too shiny, I used a fifty-fifty mixture of undercoat and gloss for finishing. This has given a semi-matt effect which is exactly right for the job. If a varnished finish is preferred, I recommend that the last coat be flattened down with pumice powder and soft soap or a cutting-in wet-and-dry paper used wet. To finish I would use a lamb's wool bonnet on a sanding disc fitted to an electric hand drill. Finally, to prevent the board slipping off my knees, I glued some 6mm thick rubber foam onto the underside with Evo-Stick.

The Mark V chart board being now complete, work can start on the parts of the pantograph. These consist of an anchoring plate, four pantograph arms, a change of direction plate and an

adjustable straight edge. As to materials, aluminium – unless a salt-water-resisting quality is obtained – corrodes too easily whilst stainless steel and brass are too heavy. There are two satisfactory materials: Perspex and good quality hardwood. I have used both Perspex and iroko for the arms, and have found both to be entirely satisfactory. I have a suspicion that Perspex could bend a bit unless the thickness of the section were to be slightly greater than that of the timber arms. If one wants to use Perspex, the parts can be made in the same way as the timber ones except that I use a super glue instead of a resin timber glue. However, acetone acts as a very good glue for Perspex, and two pieces can be cemented face to face without any loss of transparency.

One of my present Mark V pantographs is made up throughout of mahogany, including the adjustable straight edge. The anchor plate is made up from two pieces glued together as shown in Fig 9. The arms and change-of-direction disc can be made from iroko, teak or mahogany if timber is to be used, and for the plastic laminate one could use Warerite instead of Formica. The performance of all these materials is completely satisfactory since all have been tried out at one time or another. Apart from having

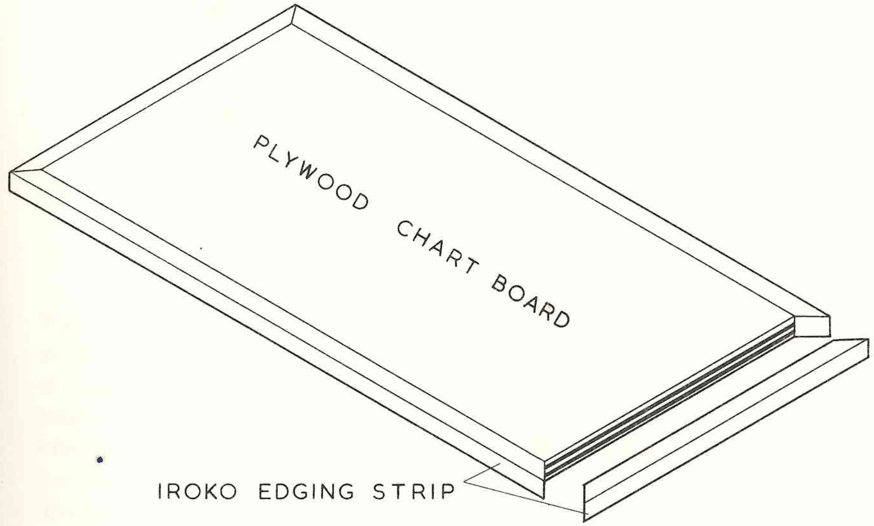

Fig 8

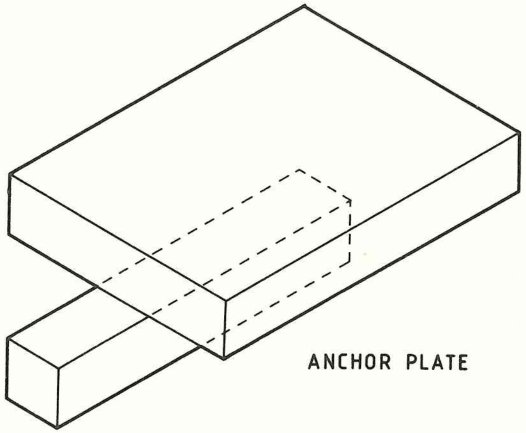

Fig 9

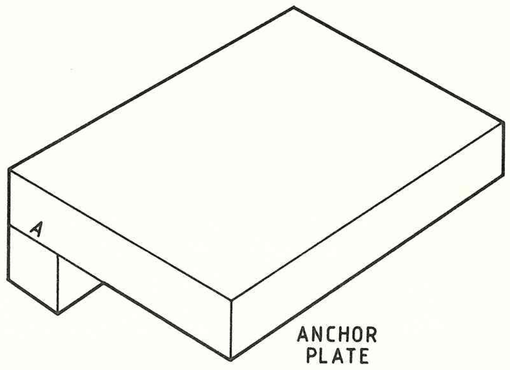

Fig 10

to drill all the holes very accurately, the whole assembly is very simple to make. Where the anchor plate is concerned, joint A in Fig 10 should be glued with either Cascamite or Aerolite 300. To glue the plastic laminate to the wood I used Evo-Stick which has stood up to the elements as well as anything I have ever tried. Super glue *can* be used for this, but I feel that it is a rather expensive way of doing it. I find that the laminate manufacturers recommend a latex-based adhesive, as do all the do-it-yourself experts in books and periodicals. The anchor plate is drilled and

countersunk to take four 8-gauge countersunk-head screws for fixing it to the chart board; alternatively this could be glued in position, but once done it cannot be removed. Two 1mm holes are accurately drilled for the horizontal arm pivots which are round-headed brass wood screws.

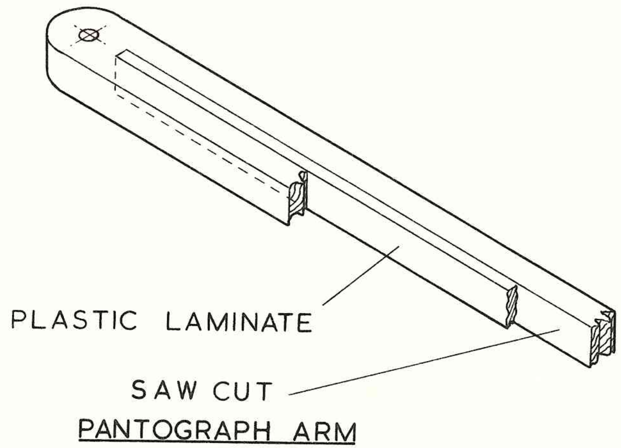

Fig 11

The horizontal arms are made from iroko or mahogany to which is glued plastic laminate, but not before a stiffener from the same material has been inserted. To do this, make a saw cut with a coping saw along the arm, leaving a short piece at either end to allow for drilling the pivot holes. After making the saw cuts, clean up the two faces with medium-grit paper, and glue in the inserts. Fig 11 shows the saw cut and the plastic laminate insert. When the glue has set, the top and bottom surfaces of the arms are sanded down and a strip of Formica or Warerite is glued to each. To produce the desired strong connection between the inserts and the top and bottom covers of the arms, I used super glue along the top and bottom edges of the insert, and Evo-Stick on the remainder. The complete assembly now has a plastic laminate 'I' beam as shown in Fig 12, to provide longitudinal rigidity without adding too much weight.

All that is necessary to complete the arms is to drill the holes for the pivots. I come now to what is probably the most difficult part of making the pantograph. All the pivot holes must be drilled to within standard engineering tolerances between centres, and to prescribed limits for hole sizes. These tolerances and limits are far tighter than most do-it-yourself enthusiasts can manage, but if the completed equipment is to be to the required level of accuracy,

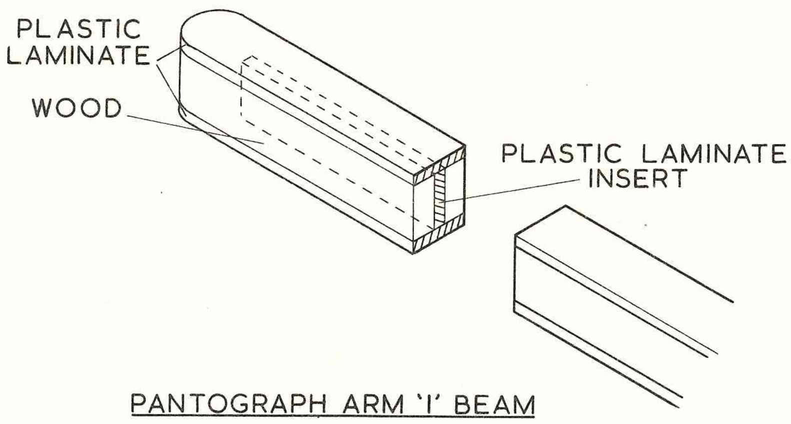

Fig 12

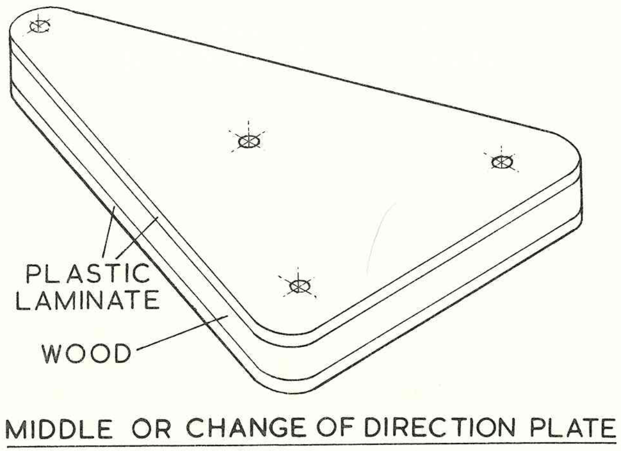

Fig 13

they must be adhered to, or the straight edge of the pantograph will wander through one or more degrees on any bearing, which is obviously totally unacceptable. As for the holes themselves, they must, as I have already said, be drilled to accurate limits so that there is only sufficient clearance round the screws for the arms to move smoothly on the pivots. The amount of clearance for these holes is decided by the size of the pivot screws being used. Again, unless one has a well-equipped workshop, these limits will be found to be almost impossible to meet. Therefore, when the time comes to do the drilling, the best way to overcome the problem is to take everything along to a good, reputable firm of mechanical engineers or toolmakers. Since I was not equipped to cope with these close limits and tolerances, I went to a firm of toolmakers I knew and got them to make me a drilling jig so that I could drill to the required tolerances between centres, and to prescribed limits for the hole sizes. In the latter case I bought some rather expensive drills which meant that I could drill exactly to the size I wanted. In this way, since I had more than one pantograph to make up, I could guarantee that the desired level of accuracy was always maintained.

The middle, or change-of-direction disc, is made from a piece of iroko with plastic laminate on both faces. The easiest way to make it is to glue the laminate onto the wood before cutting out the shape which, when finished, should be as in Fig 13. Four pivot pins are fitted to this, and the tolerances on dimensions are to be to the same accuracy as for the arms as described in the previous paragraph. The complete assembly of anchor plate, change-of-direction plate and mounting disc is shown as an isometric perspective in Fig 14.

The straight edge, the assembly of which is shown in Fig 23 on page 42, is somewhat more complicated to make, but should be well within the capabilities of anyone who can use tools fairly competently. The assembly can be made from either timber or Perspex. I have to admit that I sometimes experience difficulty in seeing the edge of a Perspex straight edge at night, but this may well be attributable to my poor eyesight and the fact that I use a red chart light so as not to spoil my night vision. As I have not yet met anyone else who has experienced the same difficulty, I intend to describe both types although there is no great difference between the two. My straight edge is made of mahogany, well-

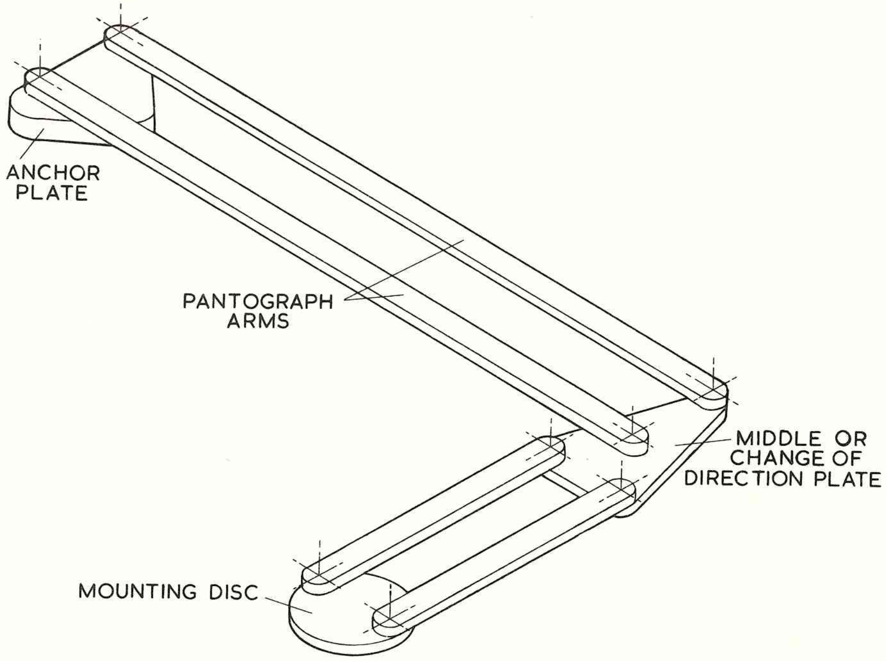

Fig 14

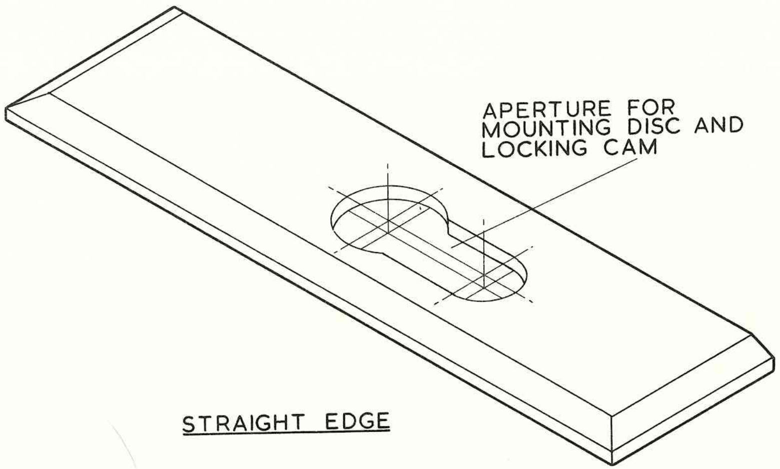

Fig 15

seasoned Honduras for freedom from warping or twisting. Also, since Honduras mahogany does not have the interlocked grain of the so-called West African mahoganies, it is very much easier to work. If Honduras mahogany is not available I would suggest teak or iroko as the next best, but be sure that the latter is brown and not yellow as yellow iroko has not been fully seasoned, and so could twist or warp.

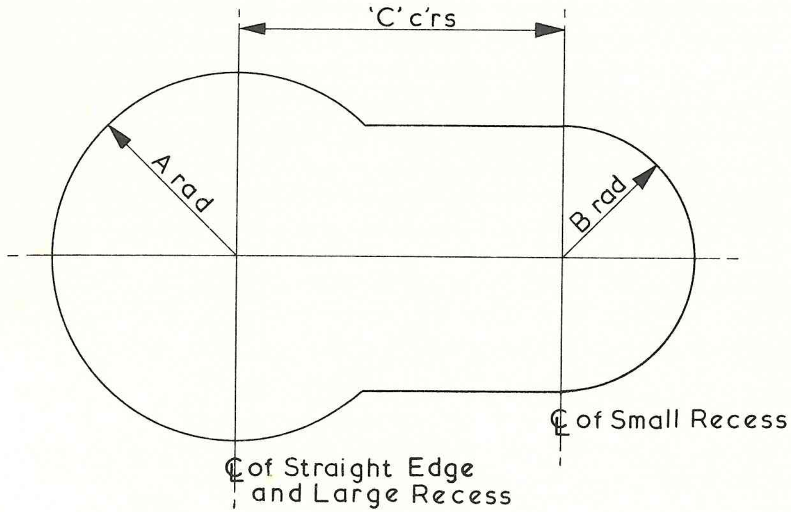

Fig 16

After cutting out the straight edge from a piece 8mm thick, the apertures for the mounting disc and locking cam have to be marked out. As can be seen in Fig 15, this aperture is more or less keyhole shaped. To mark it out, first find the exact centre of the straight edge, which is also the centre of the mounting disc, and draw a circle (radius A) on this centre. Another point (distance C) is marked along the longitudinal centre line, and a circle of smaller radius (radius B) than the first is drawn. Tangents from the smaller circle are drawn parallel to the longitudinal centre line, and these cut the larger circle as shown in Fig 16.

There are two methods of cutting the aperture; first by using a side-and-end-cutting milling cutter in a woodworker's router, or in an electric hand drill. This method requires some care, and the best way is to fix the electric drill into a drill stand, and the work into a clamp firmly fixed down on to the base of the drill stand. The trouble with a routing machine is that it requires a very steady hand and experience in use. Having fitted up the drill and workpiece, very carefully cut the smaller circle by cutting down on to the top tangent line to the depth of the locking cam, and then move the work slowly and carefully to the left, making sure that the milling cutter does not go over the boundary line of the aperture. Eventually a point will be reached when the miller is cutting close to the circumference of the small circle. STOP! Now go back to the beginning and start cutting along the lower tangent line, and repeat until the circumference of the small circle is again reached. By careful manipulation of the cutter the spare that is left in the small circle can be removed. To cut out the large circle, start at point A in Fig 17, and cut round the circumference, taking

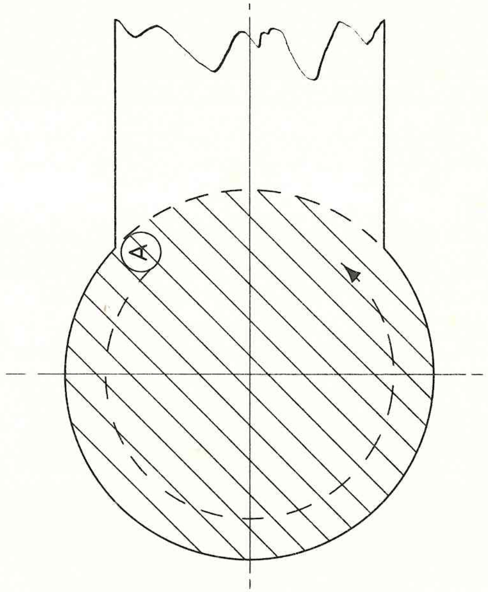

Fig 17

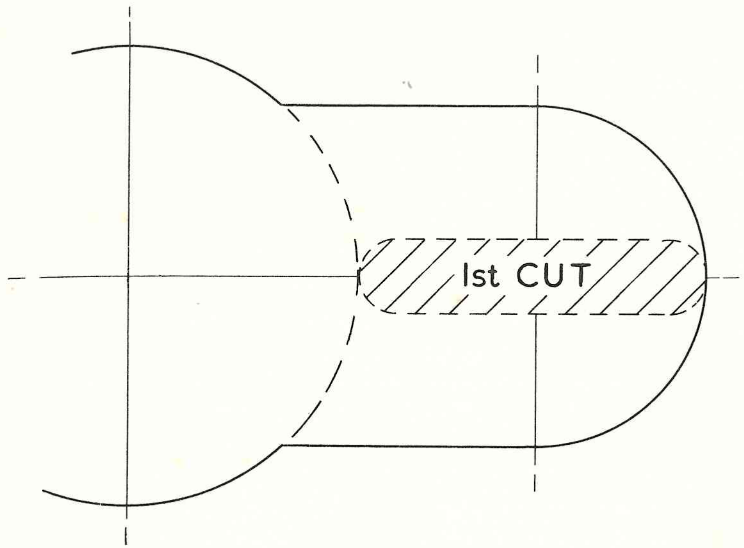

Fig 18(i)

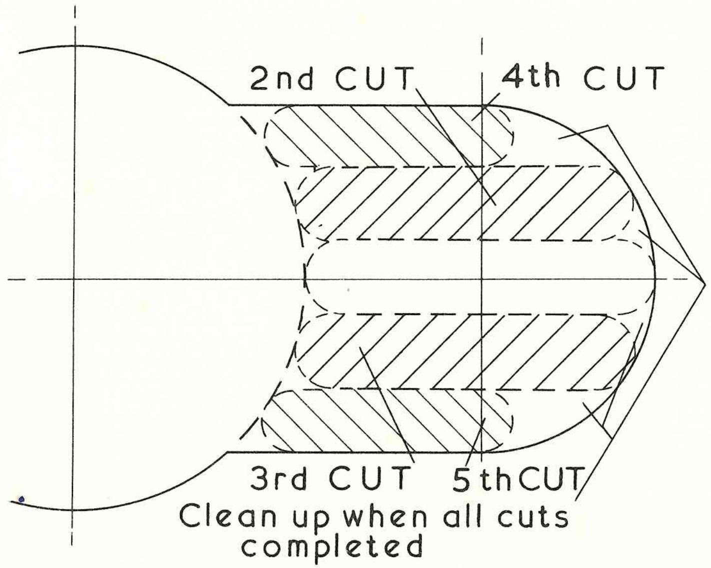

Fig 18(ii)

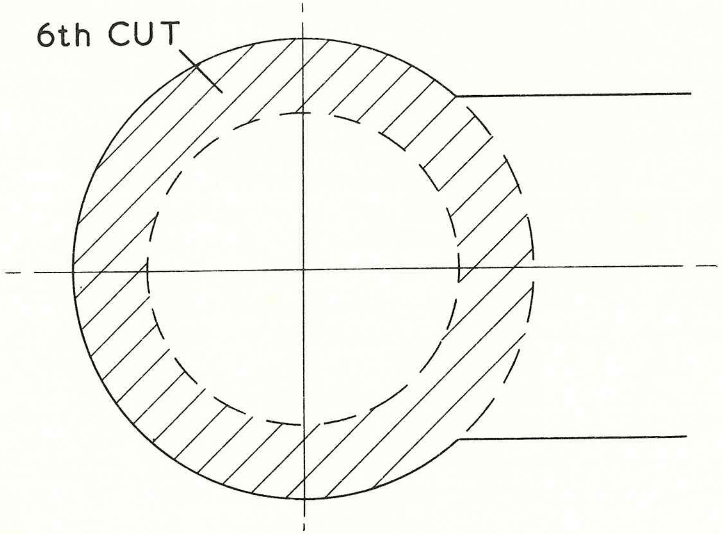

Fig 18(iii)

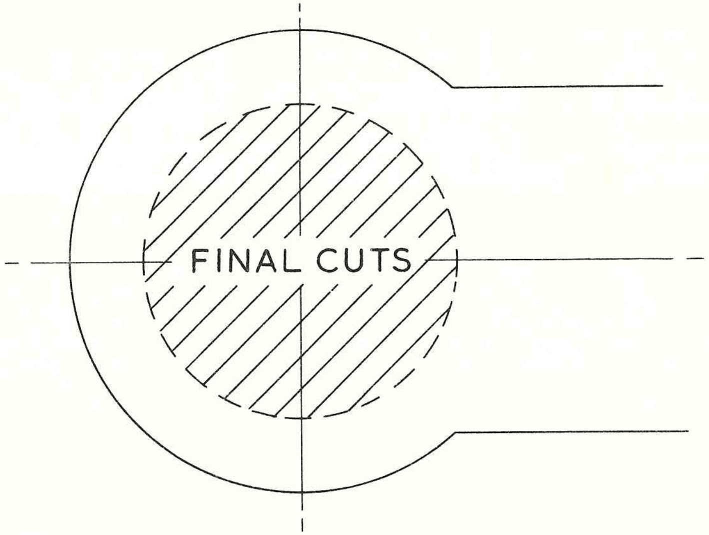

Fig 18(iv)

care not to go over the boundary line, until the whole circle has been cut out to the depth of the mounting disc. Any spare in the middle can now be removed; the aperture is complete and should not need any cleaning up if the job has been done carefully. These wood-milling cutters leave a very smooth finish when used correctly, and it is always better to go too slowly than too fast. The sequence for milling out this aperture is shown in Fig 18.

The second method of cutting out is more suitable for the do-it-yourself person, but it means that the original thickness of the straight edge material will have to be 5mm instead of 9mm. In fact, this helps to make the job a little easier as the tool to be used is a coping saw. It does take a bit longer, and is more tedious because the finished edge has to be cleaned up with a fine-cut, half-round file about 20cm long. This cleaning up has to be done very carefully as the edges have to finish square and true. A piece of 4mm plywood is now cut to the same shape as the straight edge. The two discs, the mounting disc and the cam, are cut to diameters 1mm less than those of the holes on the adjustable straight edge. These discs must be perfectly circular, and the sides must be finished square and as smooth as possible since they both have to rotate without hindrance. Some time after I made the

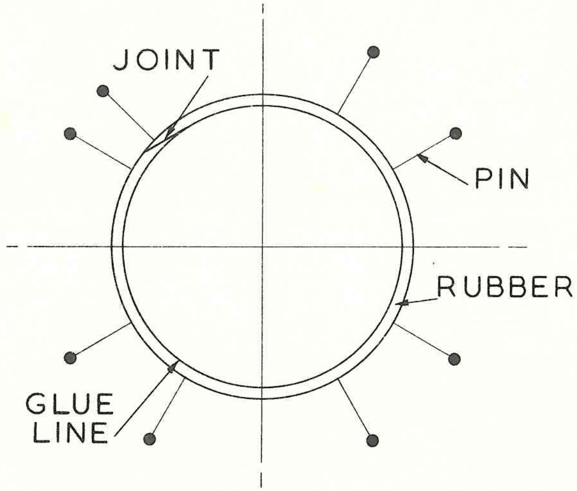

Fig 19

Mark V pantograph, I took out the locking cam and reduced it by just over 1mm on the diameter, and then stuck a slightly stretched rubber band to it. Afterwards I reassembled the whole thing and found that the modified cam worked very much better. Anyone wishing to copy this idea may find it a bit tricky to keep the rubber band in position while the glue is setting, since it is in tension and tries to slip off the edge of the disc. I held the band in position with about eight model-maker's pins as shown in Fig 19.

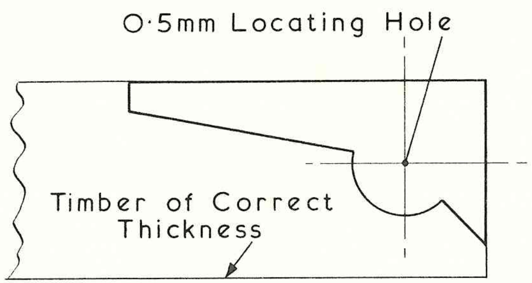

Fig 20

The next step in making up the adjustable straight edge is to make the 'ears' should these be needed. My first straight edge had them and I have to admit that I found them very useful when it came to drawing vertical or near vertical lines on a chart. However, they do add to the complexity of the job and to anyone who is not too sure about their skill of hand I would advise doing without them. The first thing to do is to draw out the 'ears' on to timber of the same thickness as the straight edge as shown in Fig 20. One is as shown, and the other is the same in reverse and if one has a small band saw both can be cut out together, and then one can be turned over. They must be very carefully cut out and equally carefully finished (a fine file is best). When they have been made, each 'ear' is placed accurately on the corner to which it is to be fitted, and its outline drawn with a fine-pointed pencil. A full circle is drawn to the same radius as the part circle on the 'ear', shown in Fig 21. This is where very considerable care has to be

taken, as the centres of the circles control the accurate continuation of the straight edge with the 'ears' in both positions. The way I achieved this accuracy was to locate the 'ears' exactly in position using a dial micrometer in two positions at right angles to one another, having first fixed the workpiece into the clamp on the drill stand. Then, having fitted a 0·5mm (0·0127in) drill into the drill chuck, I located this with the dial micrometer. The straight edge, 'ear' and drill thus aligned, the hole was drilled with the knowledge that when I came to put in the pivot pin, the 'ears' would be positioned exactly as they should, and the trueness of the ruling edge would be correct for both positions. I next put the piece of ply which I had cut out into position and, using the pilot hole already drilled, continued it on into the ply. The next part of the job was to cut out the circle in the straight edge. This again has to be done very carefully, and the cut edge remaining must be finished square and smooth with a fine half-round file.

The plywood base for the straight edge now has to be glued into position using a synthetic resin glue. Prior to drilling the pilot

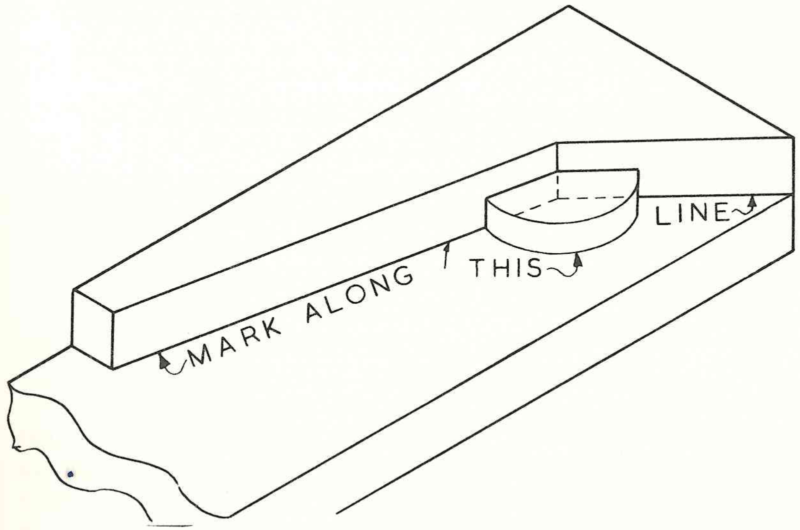

Fig 21

holes in the ply, it is most essential to use some locating pins, not less than three, so that when the gluing is taking place the ply will be accurately located in relation to the straight edge, and thus the pivot holes for the 'ears' will be correctly lined up. One other item requires careful attention; the 45° angles cut in the ends of the straight edge and on the 'ears' have to be individually fitted so that, in the vertical position, the drawing edge on the latter is at precisely 90° to the horizontal edge of the straight edge. I used a diemaker's file for this as it has a very fine cut, and one is able to make the most minute alterations, even in wood.

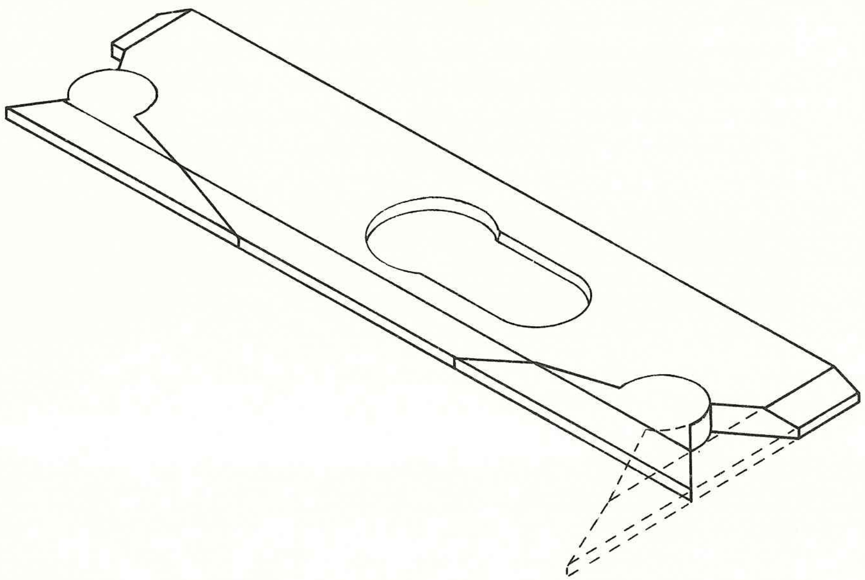

Fig 22

The pivot for the 'ears' is more effective if it is slightly larger than the other pivots because, as will be explained, it is subject to some tension. In order to hold the 'ears' in position, it is necessary to have a spring which maintains a tension in whichever position the 'ears' may be, and this spring must also be corrosion-proof. After some trial and considerable error, I found that the most

satisfactory material was the yachtsman's best friend: phosphor bronze. The final choice of spring was 6·5mm (0·25in) in diameter with seven turns of 0·711mm (22swg) diameter wire giving a rate of 1.9437kgf/cm or 4.2851bf/in. This spring is strong enough to hold the 'ears' in their correct position, but not so strong as to make it difficult to operate them when conditions aren't so good.

The methods I have described were the best I could think of to obtain the accuracy I wanted. After all, if one is going to work on a chart to the closest limits of accuracy possible, these can only be as good as the equipment in use will allow; hence the care needed to make the whole assembly. The completed assembly for the straight edge is shown in Fig 22.

As I said earlier, the adjustable straight edge can be made of Perspex. The general principle in the making of it is the same as for wood, but the tools used must be those for metal working. This puts the material beyond the scope of many do-it-yourself enthusiasts. Nonetheless, for those who have access to these tools and can use them, Perspex is a very rewarding material to work, and the results are probably better than those for a wooden straight edge. After Perspex has been cut or shaped, it may require polishing to re-establish its transparency. As a case in point, the bevel along the edges of the straight edge must be transparent if any advantage is to be gained from using the material. This, in fact, is the only time that a woodworking tool is used, and this is the hand plane with a very sharp iron set fine. The best way of polishing Perspex that I have found is to begin by rubbing it smooth with, if you can get it, pulverised pumice powder. This is best mixed with soft soap and rubbed on with a damp soft cloth, using a tight circular motion, but don't apply too much pressure. The next stage is to treat the area with a milder abrasive, and for this I have found that Eucryl Smoker's Tooth Powder is just right. The tooth powder is also applied with a soft damp cloth, and again with a tight circular motion. To follow this, use a mixture of tooth powder and metal polish; at first the mixture should be a paste with only a little metal polish, but gradually increase the amount of the latter and decrease the amount of the former until you are using just metal polish. This polishing process is very slow and lengthy, and after the pure-metal-polish stage is reached there is still a great deal of polishing to do until the perfect surface is achieved. Finally, on the subject of Perspex, treat this material with the greatest respect. It does not like being hit or jarred. Also, when using a woodworking plane on the bevelled edges, make the strokes with the tool firm and continuous; *don't stop half-way*.

With my first Mark V pantograph I made a lot of mistakes. Firstly, I did not pay enough attention to the tolerances of the various parts and secondly I was not particular enough about the limits and fits for the pivots and their holes. The result was an equipment which was far too sloppy, resulting in unacceptable inaccuracies. I had to make the whole thing again, but this time I used far more care. I then succeeded in gumming up a part of the straight edge pivot, and from this I learnt to use the very minimum amount of glue, and to apply it very carefully to those areas where it was needed *and nowhere else*. The final edition of the pantograph took rather a longer time to make, but amply repaid the extra care involved. The present assembly is

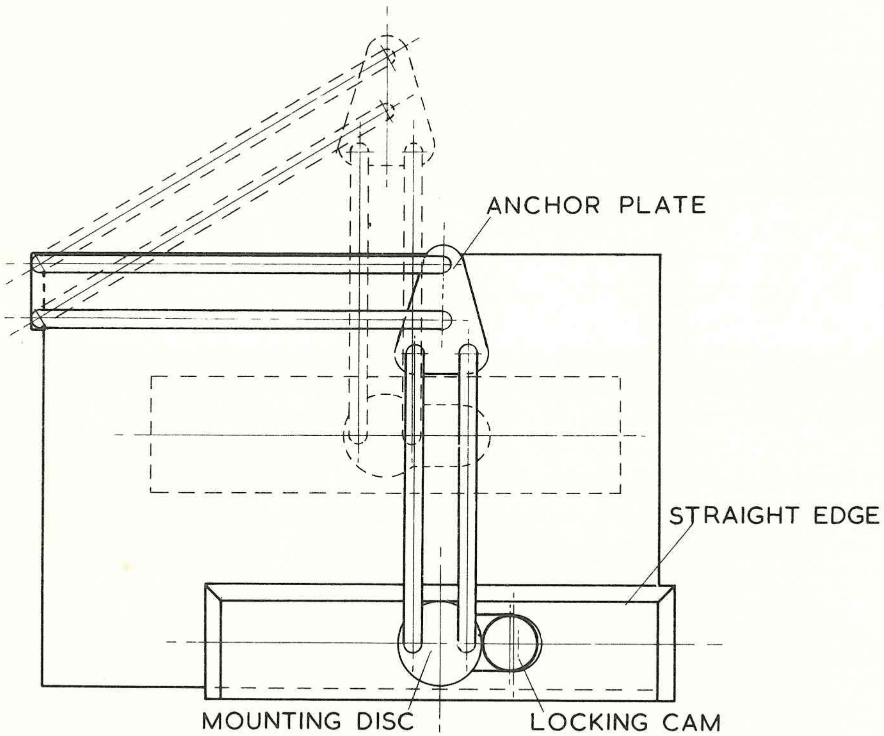

Fig 23

beautifully smooth in operation and is accurate. The completed chart board and pantograph are shown in Fig 23.

There are one or two useful tips for those who want to make their own pantograph and chart board. Wherever possible I glued up my assemblies using model-maker's cramps. Where, for one reason or another, I could not use cramps I utilised brass panel pins as locators. Where parts of an assembly needed small but nonetheless positive clearances, such as between the arms of the pantograph, I cut spacers from drawing paper, waxed them with candle grease to act as a lubricant, and put them between the pieces to be separated. Once the assembly was complete, I tore out the paper and found that I had just the clearance I wanted.

The subject of pivots needs, I think, a little more discussion. Where machine screws are used, I seem to have used nothing but 6BA, and all made of brass. One point about which I was very careful was to ensure that the screws were not threaded all the way up. By doing this I was able to glue them into their holes, thereby steadying them and keeping the pivot rigid. For this purpose I used super glue. One important point when using any of the epoxy or similar glues is to degrease the metal properly. Among the better degreasing agents are trichlorethylene, carbon tetrachloride and surgical spirit, but failing these methylated spirit can be used. I placed all metal parts in a coffee jar into which I poured trichlorethylene, then screwed on the lid. As I required the pieces, I took them out of the jar and placed them in a tray of the degreasing agent, scrubbing them with an old toothbrush. Once degreased, I never touched them with bare fingers, but held them with small long-nosed pliers so that no body grease could be transferred to them. One final, but very important, word about using degreasing agents such as those I have named: always use them in the open air, or make certain that there is a good circulation of air if using them indoors. These agents are very volatile, and if the fumes from them are inhaled, they could harm your health.

After I had been using the chart board and pantograph for some while, I added some phosphor-bronze spring clips to the bottom left-hand corner of the board to hold pencils. Some people prefer to use a pencil case or holder of some kind, but because Chinagraph pencils can break rather easily, and a replacement is usually wanted in a hurry, I prefer to take one from a clip on the board.

These clips are fixed with 6-gauge countersunk-head wood screws. An alternative which is attractive in that it is less expensive is to fit a series of loops made either of sail cloth or Pirelli webbing. All that is needed after the clips or loops have been fitted is to slip in the pencils, where they will be firmly held until needed.

3
Additional Equipment

In the previous chapters I have written about the basic navigation equipment needed aboard any boat or ship. Even very small cruisers need something more, even though they may only hop along the coast from harbour to harbour. Whilst the ordinary passage-making charts will show how to get from one harbour to another, a pilot's guide will tell you how to get in to your destination, where to anchor or tie up, and where to get water, fuel and supplies. Charts do not give tidal information in the form of tables of high and low water on a particular date, neither do they give high and low water levels. For this information, one must have a nautical almanac which is, in addition, a mine of information for the navigator, giving speed tables and distance off tables, together with a great deal of celestial navigation and other information. I use the *Macmillan Silk Cut Nautical Almanac*, and find that it gives me all the information I need, besides the great pleasure I get from just browsing through it. For planning a cruise, it is invaluable. I have heard it said that the book is too expensive, but I do not know where the same amount of information could be obtained for less money. *Brown's* and *Reed's Almanacs* are similar publications of really excellent quality, and as a boy I was rarely without one or the other because they made such fascinating reading. In all fairness I have to add that both books are published more with big ships in mind, and they do not contain the wealth of harbour information to be found in *Macmillan*.

Although not a nautical almanac, *The Cruising Association Handbook* – having been compiled by cruising yachtsmen for cruising men – recommends itself to the small boat fraternity. The wealth of information culled from members of the Cruising Association is enormous, and covers the whole of the British Isles and continental waters from the southern end of the Baltic to as far south as Gibraltar. It undoubtedly covers all waters available to mini-cruisers sailing out of British ports. For those who sail on the South Coast, *The South England Pilot* by Robin Brandon, published by Imray, Laurie, Norrie & Wilson, is the most convenient guide, and gives a very comprehensive coverage of the region. Volumes III, IV and V are already published, and cover from Hengistbury Head to the Isles of Scilly. Volume III extends from Hengistbury Head to Start Point, Volume IV covers the coast from Start Point to Land's End while Volume V is devoted to the Isles of Scilly. The two remaining volumes will cover from the North Foreland to Selsey Bill, and from Selsey Bill to Hengistbury Head respectively. Though the wrong size and shape for the small cruiser's bookshelf, all five volumes can be very conveniently stowed flat under the bunk cushions (navigator's bunk!). Again the price might seem high, but when the amount and quality of the information contained are considered, their cost appears in a very different light. *The Pilot's Guide to the East Coast of England* by Derek Bowskill covers the region from the south shore of the Thames Estuary to the Wash, an area which presents some of the best pilotage problems to be found round our coasts. For those whose taste for adventure leads them across the North Sea or the English Channel, there is an abundance of pilot's guides by such well-known authorities as K. Adlard Coles whose *North Brittany Pilot* is a must for anyone cruising those waters, and Mark Brackenbury whose *Frisian Pilot* is not only essential for cruising the region, but also makes very good reading on its own account. Edward Delmar Morgan's *Normandy Harbours and Pilotage* is another essential for that particular area.

All these books are of a suitable size to fit into a small cruiser's bookshelf. There are many more excellent publications but since a small boat's bookshelf is of limited size the owner has to make a decision regarding its contents, bearing in mind that there must be room for instruction manuals for the engine and any other mechanical, electrical or electronic equipment. These must be carried and kept in polythene bags to keep them dry for when they are needed.

One more important book for the navigator's collection is on weather forecasting, since much of his skill lies in being able to foretell, in so far as is possible, changes which might affect his plans, and taking advantage of them quickly. Just such a book

is Ray Sanderson's *Meteorology at Sea*. This is a most comprehensive coverage of the subject. In my opinion, it is not only the racing navigator whose plans are affected by the weather; a good fast sail from one port to another is just as desirable for the cruising man.

The bookshelf itself needs to be in a dry part of the boat, and so arranged that a bar or fiddle can be fitted across it to prevent everything spilling out when the going gets rough. Under these conditions, when there may well be water slopping over the cabin sole, there are few more exasperating things than to find the pilot's guide or nautical almanac soaking wet with all the pages stuck together, just when they are most needed. I know – I learnt the hard way! I advise a piece of shock cord or bunjie being fixed horizontally round the books, and another piece vertically across the tops. In this way everything is fixed firmly into the shelf, no matter what the boat does; see Fig 24. In the past, I have been surprised at the number of small boat owners who seem to think that books can be quite safely left in kit nets under the deck head. There are even those who think that books are not necessary and seem quite happy to attempt to enter unknown harbours 'by guess and by God'; some of these have stubbed their toes on rocks and others have needed to be hauled off sandbanks. The amazing thing is that in spite of experiences of this type they do not seem to learn. Pilot's guides and nautical almanacs are essential to navigators; just as essential as charts.

The best navigator is only as good as his equipment and its accuracy will allow. For this reason, one should always buy the best that finance permits, although it must be said that expensive does not always mean good. The best way in which to find out about the quality of different instruments is to talk to people with experience in their use, and take advantage of their knowledge in making a choice. I said earlier in this book that the navigator's basic tools are chart, log and compass. A compass is worse than useless, it is actively dangerous, if it has not been correctly swung so that its deviation on all points of sailing is known. In any case of doubt, call in a qualified compass adjuster; his fee will be amply repaid by the peace of mind gained from the knowledge that the compass can be relied upon at all times. And on the subject of compasses, do site them so that the helmsman can view the card without having to crane his neck this way or that in order to be able to see it. That way lies unnecessary helmsman fatigue which in turn leads to errors in steering which could lead to disaster. A fully corrected compass with a proper deviation card is a must, and every navigator should insist on the deviation card being sited where he can see it when at work. And while on the subject of compass cards, for small boats I recommend a domed-type compass with three lubber lines; one on the fore and aft line with one on either side at about 45° so that the helmsman can steer a course from either side, adjusting the compass reading to suit.

The navigator's second basic tool is the chart, and I have already dealt with this, so we can get on to the third item which is the log. Again, if this cannot be relied upon it is, like an unswung compass, worse than useless. It is the duty of every cruising owner to check his log under as many conditions of wind and sea as

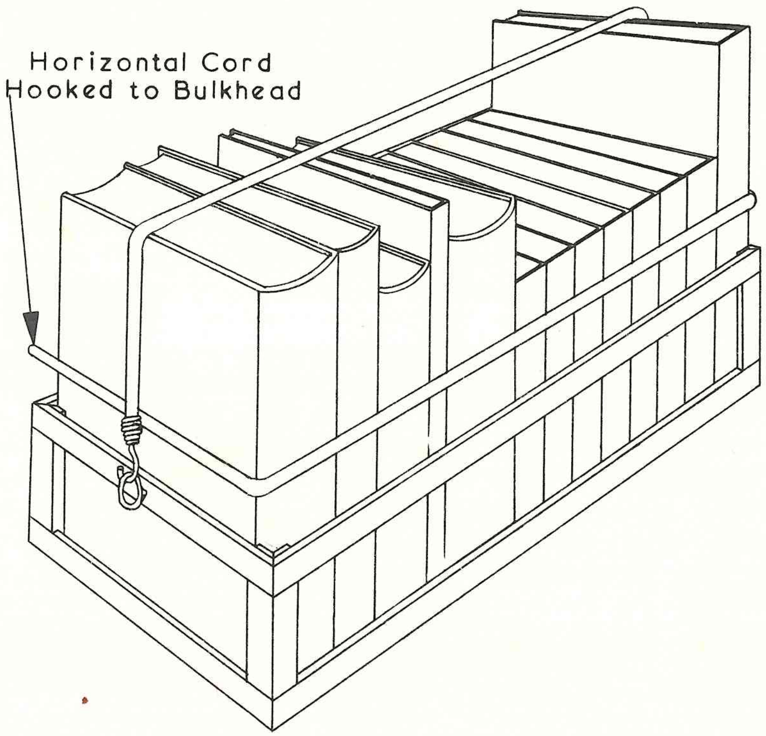

Fig 24

possible, as well as on all points of sailing so that its characteristics shall be thoroughly known. An example of what I mean is when, beating to windward in a big sea, the log would probably over-read, and it is by how much it over-reads that is important. Speed also can affect the performance of a towed log spinner (so can sharks!); if the boat is travelling really fast, the spinner will come near the surface and jump clear from time to time, thus under-reading. With a well-designed log, the combination of spinner and sinker weight should take care of this, but some small cruisers will plane very fast indeed downwind, and even the best of spinners will jump clear from time to time.

Paddle-wheel and doppler-type logs are very much more efficient when sited correctly, but even they can give false readings from time to time and of course they are more expensive. Another point about logs is that, in so far as my experience goes, different types perform better or worse according to hull shape, and whether or not they have been correctly sited. So it all adds up to the individual owner getting the best from his boat's particular log. It must also be realised that the log gives distance run through the water and not over the ground, so that tide and surface drift can well have an effect upon readings.

A refinement of the log, of whatever type, is the log/speedometer. Not only does this tell the helmsman whether he is getting the best speed out of the boat, but if speedo readings are recorded on the deck log every quarter of an hour it also gives the navigator an additional check on distance run over a one-or two-hour period; and I cannot stress too strongly the value to the navigator in having two or more ways of checking his calculations. It may increase his work load, but information from one source showing up an error from another is of the greatest help in working up an Estimated Position (EP), as well as adding to peace of mind which, as every navigator knows, leads to contentment for all on board and increases his own personal efficiency.

Many people would say that it is perfectly obvious that a watch is an essential piece of navigation equipment, and this is so. But how good a watch? The best that one can afford is the answer. In these days of quartz watches I would even say buy one that is *more* than you can really afford, and make certain that it is water-resistant at least. My watch is a Seiko Chronograph, and over the time that I have had it, I have been able to work out its rate so that when working a position line from sun sights I can use it with complete confidence as a chronometer. Although it is water-resistant, I take very great care not to get it wet. With watches of this type it is very important to keep a record of the date when the battery is due for replacement. The battery for my watch lasts two years, so I keep a note of the date when it was last purchased. I must admit that I find the digital read-out, which can be illuminated at night, preferable to two hands which can be difficult to read even by torchlight.

On the subject of torches, I recommend that at least two be carried on board: one small torch of the pen type with the bulb coloured red, and a big powerful one for use as a searchlight when required. My small torch is an Ever Ready pen torch, and I have covered the bulb with red cellophane paper from a sweet wrapping. This is ideal for chart reading at night since it does not destroy night vision to the same extent as would a normal white light, and at the same time it provides enough light to enable the chart to be read.

The skipper/navigator/helmsman usually only has one hand free for chart work, even with the Mark V chart board. For this reason, I consider a pair of one-handed dividers to be indispensable, and would add that it is essential to learn to use them equally well with either hand. Problems can arise if you have to change hands to use the dividers; you finish up with crossed hands, and can get into a fearful tangle.

No cruiser should ever put to sea without a deck log. On this the helmsman enters, once every quarter of an hour, the *actual* course he is steering, boat speed if equipped with a speedometer, log reading and any alterations of course caused by shipping and the like. The helmsman *must* be honest about the course sailed at the time of entry. After all, no one is going to bite off his ears if he was a degree or two off; he may not have been able to help it, and the man has yet to be found who can sail a small boat to within less than 3° of a given course. At the top of the deck log should be written the course to be steered, time at which course is to be altered, the new course to be steered, and the time at which the navigator is to be called. Down the right-hand side there should be a column for any additional remarks which may be of use to the navigator when he is working up his EP. My deck log is as shown in Fig 25. The importance of the deck log is that it gives the navigator

a running account of what the boat has been doing since the last time he plotted an EP, and from it he can work out the Estimated Course (EC) and so produce an EP. I have found it very useful if the helmsman enters such details as wind speed and direction, sea state, and when he altered course for shipping and for how long before he came back on to his proper course. Once every hour or two hours, the navigator transfers the deck log information into his navigation log, then wipes the deck log clean so that the helmsman can start again. In estimating course and position the deck log plays a very important part in the navigator's work.

So far I have dealt with the very basic equipment required for small cruiser navigation. Anyone who reads the yachting journals will realise the mass of electronic equipment and navigation aids available. However, it has to be said that a great deal of this is beyond the purse of small boat owners, but there are some items which can be afforded, and I intend dealing with these. First amongst them I would put echo sounders. Most small cruisers spend a good deal of their time sailing on estuaries, and an echo sounder for this type of sailing is invaluable, as it is in fog, since one can navigate by comparing the contours of the sea-bed as shown on the chart with information from the echo sounder. It is also of considerable assistance when tacking along an unknown channel in areas such as the Thames Estuary or the Wash. With care, and more importantly with experience, it is possible to survey areas where there is little or no information to be obtained from charts or pilot's guides. However, this does require an additional transducer to be fitted aboard the dinghy unless, like mine, the boat is of very shallow draught with a centreboard. This type of work is fascinating and can be of future use to others, but it calls for care and precision.

Among the lower-priced echo sounders, I have used the Seafarer for a number of years now, and can only say how valuable it has been. It has failed only twice: once when I forgot to renew the batteries, and the second time when the transducer lead came out of the set. In other words, both times the fault was mine.

Proper maintenance is the secret of ensuring reliability in any item of electronic equipment, not just echo sounders. By 'proper maintenance' I mean that the set must be treated carefully, not left aboard during the winter with the old batteries still connected. These *must* be taken out and thrown away, the set

YACHT Denebola			
DECK LOG			
Course °C until hrs Then change to °C			
CALL ME AT hrs*			
TIME	COURSE	LOG	REMARKS
*SEE BACK OF DECK LOG			

FRONT

Fig 25

CHANGES OF COURSE			
TIME	FROM	TO	REASON

MARKS, LIGHTS, ETC		
NAME	INFO	ACTION
CALL ME IF/WHEN:		

BACK

taken home and stored – in its original box if possible – in a cool, dry place. It should also be returned to the manufacturers at least once every two years for servicing. The reason for taking out the old batteries is that, if left in the set, they will almost inevitably run down at which point they will weep acid and cause very damaging corrosion inside the set, which could very well ruin it. Servicing, and this applies to all marine electronic equipment, is vital if the item in question is to continue to function efficiently every season, all season long.

There are a number of reasonably priced echo sounders on the market and, since the proof of the pudding is in the eating and these brands have been on the market for some time, they have proved their quality. But do buy a set of known make. The reason that I mention the Seafarer range is that I have known it and owned one for some years, and have learnt to use it correctly. I have been shipmates with other equally good makes, but was very amused once aboard a boat which was fitted with a very expensive foreign-made set – it jumped about all over the place with the boat's motion and required some fairly skilful interpolation to get anything like a reasonable reading from it. Also, the dial was not very easy to read. There is more information about echo sounders in Chapter 5.

I suppose that one of the biggest innovations in small boat equipment has been the hand-held radio direction finder (RDF). I remember that before the 1939–45 war about the most compact radio direction finding equipment was made by the Marconi Company. It was of comparable size to a present-day MF/RT set, with a large loop aerial on deck which always seemed to be getting in the way. It was a very efficient set, mind you, and I was amazed at its accuracy. Today, the hand-held RDF sets such as the Brookes & Gatehouse Homer and Heron, and the Seafix range are as good as anything one can get anywhere.

There are now so many radio beacons round the coasts of the United Kingdom and on the continent of Europe that it would be difficult to find an area where one cannot pick up at least three such stations. However, care has to be taken in the time and selection of beacons. This is because for about an hour before and after sunrise and sunset the 'nul' could give a false bearing. Also, a radio signal passing over land behaves rather like a beam of light travelling through water or glass. If light enters either medium at

an acute angle it is refracted, and the amount of refraction reduces with the angle of incidence of the light beam, see Fig 26. So with a radio signal: if it crosses the coast at an acute angle it is bent quite considerably, and as the angle reduces so the amount of 'refraction' reduces. So, wherever possible, use beacons whose beams travel only over water, or which cross a coastline at right angles. I was once caught out through using the Round Island Beacon with the Land's End peninsula between us, and decided as a result that my EP was nearly ten miles away from my actual

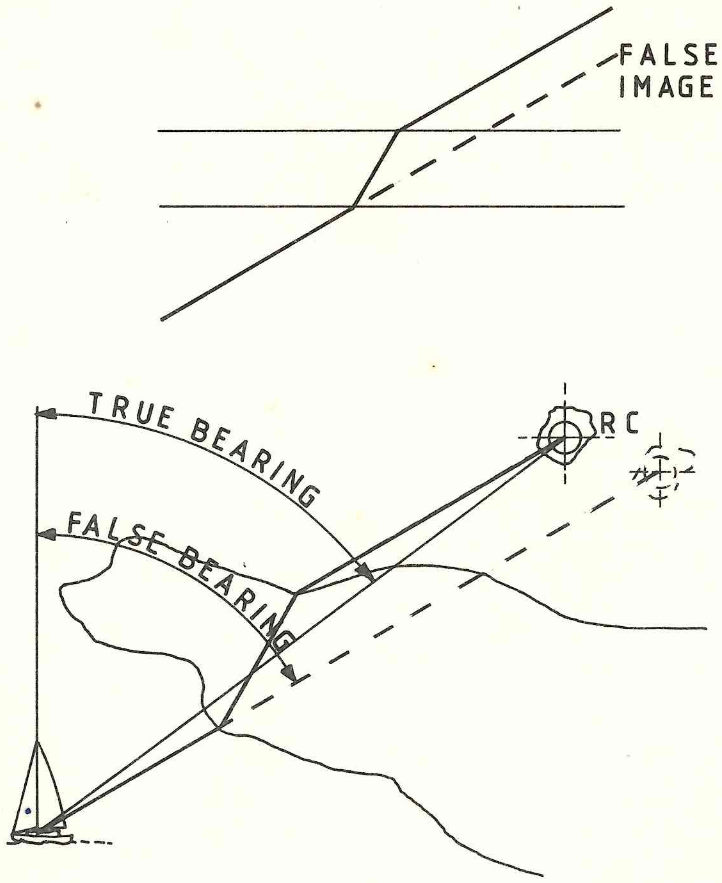

Fig 26

position. Until I learnt the errors of my ways, I used to be led astray by using the RDF set too close to sunrise and sunset. Basically, RDF works by taking bearings on a series (usually three) of beacons of known geographical position. The bearing obtained is that of the beacon FROM the boat, and the navigator wants the bearing TO the boat from the beacon. To deduce this he must add or subtract 180° depending upon whether the original bearing is smaller or greater than 180°; if smaller he adds, if greater he subtracts. The result is known as a back bearing or the reciprocal bearing from the beacon. Thus, if St Catherine's Point Radio Beacon bears 315°M, the back bearing is 315 – 180 = 135°M, so the boat bears 135°M from St Catherine's Point. If Cap d'Antifer bears 109°M, then the back bearing is 109+180 = 289°M, see Fig 27.

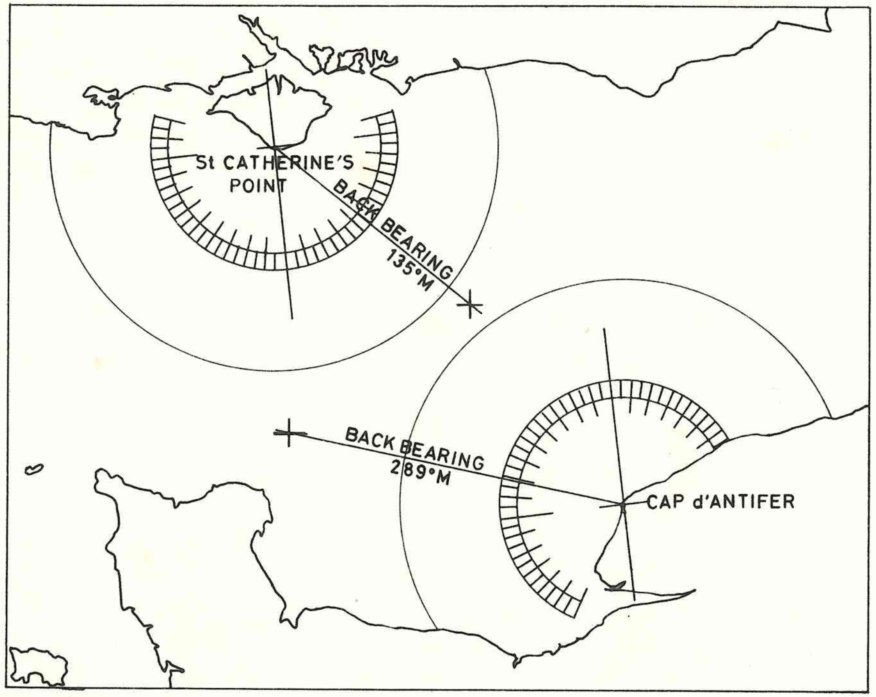

Fig 27

A very important point to watch for with a hand-held RDF set is that its compass is swung as is the steering compass, and that the set is always used with the operator standing in the same position. There should be a deviation card for the RDF set's compass, and this will have been produced with the set in a particular position; any movement away from there might be towards an item of the boat's equipment or rigging which could alter the deviation by enough to give an erroneous fix. In addition, it is important to make sure that there are no ferrous metal objects such as knives, winch handles, beer cans, etc nearby when the RDF set is in use. Items such as these can cause quite serious deviation which at best would produce a fix which was completely false, and at worst could cause disaster. On one occasion I was showing someone how to use a hand-held RDF set, and the bearings he was obtaining were totally at variance with mine. Eventually I found that he was carrying a knife in the kangaroo pocket of his sailing smock! I even take off my glasses when using either an RDF set or a hand-bearing compass since they can have quite a measurable effect on a compass needle. Another point to note is not to use the RDF set too near the boat's steering compass; they can interact with each other. For this reason also, the RDF set should be stowed well away from the steering compass (not less than five feet).

There are sophisticated RDF sets which give all kinds of digital read-outs, but providing that the small boat navigator is a person of sound common sense, this facility is not vital. What is vital is to know the Morse Code, the frequency of the beacon being sought, and its mode and sequence. It is no earthly use searching for the Outer Gabbard Light Vessel at ten past nine in the morning, because it broadcasts at nine and fifteen minutes past the hour; refer to the nautical almanacs. Also, should the set be equipped with a beat frequency oscillator (BFO) and since the Outer Gabbard Lightship's mode is A2*, then the BFO must be switched off for identification purposes. When identification has been made it can be switched back on or left off as the operator prefers.

All the necessary information regarding radio beacons is obtainable from the nautical almanacs. Full details of all beacons in the area of a cruise should be entered in the navigator's notebook. As the cruise proceeds, those which can be used on a particular day should be entered in the white space at the left-hand side of the chart. The characteristics of each beacon should be entered so that no time is wasted in looking them up.

One further comment on the subject of hand-held RDF sets: don't, just because your first few efforts with the set are not very successful, condemn the set out of hand as being inaccurate and useless. As with all other aspects of pilotage and navigation, real accuracy only comes with practice. It is vital that the small cruiser navigator gets to know his equipment, especially electronic equipment, really well so that he understands any peculiarities it may possess. I remember once, in the early days of small RDF sets aboard yachts, a man with far more money than sense trying out a new set. The results of his first effort produced what must have been one of the biggest cocked hats on record. 'This thing is no bloody use' was his assessment and, believe it or not, he threw it overboard! I was just too late to catch it. It was not that the equipment was no use; the fault was lack of patience on the part of the user and his failure to understand that such equipment needs practice in order to produce the desired results; two attributes which are essential for the navigator of any yacht, irrespective of size. A good example of this was the late Sir Francis Chichester. If his sun sights produced a 'pig's breakfast' of a position he would go back to the beginning and check every figure in every step of his calculations until he found the error. There is more information about RDF sets in Chapter 5.

So far I have dealt with out-and-out navigation equipment. There are other items which can be of great assistance to the navigator, one of them being a radio. No cruising boat, no matter what her size, should ever be without a radio receiver of proven reliability. It is difficult to be precise about transistorised radio sets because the variety is so enormous, but a reasonably small set which covers the broadcast, aircraft and marine bands is not very expensive, and many types can be obtained through mail order catalogues. The reason that I recommend this type of set is that, not only can one obtain the standard BBC shipping forecasts, but also weather and shipping information from coastal radio stations which very often broadcast matters of interest to the small cruiser navigator. Information regarding frequencies and times is to be found in all the nautical almanacs. By whatever means it is obtained, weather information is extremely important to a navigator in making up his mind as to his course of action during the following few hours. If any gale warnings come up for the

area in which I am sailing, I scoot for shelter or, if already there, I stay there. Radio information regarding visibility is also of great value in decision making. If the navigator is not the skipper, he must use his experience and knowledge to help the skipper in making decisions, particularly those which affect the safety of the crew and boat.

From the ordinary radio receiver we go on to the transmitter/receiver (transceiver), a set which not only receives messages, but can transmit them to other vessels or to shore. For yachts, these transceivers cover two sets of frequencies: Medium Wave/Radio Telephony (MF/RT) Marine Band, and Very High Frequency Radio Telephony (VHF/RT). The MF/RT sets employ single side-band techniques (SSB) which means that they are expensive, and must be considered beyond the means of most small boat owners, but it must be said that their range (up to two hundred miles) does make them attractive.

At a much lower cost there are the VHF/RT sets, the operation of which, since they are crystal tuned, is simplicity itself and well within the capabilities of the average sailing man, but it must be realised that an operator's licence is required for them. Since these sets operate on very high frequency radio waves their range is more or less limited to line of sight. The absolute maximum range of a VHF set depends upon the quality and height of the aerial and the power output (25 watts max) of the sets. Under optimum conditions it is possible to operate effectively at a range of forty miles. VHF sets can operate in three modes, depending upon how they are equipped. For sets equipped with the Simplex mode only, it is necessary to use standard voice procedure. That is to say that when one person has finished speaking he must say 'Over' and release his transmit switch because his set will not transmit and receive simultaneously. Messages on one VHF channel can only travel one way at a time, like liquid in a pipe where the direction of flow is controlled by a valve. If the liquid is flowing in one direction it cannot accept a flow in the opposite direction at the same time; the valve must be altered to reverse the flow. The transmit switch on a VHF set equipped with the Simplex mode acts like the valve; press it and the message flows from you to the other set. When the transmit switch is released the set can receive an incoming message. It is for this reason that it is sometimes erroneously stated that Simplex-equipped sets cannot be used for link calls (telephone from yacht to telephone number ashore via a coastal radio station). They can be so used, but the person on the telephone ashore *must* obey the correct voice procedure and say 'Over' each time he or she has finished speaking so that the yacht's operator knows when to press his transmit switch and start speaking. For normal ship-to-ship and ship-to-shore (Coastguard or coastal radio station) the Simplex mode is perfectly adequate.

A frequently quoted disadvantage with Simplex is that it gives no privacy; anyone can tune into the channel in use, and listen in on the conversation. As far as I am concerned, I do not in the least mind if this happens when I am making any type of call, but for the business man who uses his VHF radio to keep in touch with his office, this could prove very undesirable. The Semi-Duplex mode does give the privacy advantage but does not give the 'telephone type conversation' that is available with Duplex.

The Duplex mode, although it adds to the cost of the set, does have the advantage of privacy as well as providing 'telephone type' conversation; in other words it obviates the necessity of having to say 'Over' at the end of each period of speech, and both ends of the 'line' can speak at once if they so wish. Considerable discipline is required on the part of the yacht's operator not to keep his transmit switch pressed for longer than is absolutely necessary because transmitting makes a far greater demand on the battery than does receiving. The Duplex system works by using two channels at opposite ends of the marine broadcast spectrum. The ship sends on Channel 'A' and receives on Channel 'B', and the shore station sends on Channel 'B' and receives on Channel 'A'; consequently, in order to listen in on a conversation on Duplex, one would need to know both the channels in use, and to have one receiver for each channel.

There is always argument amongst yachtsman, and I have known the Coastguards to join in, regarding the number of channels needed aboard a yacht. There are six-, twelve-, twenty-four- and fifty-six-channel sets on the market. With current congestion on the VHF frequencies, the six-channel set is really only usable for local cruising since its range is limited. The normal channels with one of these sets are 6 (ship-to-ship), 16 (distress and calling channel), 8 (ship-to-ship) and 67 (Coastguard Yacht Safety). This leaves two channels for the owner to choose from.

One of these, which is of considerable use to yachtsmen is Channel M (157.85MHz) which has been allocated to marinas and yacht clubs. The last one could be another private channel or a public correspondence channel, although this latter would limit ability to communicate with the shore if the traffic on the chosen channel should prove to be particularly busy. Alternatively the remaining channel could be 12 or 14 which are allocated to port operations, but this would limit the number of ports one could contact. The twelve-channel sets must have Channels 6 and 16 as these are obligatory for all VHF sets. The remaining channels could be those mentioned for the six-channel sets plus the missing port operations channel and a selection from the ship-to-ship and ship-to-shore channels. The twenty-four-channel sets would have those channels already mentioned plus a choice, at the owner's discretion, of the remaining available channels. The fifty-six-channel sets would have the full complement of numbered channels plus Channel M and another four private ones. These latter sets, whilst covering the entire VHF Marine Band, do cost more than the smaller sets – obviously the individual must weigh convenience against bank balance when making a choice.

Details of all the marine channels and their uses can be found in the nautical almanacs and other maritime publications. The choice of channels used by the smaller sets with only a limited number available must be governed by the cruising area of the boat, and any authoritative publication on the subject of VHF radio should be carefully consulted before making a choice as to the channels to be fitted to your particular set. Also, it is a sound idea to consult with the local Coastguards because they know the best ones for use in their area.

There is one other type of radio set which the yachtsman must consider – the Callbuoy which is a portable distress radio telephone set which transmits on the International Distress Frequency on medium wave at 2182kHz. The set is completely self-contained and waterproof and can be operated from a yacht, life raft or even by a person in the water. It has a range of between sixty and eighty miles which gives an enormous coverage. For anyone sailing well offshore, whatever the size of boat, a Callbuoy is a must for safety reasons. It can reach other ships or the rescue organisations from a far greater distance than can a VHF set, and it alerts other ships which will either be able to render help themselves, or alert the

Search and Rescue organisations. Its cost is a small premium for the lives of everyone aboard the boat. I have heard it said by people who ought to know better, that a radio transmitter aboard a small boat is an unnecessary luxury. Utter rubbish! A radio transmitter is a small boat's link with the land, a source of confidence at all times, comfort in time of danger and help in time of distress. There is more information about radios in Chapter 5.

There is no worse situation in which a yachtsman can find himself than to get caught in a busy shipping lane by sudden fog. This can happen all round our coasts, and I for one am not ashamed to admit that I am frightened when it happens to me. It even happened once in Plymouth Sound, inside the breakwater. I was beavering away at trying to get the boat over on to the western shore of the Sound to get out of the way of the big chaps, when the Roscoff Ferry loomed out of the fog right on my tail! I knew that she was coming in and could hear her siren; whether she could hear our pipsqueak compressed air horn is doubtful. Fortunately she had a look-out right up in her bows in communication with the bridge, because she altered course surprisingly quickly to starboard. That gives some idea of how fast things can happen in fog, even in inshore waters. One of the navigator's jobs is to

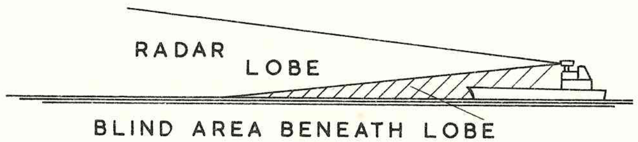

Fig 28(i)

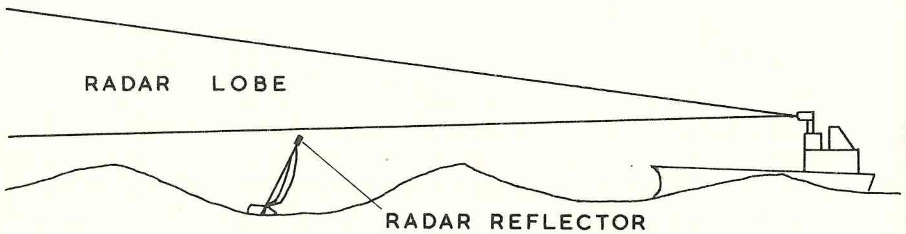

Fig 28(ii)

establish, as best he can, the position of other vessels in his area, whether risk of collison exists, and if so what action to take to avoid it. Also he has to keep a running plot going on his chart so that he can, at a moment's notice, say exactly where the yacht is.

It is most unlikely that a mini-cruiser will be equipped with radar, but she must be equipped with the largest and most efficient radar reflector possible, and it must be rigged at the correct attitude and as high as possible. In my opinion the only place for a radar reflector is at the top of the mast, but it must be realised that this will not necessarily produce a 'break' on a big ship's radar screen. There are a number of reasons for this; the most important of which are the attitude of the reflector due to the yacht being heeled, the 'blind' area ahead of the ship, and the amount of 'clutter' on the screen, see Fig 28(i) and (ii). Since at best the 'break' from a yacht's radar reflector will be small and will probably only appear intermittently, there is a strong chance that the officer of the watch will miss the yacht altogether. In other words, she will not be 'seen', especially in rough weather when the reflector will be going up and down and can easily be dipping below the bottom of the radar lobe. However, I do know of a number of cases where big ships have altered course for a yacht because the officer of the watch saw the 'break' on the radar screen and recognised it for what it was.

With the new generation of radar reflectors, such as the Firdell, the chances of being 'seen' are greatly increased. But any handyman can make for himself a better reflector than can normally be bought by making up a gang of three reflectors – one above the other – all in the 'catch rain' attitude, but each one offset by 120° from the one below it as shown in Fig 29. The only tools necessary are a hacksaw, a file or two and access to welding gear.

In addition to radar reflectors, there are radar detectors on the market which are within the pocket of most small boat owners. The Marine Check set marketed by Telesonic Marine Ltd and the Watchman made by Lo-Kata Ltd are two such sets which come to mind.

There are some items without which some navigators say they cannot do; course plotters, for instance. In my opinion these and other navigation devices are luxuries for the mini-cruiser, besides which the less gash gear one has floating about the cockpit aboard boats of this size the better. The need for most of them is negated by the Mark V chart board anyway. However, there is one little device, which I invented, which is of some use in the planning stages of a cruise. This is a tidal vector. All it consists of are three pieces of wood held together at the ends by sliding clips which have a pivoting capability. This device is shown in Fig 30 (i) and (ii), and is simply used to work out a course to be sailed, taking tidal stream and speed into account. By using this aid for different courses and boat speeds it is possible to plan a series of courses to be sailed under a number of different conditions of wind and tide.

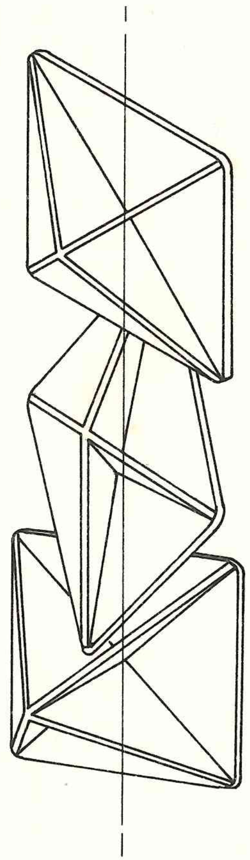

Fig 29

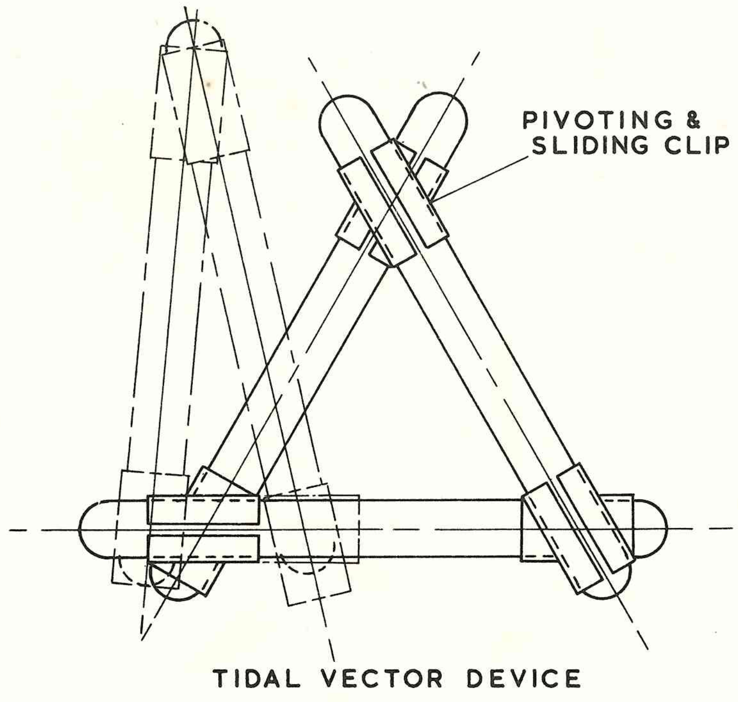

Fig 30(i)

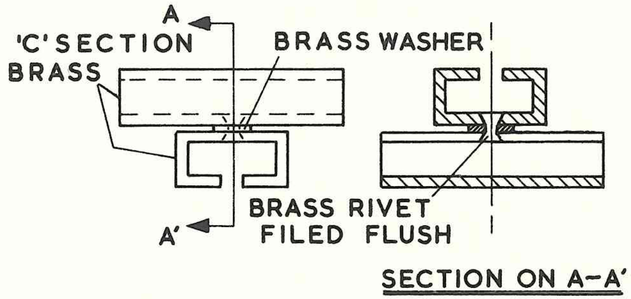

Fig 30(ii)

When these have been plotted on to the relevant chart, they can be transferred to a trace which is then put into the cruise planning folder, to be taken out whenever needed for reference. A series of these traces prepared during the winter months, once the next year's tide tables and nautical almanacs are available, will save any navigator an enormous amount of concentrated work as the weeks draw nearer to the date of the cruise. When the actual day of departure dawns, all that has to be done is to take out the relevant trace and transfer all its details on to the passage-making chart. From there on, all one's time can be devoted to actual pilotage and navigation. Only unforeseen circumstances will cause any major alteration in the basic plan. The preparation and use of traces are explained in the next chapter.

Since mini-cruiser long-distance voyages form a very small percentage of the total number of deep-sea voyages, I do not intend to go into the realms of celestial navigation; in any case the subject has been very competently dealt with elsewhere. Nonetheless, although it must be considered a luxury, a sextant is a very useful instrument to have aboard. There are a number of plastic sextants on the market and for small boat purposes they are perfectly adequate. Also, they are considerably cheaper than the normal sextant. It is a popular misconception that the sole use of a sextant is for taking sun and star sights. In fact, with its aid it is possible to obtain a positive fix from objects ashore, as will be explained later.

Aboard small boats it is doubtful if the steering compass is of a type, or in a position, which permits the use of an azimuth ring. This is a device which allows the navigator to take bearings of objects, including the sun, outside the vessel using the steering compass. It consists chiefly of a sighting device coupled to a prism so that an object can be seen through the sights, and its bearing read simultaneously through the prism off the compass card. In order to obtain bearings of important navigational features or other vessels, a hand-bearing compass is, in my opinion, the best instrument for the mini-cruiser navigator. It consists of a small compass with a prismatic sight of one type or another, and a light source so that it can be used at night. The light source may be supplied by torch batteries in the handle with a bulb to illuminate the card, or it can be a Beta light such as in the Mini Compass. It is important to swing the hand-bearing compass so that all bearings

taken with it are accurate, and always to use the hand-bearing compass in the position in which it was swung. As with the steering compass, an inaccurate hand-bearing compass is a menace.

In addition to the instruments and aids discussed above, there are a few items which should be part of every cruising boat's inventory. Among these are a barometer, a clock or watch, and

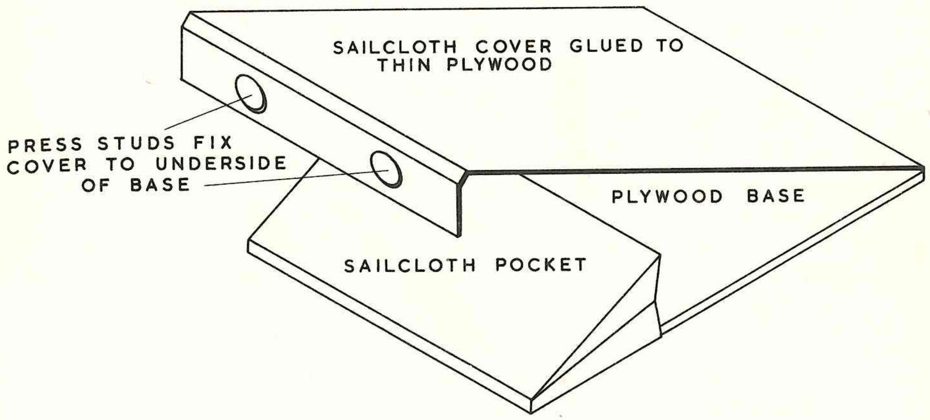

Fig 31

proper folio covers for charts. The navigator will be as interested as the owner, if the two are not the same person, in the weather, so that a reliable barometer is a must. A conjunction of intelligent reading of the barometer and sound interpretation of weather forecasts can give a reliable guide as to the weather to be expected in one's immediate cruising area. For the safe completion of a passage this is vital. I recommend reading one of the very good books on weather forecasting for yachtsmen which are on the market – they can help a great deal.

An accurate watch or clock is essential for every navigator. I recommend a quartz movement as this gives considerable accuracy with a very even rate. My watch gains two seconds per month, but I would stress that it was expensive. Quite low-priced quartz watches will give a rate of plus or minus a second per week, and this is accurate enough for most purposes.

Folio covers are essential if charts are to be kept in order and not get misplaced. Using the small A3 size charts which I recommend, it is very easy to misplace one unless they are kept in numerical order in a chart folio, see Fig 31. This habit of keeping charts in their right order is something I learnt very early on.

4
Basic Methods Without Electronic Aids

Everyone who drives a car has at some time or another used a map, and has taken note of the scale. Until recently the most popular maps were the Ordnance Survey one-inch-to-a-mile series, the representative fraction (RF) of which is quoted on the maps as 1:63360. This means that one inch measured on the map represents 63,360 inches ($1760 \times 3 \times 12 = 63{,}360$) on the actual ground. This RF is also called the natural scale. The modern metric series of Ordnance Survey maps is to a natural scale of 1:50,000, which means that one metric unit measured on the map represents 50,000 of the same units on the actual ground; thus one metre on the map represents 50,000 metres or 50 kilometres on the ground, and one millimetre on the map represents 50,000 millimetres or 50 metres on the ground. The small figure on the natural scale represents the map and the large figure represents the ground. As with maps, so with charts, but the natural scale of a chart is based on the scale of latitude and distance; since charts are to Mercator's projection this scale will vary between the Equator and the Poles, but for any given latitude the scale of latitude on the left- and right-hand margins of the chart is correct for that latitude, and so one minute (0° 1′) represents the British Standard Nautical Mile of 6080 feet (1853.18 metres).

Most countries outside Britain use the International Nautical Mile of 6076.06 feet (1852 metres), but British yachtsmen use the British Standard Nautical Mile of 6080 feet which is divided up into 10 cables of 608 feet or 200 yards approximately. Charts are published to a number of natural scales, and all British publications are based on the BSNM which is usually abbreviated to n mile. (It should here be noted that the Statute Mile which is used on land is one of 5280 feet [1609.34 metres] and is not used in navigation at sea.) The natural scales which we, as British yachtsmen, use vary from 1:768,600 at latitude 50°N to river charts at 1:28,062 or 2.6 inches to one nautical mile.

The scale of the chart one uses must depend upon its purpose. For instance, it would not be a very good idea to use a series of charts of 1:100,000 for planning a cruise from Heybridge Basin to the Isles of Scilly. Neither would much good come from trying to navigate across the Thames Estuary using a chart to a scale of 1:500,000 or 1:750,000. For crossing the North Sea a chart to a scale of 1:750,000 to 1:200,000 is amply good enough, and at the western end of the English Channel charts to the same scales would fit the bill admirably. For coastwise passage making I would recommend charts to a scale of 1:75,000 to 1:100,000 for the English Channel, but for the East Coast I would go for a scale which gives more detail of the sandbanks and buoyage system; something in the region of 1:50,000. It must be realised that the smaller the natural scale or RF, the larger the amount of detail, and that for sailing in difficult waters one should employ the smallest natural scale available. Oddly enough, a chart to a scale of 1:50,000 is referred to as a large scale, and one to 500,000 is called a small-scale chart.

On all charts it will be seen that there are one or more compass roses, and that these consist of two concentric rings, both marked off from 0° to 360°, but with an offset on the inner circle of between 4° and 8° West. The North–South axis of the outer ring is parallel to the lines of longitude on the chart, and is the TRUE North–South. The axis of the inner ring, which is a few degrees West of True North, is MAGNETIC North–South, see Fig 1, p13. The amount by which Magnetic North varies from True North is called Magnetic Variation, and is not constant; it changes from year to year. Also, it changes according to geographical position. On the East–West axis of the Magnetic compass rose is shown the amount of Magnetic Variation, the year for which it had that value, and the annual rate of change, but since this is so small and takes between ten and twelve years to change by one degree, it can to all intents and purposes be ignored by the small boat sailor, see Figs 1 and 32. For example, on my current chart of the southern North Sea the Magnetic Variation is shown as being 5°W in 1979, decreasing by about 5′ annually (1′ is 1/60th of 1°). So, by 1991 it

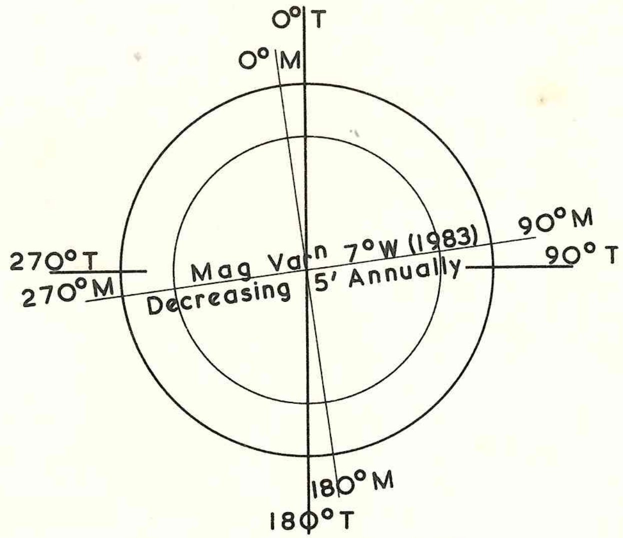

Fig 32

will be 4°W, and 1° is neither here nor there when steering a small boat.

To change from True to Magnetic, one adds the Variation if it is West, and subtracts if it is East. So the first thing a navigator has to do is to check on the amount and direction of Magnetic Variation. But he also has another variant with which to deal. This is Compass Deviation which represents the individual characteristics of a particular compass. Take the compass out of one boat and put it into another, and it will have a different set of characteristics or Deviation. In the chapter on navigation equipment I talked about swinging the compass; this is done to establish the amount of Deviation in a compass at 10° intervals throughout the whole 360°. Because most steel-built boats have an inherent magnetism, the Deviation of the compass can be quite considerable, and in order to reduce it to ensure the accuracy of the compass, the compass adjuster positions correcting magnets in the best place to obtain an overall reduction in the Deviation for that particular compass. When he has completed his work, the compass adjuster supplies the owner with a Deviation Card which gives the amount of Deviation of his compass for each 10° from 0° round to 360°. Each time a navigator works out a course or bearing he has to refer to the Deviation Card so that he can make the necessary adjustments to his calculations. Since, in the Straits of Dover, Magnetic Variation was 7°W in 1979, decreasing by about 5′ annually, it will take six years to change by 30′, and because many small boat compasses are only graduated in 2° intervals, the navigator can ignore the annual change.

However, he has to take Magnetic Variation into account when plotting a course, and this is how he does it. Let us assume that a yacht is in Dover Harbour, and that the owner/navigator wants to cross the Channel to Calais. Because the Regulations state that a vessel crossing the separation lanes *must do so as near at right angles as is practicable*, this means that he cannot steer a direct course for Calais, but must take a course which will take him across the separation lanes at 90°. From the chart this turns out to be a course of 131° True. He now has to correct this for Magnetic Variation *and* Compass Deviation.

131° True plus Magnetic Variation at 4°W = 135° Magnetic.
Compass Deviation for 140°M is 2° East.
∴ 135°M–2°E = 133° Compass.

This is the still water compass course. Allowance now has to be made for other variants, which include tidal stream, surface drift (if any) and leeway; so let us complete the calculations.

The navigator draws in the compass course of 133°C on the chart to carry him clear of the separation lane on the French side of the Straits. Knowing his boat, he works out what his speed should be under the wind conditions at the time; say, 5 knots. From the entrance of Dover Harbour to clear the separation lanes on the French side is 14 miles which will take him 3 hours at his estimated speed. He adds 1 mile to the actual distance to carry him clear of the north-bound lane. On a piece of paper he draws a line at 133° and scaled (chart scale) 15 miles long. From the tidal atlas and tide tables he obtains the following information:

At the time he plans to leave, the tidal stream is flowing at ½ to 1 knot at 45°T.
One hour after leaving it is flowing at 1 to 1.5 knots at 45°T.
Two hours after it is flowing at 1 to 3 knots at 45°T.
During the third hour the tidal stream is flowing at 1 to 2 knots at 45°T.

He writes down the averages because it is half-way between Springs and Neaps.

Zero hour average rate of stream =	1kn
After 1 hour average rate of stream =	1.25kn
After 2 hours average rate of stream =	1.5kn
3rd hour average rate of stream =	1kn
	= 4.75kn

∴ Average tidal stream for 3 hours = 4.75÷4 = 1.875kn

He will be quite safe in allowing for a tidal rate of 1.8kn, and he multiplies this by three (estimated time to clear the lanes) and arrives at a figure of 5.4. This is the amount he will be carried by the tide at 45°T. He now corrects for Magnetic Variation, so adds 4°

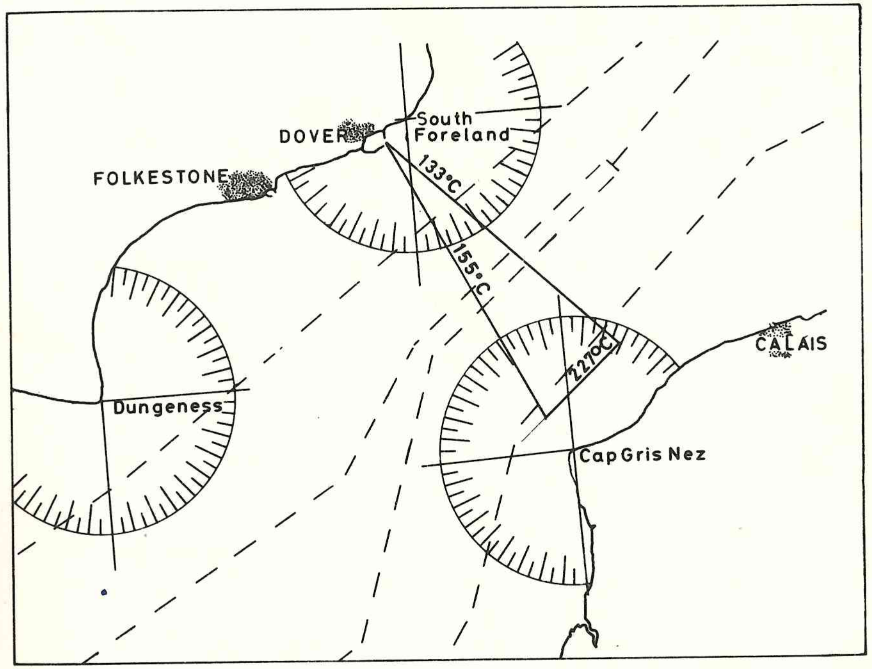

Fig 33

and subtracts 2°E for Compass Deviation. He has now reduced everything to the same value, ie compass degrees. On his piece of paper he draws an angle on the reciprocal of 47°C at the outer end of his 15-mile line, and scales the line at 5.4 n miles. He joins the end of this line to the Dover end of the 15-mile line, and this gives him the course to steer in order to cross the separation lanes at 90° *over the ground*. This proves to be 155° Compass. His working on the chart is shown in Fig 33.

In this particular case surface drift and leeway could be ignored as they would be negligible; had it been blowing hard for more than twenty-four hours, he would probably have to make an allowance for surface drift, but with the wind coming from almost dead abeam he could still afford to ignore leeway. What in fact the navigator did in this case was to draw a tidal vector. Always remember to draw the direction of tidal flow on the reciprocal of the actual direction of tide, and don't forget to make the necessary corrections for Magnetic Variation and Compass Deviation. I have known many navigators to forget these two corrections, with the result that they did not end up at their intended destination. It was only afterwards, when checking their calculations, that I discovered their errors.

To revert to the above example, had the wind been blowing at an angle of less than 60° off the bow, the best thing to have done would have been to cross the separation lanes under power. The calculations for course would have been exactly the same.

To revert to the compass; there are three separate North points – True North which is in the direction of the North Pole, Magnetic North which is in the direction of the North Magnetic Pole, and Compass North which is in the direction taken by the North-seeking pole of the compass needle, and is individual to each compass, see Fig 34 (i) to (iii). Corrections for Magnetic are 'add for West', 'subtract for East'; if one is a purist, it varies from year to year. Corrections for Compass Deviation are the same, but it does not vary from year to year; nonetheless, it is not a bad idea to swing the compass once every five years. In that time there may have been additions to and deletions from the boat's equipment, some of which could be made of ferrous metal and thus affect the compass for better or for worse. Also, should it be found necessary to alter the position of the compass, it should be swung in its new position. Finally, Magnetic Variation remains the same no matter

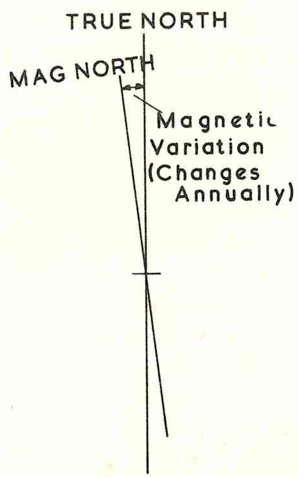

Fig 34(i)

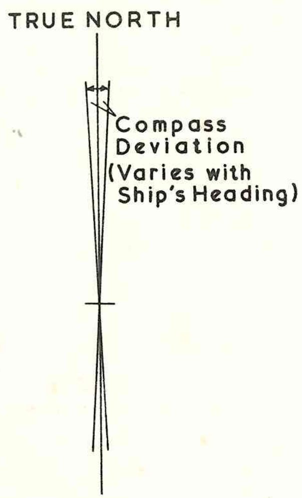

Fig 34(ii)

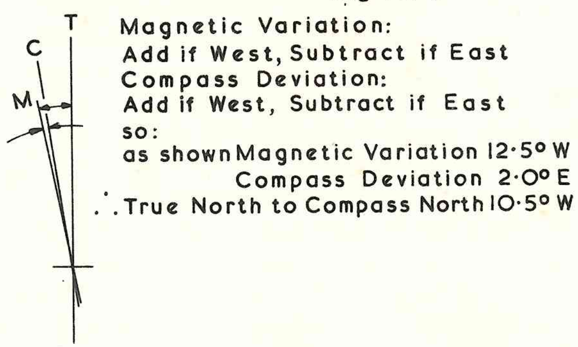

Fig 34(iii)

what the boat's heading, whereas Compass Deviation changes with the vessel's heading.

Having dealt with the corrections the navigator has to make for the compass, we come to the outside influences for which he has to allow when deciding on the actual course to steer. I have already mentioned them: surface drift and leeway. Unfortunately for the navigator both of these are variables. Surface drift depends upon wind speed and direction, and also for how long the wind has been blowing from that direction. Remember that the direction of wave motion has little or no bearing on surface drift, so do not be led into thinking that it does. Waves do not always travel in exactly the same direction as the wind. The method of estimating the speed and direction of surface drift is simple enough. Stand with your back to the *true* wind and the direction of drift will be 40° to your right front in the Northern Hemisphere (left front in the Southern), and the speed will be 2 per cent of the speed of the true wind.

The amount of leeway depends upon the individual boat, her point of sailing and conditions of wind and sea. Obviously, downwind leeway will be nil, and it will increase as the boat comes round on to the wind. The best way of computing the combined effects of surface drift and leeway is to judge from the first 2 miles or so of sailing from the point of departure. Take a bearing on a feature dead astern and then, when the log reads 2 miles, take another. The difference between the first and second bearings will give the combined angle of leeway and surface drift. With this information, the navigator can draw a drift and leeway vector to add to his Estimated Course. On passage, this should be the last bit of special plotting and calculating that is required until the tide turns, when a fresh set will have to be produced.

Having performed all these tricks, a navigator would be forgiven for thinking that his work was well done, but it is not over. At least once every two hours he has to transfer the deck log information to his notebook and then work out his Estimated Position. This needs to be checked once every four hours either by a fix from visual bearings or by RDF. Should there be a large discrepancy between the EP and the fix, the latter must be taken as being nearer to the boat's actual position, and any course adjustments made. And so he continues through the long and weary night and the next day until port is reached. Being a navigator is no sinecure aboard any boat, but aboard a mini-cruiser it is a hard, hard slog.

Navigation is a continuing process which starts as early as possible before passage planning begins. It must be assumed that, aboard a small cruiser, the owner is also the navigator. If not then it is up to the owner to let his navigator know his plans as soon as possible. The first action is to obtain small-scale charts of the whole area of the projected cruise, thus enabling the navigator to, as it were, see the whole picture at once. For this purpose, I use small-scale Admiralty Charts, and spend hours just looking at the charts, soaking up as much information as possible. By doing this I build up a large amount of detail in my head, some of which goes

into the passage-planning notebook, while the rest – because it does not bear immediate relevance to the route envisaged – remains in my head in case of need. All my planning charts are their original size, and I draw projected courses on them in 2B pencil, modifying as I go along until I reach a point where I am satisfied that I can make no further improvements. This of course includes possible alterations which might need to be made through force of weather or some other circumstance dictating a course of action which differs from the original plan.

One point I do make is to keep open-sea courses as short as possible with a maximum of twelve hours, because sailing a small boat for long periods can be very tiring, especially when one reaches my age! Also, I plan my departure for a time which will bring me towards the coast during the hours of darkness; preferably the last hour or two before dawn. By doing this I can take advantage of the distance at which one can pick up lighthouses in the dark, and so begin the coastwise section having obtained a positive fix on one or more of them.

Another point I make, and one to which I attach considerable importance, is to draw up a list of the nearest harbours along the route to which I can run in the event of unforeseen heavy weather; and on this point, I take Force 6 as the wind strength at which I look for the nearest shelter, and make for it. After all, I cruise for pleasure and can find nothing good to be said for masochism! Any wind force up to 6 is acceptable but at the top end of that force the fun has gone out of things, and one is left with a struggle for survival which is never pleasant. The problems attendant upon plotting a course to the chosen shelter in heavy weather are reduced by knowing beforehand where it is. At the planning stage I also make a list of all the lighthouses and navigation marks which will be met with along the way, together with notes regarding any hazards which might present me with problems.

When I have completed all this preliminary planning, I get down to the fine detail, and start by dividing the route into sections of one day's sail of not more than ten hours at a stretch. This allows two hours for mistakes or changes in the weather. In order to calculate distances to be covered each day, I assume a wind strength of Force 3 to 4 and a direction between due South and North-West. Should the wind go bad on me by coming right on the nose, I have immediate resort to the engine in order to make my destination before nightfall. The same applies if the wind falls light. I must say that I only use the engine as a last resort; I loathe the thing. But sometimes it has to be used, so part of my planning involves making sure that I have sufficient petrol for the maximum distance to be covered plus at least 25 per cent for emergencies. There is nothing more embarrassing and infuriating than to run out of fuel just outside a harbour entrance; and it can also be dangerous. Always allow for the unforeseen and you reduce the risks considerably. It is at the planning stage that these occurrences *must* be anticipated and allowed for. I call these the 'K' factors, and where they can occur I add 25 per cent to allow for them. I remember my father, from whom I learnt a great deal about navigation, saying that the good navigator made an allowance for every contingency that might arise, and then added a little bit more, and that to be a good navigator one had to be something of a pessimist so that everything that came out in your favour was a bonus.

Having completed all his planned courses and lists, the navigator transfers everything to his passage-making charts and his navigation notebook. But before he does this, he will be wise to make A3 size traces on polyester film of the entire planned route including as much detail as is necessary for him to recognise the meaning of the trace. All the charts shown in this book are reproductions of traces. To make a trace, fix the chart firmly to a drawing board or smooth table. Using a mild-strength draughting tape, fix an A3 size sheet of polyester tracing film over the portion of the chart to be traced. Trace in the coastal outlines and any features (outlying rocks etc) which have an important place in the overall plan. Don't forget to add in lines of latitude and longitude and the scale of miles taken from the left- or right-hand margins of the chart. Tracing can be done with a fine-point felt-tipped pen. With regard to colours, I always use black for the coastlines and red or green for the planned courses, but a key must be shown on the trace to indicate the meanings of the colours employed. The same process can be carried out for making a trace of an actual course sailed. One important fact: lines drawn with a felt-tipped pen are water washable, so don't let the traces get wet. As an experienced draughtsman, I prefer to use waterproof drawing inks and special pens for my traces.

The traces completed, the navigator goes back to his small-

scale charts and begins to transfer the courses on to his A3 size passage-making charts in black Chinagraph pencil. Proposed four-hourly positions can be marked as shown in Fig 35. If this position is in sight of land, a lightship or Lanby, the bearing and distance to it should be indicated as shown in Fig 36. By using the magnetic compass rose and correcting for Deviation, the navigator can enter all his courses in degrees Compass, thereby saving himself time at a later date.

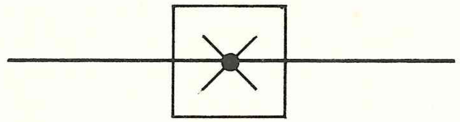

Fig 35

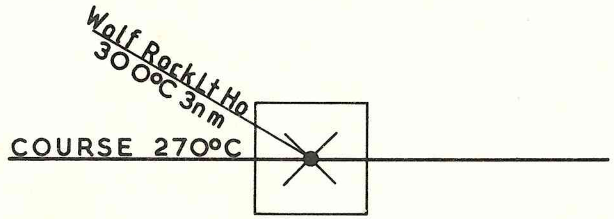

Fig 36

Since there are a number of imponderables in navigation, it is no bad idea to plan courses for the same route but with different wind directions, and here a good deal depends upon experience of an individual boat's capabilities. For instance, it is generally assumed that a boat can sail as close as to within 45° to the true wind. Maybe this is so, but she will not hold to this all the time; the wind does not blow continually from exactly the same direction, added to which the boat will point higher in the puffs than in the lulls. Only experience of the boat will tell the navigator what she will average to windward while making her best speed for a particular wind strength. Different boats are affected more or less by the action of waves. In planning it is necessary to take all these factors into account to assess the likely performance under average conditions, if such things exist. For my boat I never allow for a closer-winded ability than 50° to the true wind. In a Force 4 wind she only appears to make about 2° leeway and her sea-kindliness is such that in a seaway in the English Channel she appears not to be affected by wave action. However, in the short steep seas of the Thames Estuary I would allow another degree or two for wave effect. Were I making for Morlaix from Salcombe I would lay off a direct line course of 192°M, distance 88 n miles. With a wind South of South-West I could not lay the rhumb line (direct course), and would have to tack. The question which would then arise would be which would be the favoured tack? See Fig 37(i), where Wind 1 relates to Angle 1 and so on. In each case it is best to choose the worst condition which could prevail, assuming a wind speed of 17 knots. This would be from the West-South-West to South-South-East. Since sailing under these conditions would involve at least twenty-four hours at sea (the first leg of a cruise can always last this long if there are at least two helmsmen), one can ignore the effect of the tides since they will cancel out, and the

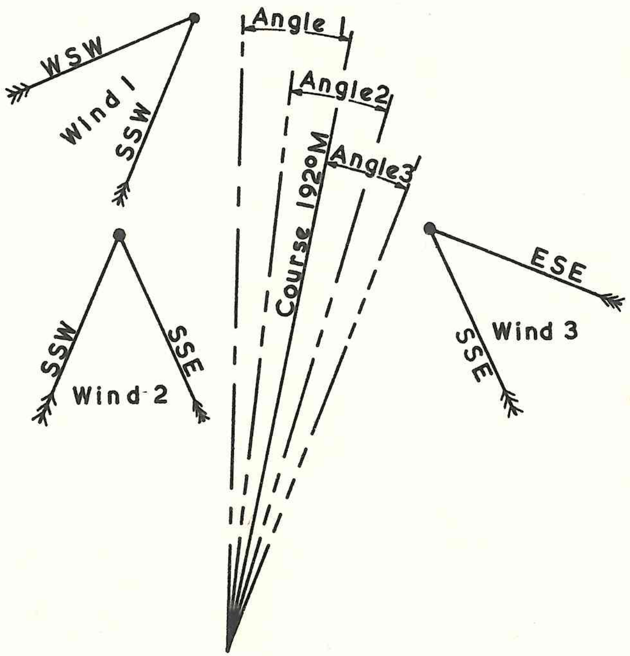

Fig 37(i)

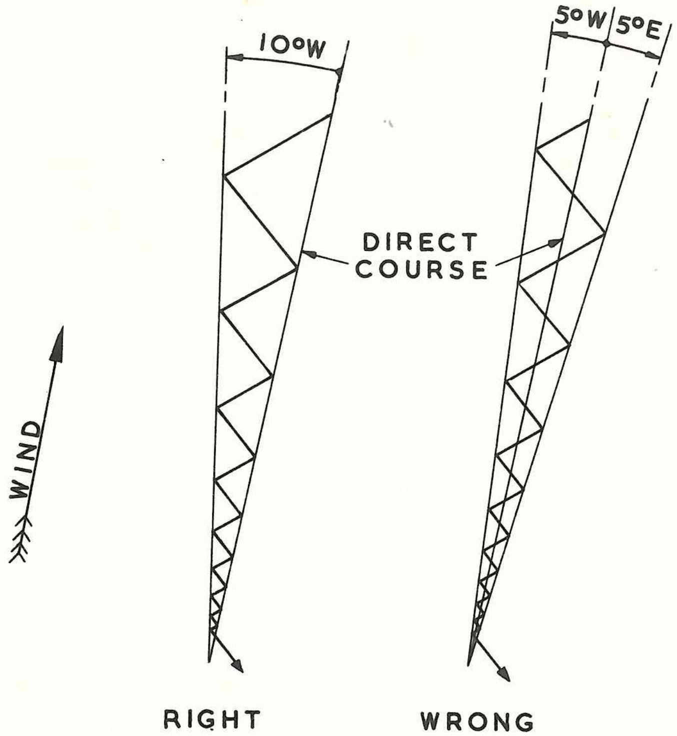

Fig 37(ii)

rhumb line would be from Bolt Head to Stolvezen Buoy at the entrance to Morlaix River.

Now the choice has to be made whether to set the angle of approach to windward of the rhumb line, to leeward of it, or right down the middle. With the wind from West-South-West there is no choice but to sail a mean course of 10°W of the rhumb line to the rhumb line itself. If the wind veers to South-West by South as shown in Fig 37 (ii) the 10°W angle would be about 3 miles to the good after six tacks, so it would be about 4 to 5 miles to the good by the time the apex of the angle was reached. The 5° either side of the course would finish up evens, whilst the 10°E angle would end up about 3½ to 4 miles to the bad; in other words it would mean at least another hour at sea. If the wind backed to South-South-East all three angles of approach would benefit considerably. If it only went back as far as South, the two outer angles in Fig 38 would be

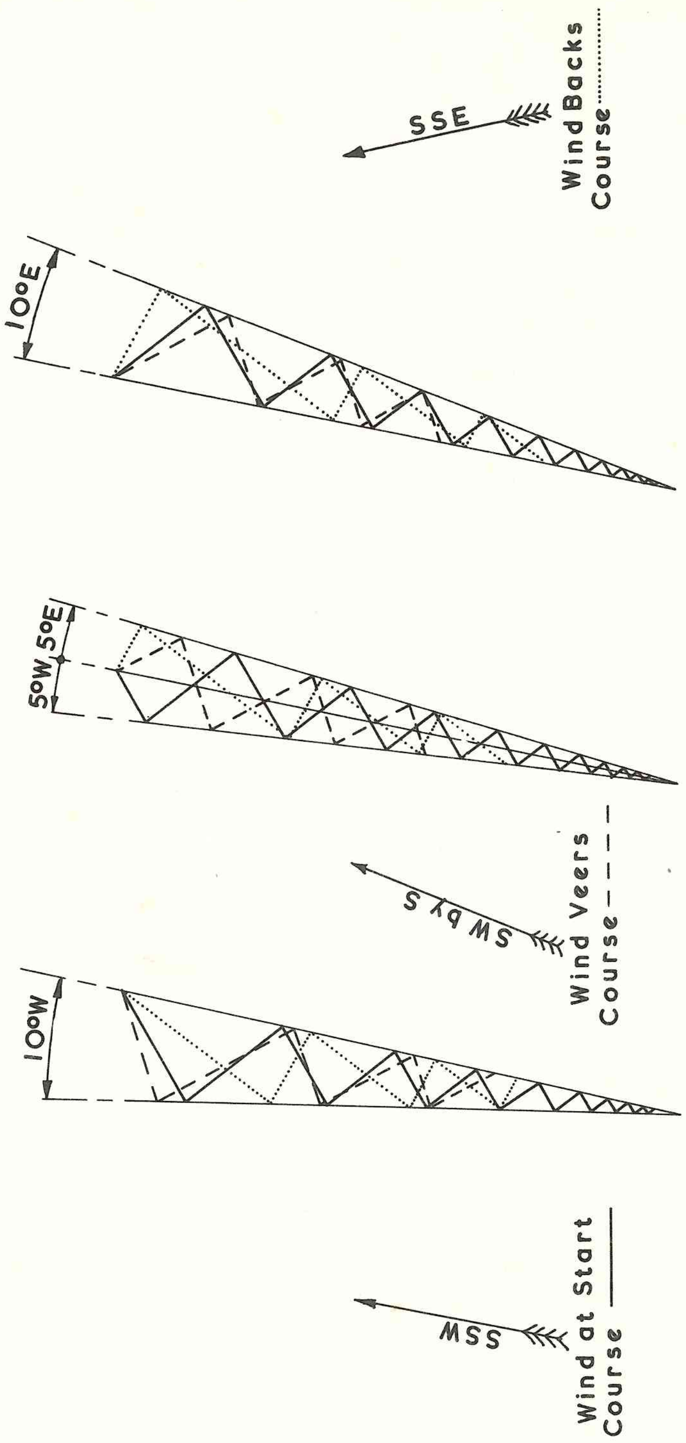

Fig 38

the losers, and the middle one would gain slightly. This example shows how valuable planning on the latest weather forecast can be. Never sail so that the mean course drops to leeward of the chosen one. Should the wind be blowing from East-South-East, then the angle of approach could be 5° either side of the rhumb line, see Fig 38. In either case, should the wind veer you will have gained considerably; should it back, you will not have lost too much.

These cases show the importance of forward and intelligent planning, choosing the plan best suited to the weather conditions when you set out and, providing that there is no major change in the weather, *sticking to it*. Do not alter a plan half-way through the trip unless there is a very sound reason indeed for doing so; that way lies uncertainty and despondency later on. I remember leaving Plymouth bound for Treguier on the North Brittany coast. With the wind West of South-West we could lay the entrance to Treguier River easily without having to strap everything in hard, and we had a very comfortable ride until, for no known reason, the navigator (not me!) decided to alter course for the Sept Iles Lighthouse which we picked up shortly before dawn. Instead of altering back to the mouth of Treguier River, he stood on until we were almost up to the Sept Iles themselves. In the meantime the wind backed, and we finished up with a most uncomfortable slog, short tacking in a very lumpy sea along that horribly rock-strewn coast. Had the navigator stuck to his original plot, the amount of windward work would have been reduced to, according to my later calculations, one short leg to get us to windward of the river mouth, followed by a long leg into and up the river.

The angle of approach may worry some people, but there is nothing to it. It is simply an angle between the arms of which all tacks are confined, the optimum angle being 10°. Any angle greater than this and too much sea is being covered for the ground gained, while the chances of making an accurate land-fall are reduced. Any angle less than 10° means too many tacks for the ground covered, see Fig 39 (i) and (ii). Apart from anything else, this can be tiring for the crew, upsetting (literally) for the cook, and generally bad for morale.

In addition to planning courses for a cruise, since the navigator also has to get the boat safely into harbour, he not only has to plan the pilotage into the ports and harbours it is intended to visit, but

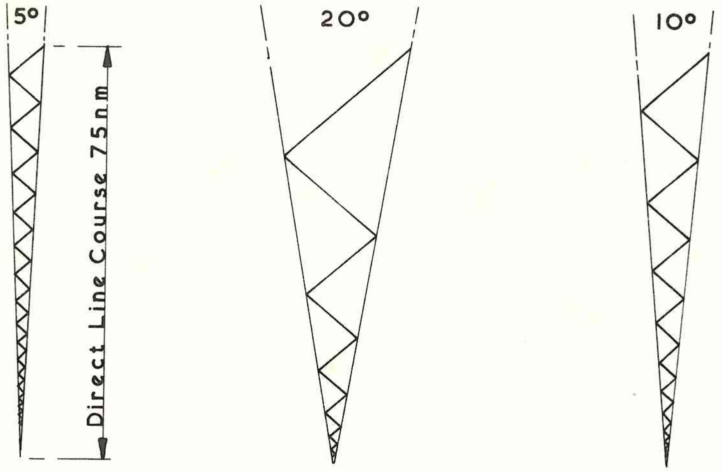

Fig 39(i)

Angle	Area Covered	Course Run	Tacks	% Distance	% Tacks
5°	236sq m	103nm	34	Nil	Plus 161·5
10°	483sq m	106nm	21	Plus 3	" 61·0
20°	966sq m	113nm	13	" 10	Nil

Fig 39(ii)

also into those to which it might be necessary to make for shelter. In his navigation notebook he should enter the name of each place together with the number of the relevant page in whichever pilot's guide he uses. For instance, he might be cruising down West to the Isles of Scilly and would enter the appropriate page numbers from the *South of England Pilot* or the *Macmillan Silk Cut Nautical Almanac*, as well as the number of the relevant large-scale chart in the folio which gives details of the entrance, anchorages and moorings. It is no use planning a cruise and at the last minute, possibly in the dark, searching through one or more books to find the way into a harbour, especially if it has started to blow up a bit. Far better to know exactly where to look for the information you need and to be able to get at it quickly. I find that if I have the time

to read up the details of an entrance, I can absorb a major part of that information and, as a result, the nagging worries that can beset a navigator when approaching an unknown harbour are greatly reduced. I have spoken to people who have got themselves into trouble while trying to make entrance to a strange harbour who have either said 'I couldn't find it in the pilot's guide' or 'I couldn't make the channel out'. In other words they had not done their homework properly. Never try to make an unknown entrance blind; good advance planning will tell you where to find quickly the details you want; this is a small premium to pay to ensure safe arrival.

In the navigator's notebook therefore there will be entries referring to the planned course traces, the passage-making chart numbers, details of entrances to harbours and estuaries, and any special hazards or possible problem areas for which to keep a look-out. This notebook needs to be fairly large because it will contain more than the planning notes; it will contain information about each day's sailing (written up the day before), as well as the navigation log and space for calculations. The good navigator takes with him a plentiful supply of tracing material, pencils (HB and 2B), more than one pencil eraser and, if he uses the encapsulated charts described in Chapter 1, a large supply of Chinagraph pencils (black, green, red and yellow), and a block of notepaper for making additional notes and performing all the odds and ends of calculation that make up so much of a navigator's life.

I use the second half of my navigation notebook as the navigation log. I write details of courses, times and extracts from the deck log, plus any other relevant information such as times of high and low water, and the log reading at the time of departure. This latter is vital because no one will remember the reading an hour later, let alone three or four hours on. If for any reason I have to take a sun sight, which is very infrequent in my sailing area, I use a sheet of the type recommended by Mary Blewitt in her book *Celestial Navigation for Yachtsmen*. When completed, it is put into the boat's log. By keeping this separated from the navigation notebook I eliminate the possibilities of muddling up two entirely different types of working. I would add here that, so as to keep his papers, charts, notebooks, etc in order, the navigator should have some type of waterproof satchel or hold-all. This must be of a size to hold at least three A3 size chart folios, tidal atlas, nautical almanac, notepad, sheets of tracing film, all his instruments (in a separate pocket), and it is no bad thing to include pads of weather forecast sheets and the ship's log, either in the form published by a number of firms, or a good A4 size stiff-backed notebook ruled up to suit the method of entry. The radio log, if a radio transceiver is carried, should also be a stiff-backed notebook ruled up to suit and be kept in a safe place near the radio set. The main ship's log will carry a certain amount of information transferred from the navigation log such as the EPs as they are worked up, and any positive fixes obtained.

Lastly, on the subject of mini-cruise planning, I would stress the fact that this can make or mar a cruise, so it must be as thorough and accurate as possible and, once the whole cruise is planned, re-written in the correct sequence.

I have talked about planning in relation to cruising, but in these days of trailer-sailers when the point of departure can be a different place each week-end, it is sound policy to plan the week-end cruise on week-day evenings, especially if the area is unknown. A few hours spent in encapsulating new charts, looking at them and making relevant notes, will be amply repaid by a couple of days free from worry about safe navigation.

When making a coastwise passage of a few hours' duration, three things need to be taken into consideration: the best course or courses for reaching the destination, obstacles to these, and the weather in all its aspects. Let us assume that the first leg of an intended cruise is to be from Burnham-on-Crouch to Lowestoft, and that it has been decided to leave Burnham just before high water at 0350hrs. The weather forecast has given a wind from the South-West, Force 4 with a bright sunny day. At 0330hrs you are under way with the first of the ebb under you after the first half hour, and you make the Whittaker Beacon at 0500hrs. The trace (Fig 40) shows that the best course takes you within $3\frac{1}{2}$ miles of Orfordness at 41 n miles. The only likely obstacle on this course is the Gunfleet sand, and it takes you just under a mile along its Eastern side. Having deducted the necessary 2° for Compass Deviation from the Magnetic course of 61°, you give the helmsman a course of 59° Compass to the sunk light vessel 21 miles distant. For the first three hours you will have $1\frac{3}{4}$ knots of tide under you, so that you will reach the light vessel after

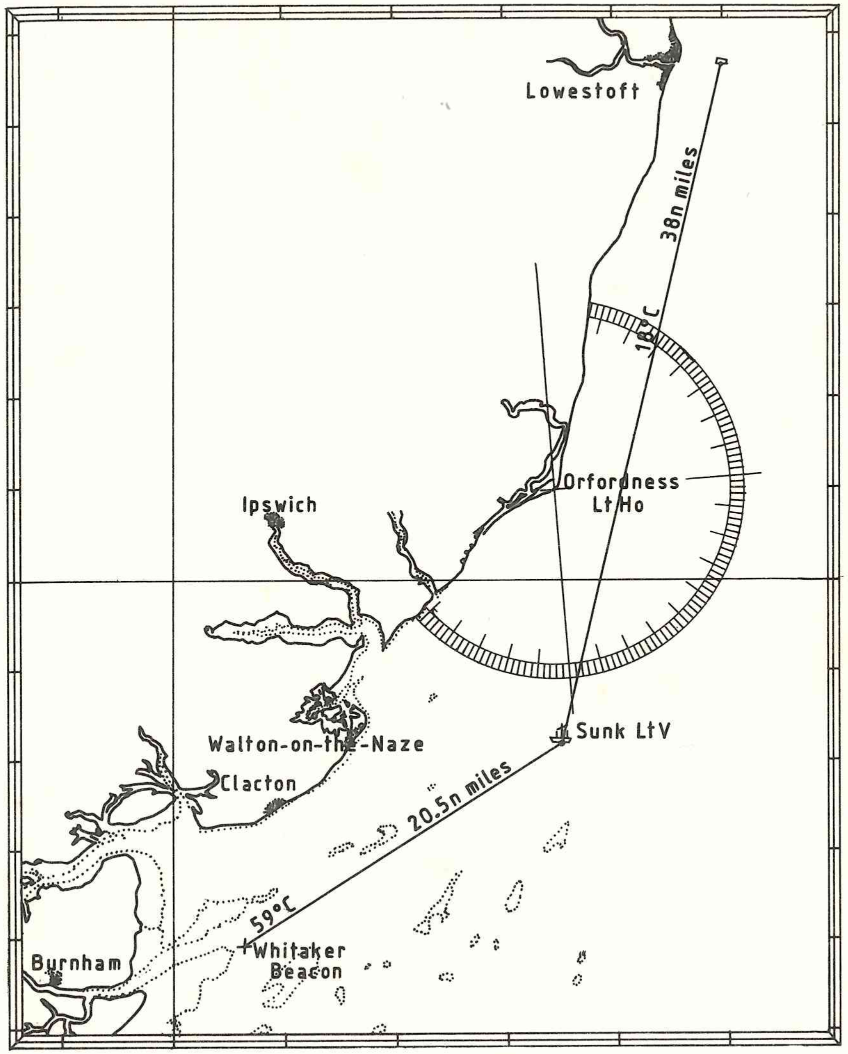

Fig 40

approximately two hours and forty minutes, and for the next two hours you will still have one knot to help you on your way. You will however have to alter course at the light vessel for the West Newcombe Buoy 38 miles distant. This means that you can add just over 7 miles to your distance run after five hours. With a Force 4 South-Westerly and a spinnaker set, you should make a good 6 knots. So, with 1·4 knot tide under you, you'll be making 7.4 knots over the ground with no leeway to allow for. Surface drift will be negligible, but it is as well to check by taking a bearing on the Whittaker Beacon just after altering course, and another after 2 miles have been registered on the log. This will show the combined effect of tide and drift. But under the circumstances I

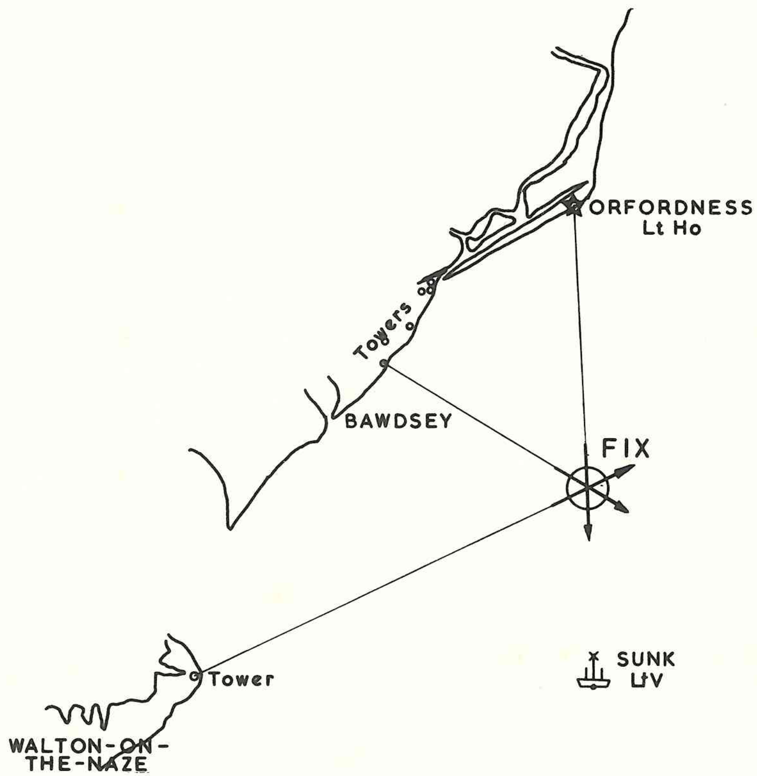

Fig 41

have outlined, it is my guess that these effects will have no appreciable influence on the course to be steered.

As the boat sails up the coast there will be a number of features on which the navigator will be able to obtain a fix. The first two are Clacton Pier and the Tower on Walton Naze. In the chapter on charts I describe how compass roses are drawn round important navigational features. On my East Coast chart I have drawn a rose round Orfordness lighthouse. The method of using this is as follows. Standing in the best position for using the mini compass, take a bearing on Walton Tower, and if you can see it – and with good visibility you should – repeat for the southernmost of the Bawdsey radar towers, and the Sunk light vessel. In each case

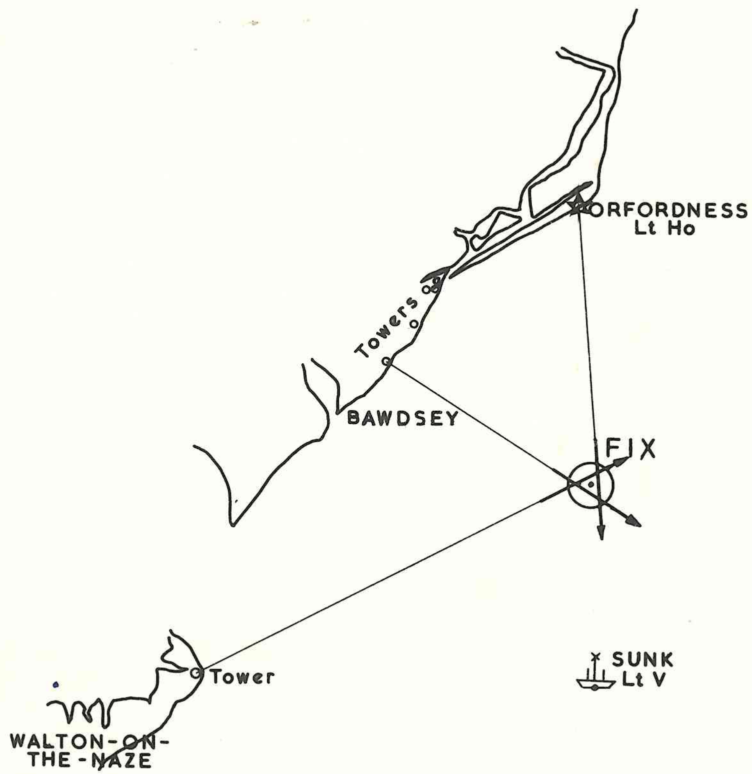

Fig 42

where the bearings are greater than 180°, it will be necessary, in order to obtain back bearings from them, to subtract that sum from the bearing obtained. Where the bearing is less than 180°, it is necessary to add that amount. Then, using the centre point of the compass rose, the straight edge of the pantograph is locked on to a bearing, and a straight line drawn from the relevant point. This is repeated for each feature in turn. There will then be three lines drawn on the chart, and where they cross will be the boat's position as shown in Fig 41. The time interval between the bearings, if short, can be ignored. Should there be an appreciable time interval, the result of drawing in the back-bearing lines will be a triangle or 'cocked hat' as in Fig 42. In fact, the chances are that not even a set of simultaneous bearings would produce a one-point crossing of the back-bearing lines, but the centre of the triangle will be the boat's position as near as makes no odds. If the triangle is a large one the navigator will, having checked his work, take a fresh round of angles, this time taking more care.

As the passage proceeds, Orfordness will come in sight and this can now be used for fixes. Each time a fix is obtained, the navigator plots it on the chart and compares it with his planned course. In between obtaining fixes the navigator should keep a running plot going, using courses steered and readings from the log. This produces the Estimated Course (EC), and each time it is worked up the result gives the Estimated Position (EP). The difference between the EC and the course obtained from fixes should not, on such a passage as this, be very much. But where there is an appreciable difference the course obtained from fixes is the one to rely on. In the event of the course sailed differing from that which was planned, the navigator has to work out the alteration necessary to come back on to it.

When Orfordness lighthouse is abeam, by taking a running fix on it it is possible to obtain a positive point of departure, or by doubling the angle on the bow. To obtain a running fix, a bearing is taken of a fixed object – in this case the lighthouse – and at the same time the log is read. After sailing *on the same course* for a period of time which gives a reasonably open angle, another bearing is taken and the log is read again. By drawing the two back bearings on the chart the two main lines for the method are in place. The first log reading is subtracted from the second, and the distance run is the result. This distance is marked off, to chart

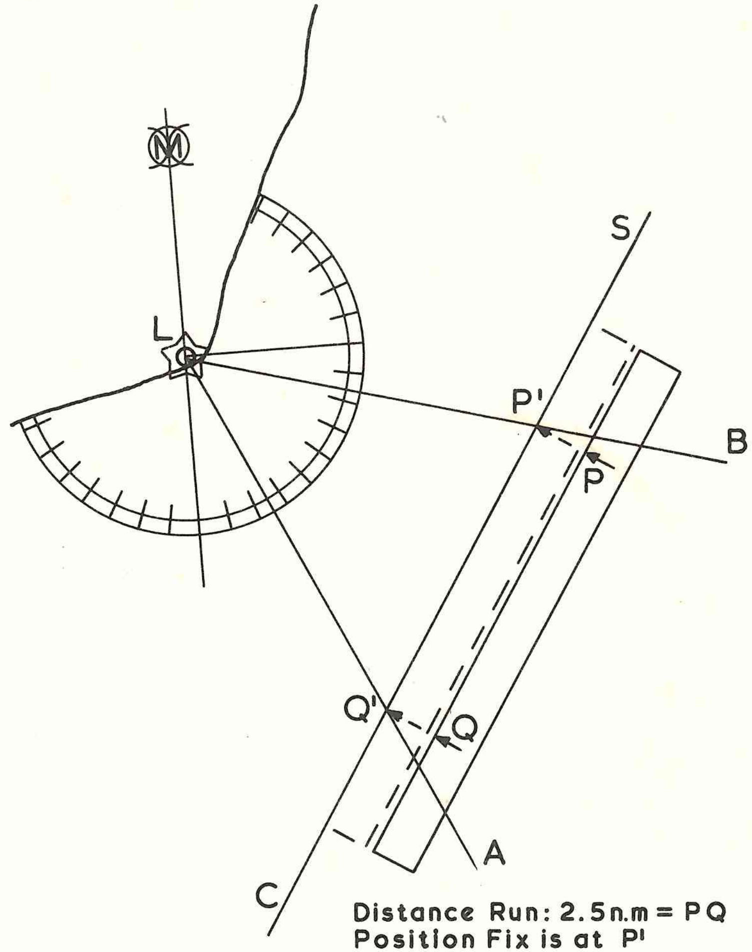

Fig 43

scale, on a piece of paper which is laid on the chart along the line of the course sailed, and moved back and forth across the chart until the two marks on the paper coincide with the back-bearing lines. The second position is the fix. See Fig 43 where the lines LA and LB are the two back-bearing lines. PQ is the scaled edge of the piece of paper, CS is the course steered and P1 and Q1 are the two points where the distance run coincides with the back-bearing lines. Remember that PQ must always be parallel to the line CS.

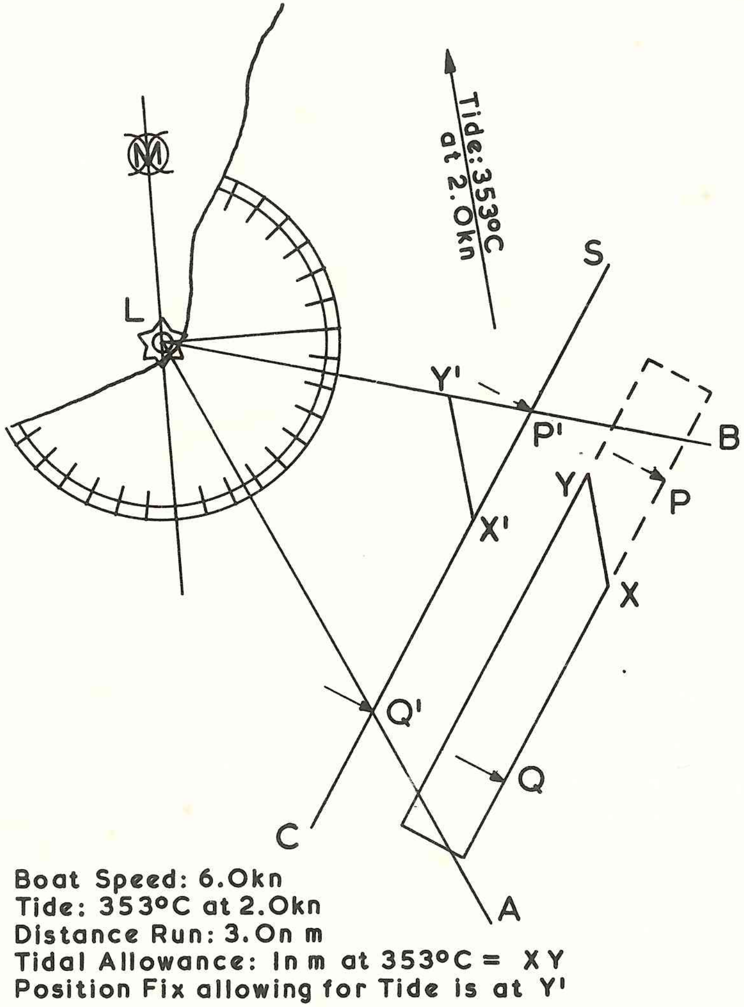

Fig 44

Using the Mark V chart board one can mark the distance run on the straight edge in Chinagraph pencil, set the straight edge on the course steered and move it across until the two points coincide with the back-bearing lines. When taking a running fix it is often necessary to make an allowance for the tide, and this is done as follows. The distance run PQ in Fig 44 is marked off on a strip of paper and the allowance for tide XY is drawn to scale at the angle

of the tide. The paper is cut or folded along the line XY, and is moved across the chart keeping PQ parallel to CS until PQ corresponds with P′Q′. X′Y′ being the tidal allowance, your actual fix will be at Y′.

Doubling the angle on the bow is really only another form of running fix, and can be done in two ways. In method one, the navigator takes the log reading when the object bears 45° on the bow, angle LPQ in Fig 45. The log is again read when the object is abeam at 90°, angle LQP. The distance run between the two log

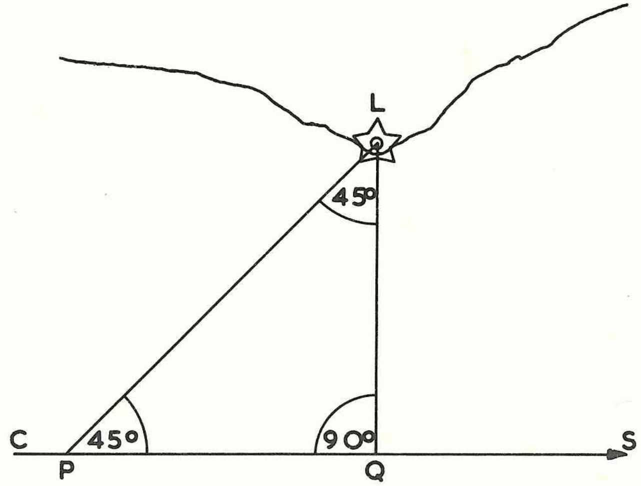

Fig 45

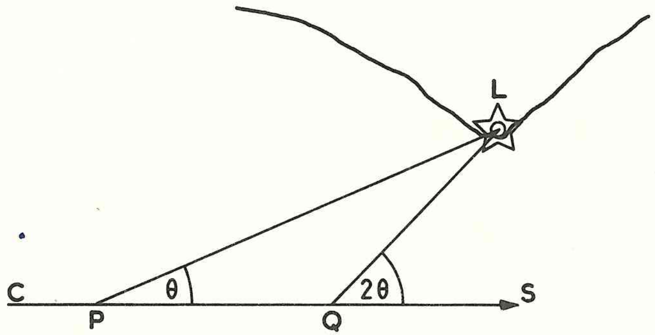

Fig 46

readings is the same as the distance between the object and boat when the former is abeam since the two distances form the equal sides of an isosceles triangle (LQ=LP). In method two a bearing θ, angle LPQ in Fig 46, is taken at the same time as the log is read. When the angle to the object is $2\times\theta$, angle LQS in the same Fig, the log is again read. As in method one, the distance from the object is the same as the distance run, and for the same reason. There are therefore three different ways of obtaining a fix when coastwise cruising. All three are reasonably accurate providing that care is taken when obtaining the bearings. Of the three, I prefer the running fix as it takes less time than obtaining a set of cross bearings, and only requires one point ashore. Using my Mark V chart board the whole thing is very easily worked out. All three methods are considerably simplified if compass roses are drawn as described in Chapter 1.

To return to the trip from Burnham to Lowestoft; the navigator has fixed his position off Orfordness, and has altered course to 020° Compass. From here to Lowestoft he has plenty of features ashore on which to obtain fixes. Among these are three churches, the Signal Station Tower at Southwold, and – if it is getting dark – the light on the North Mole of Lowestoft Harbour. Although he now has to buck a South-going tide, he has brought the yacht safely to where he would have her be. His only remaining problem

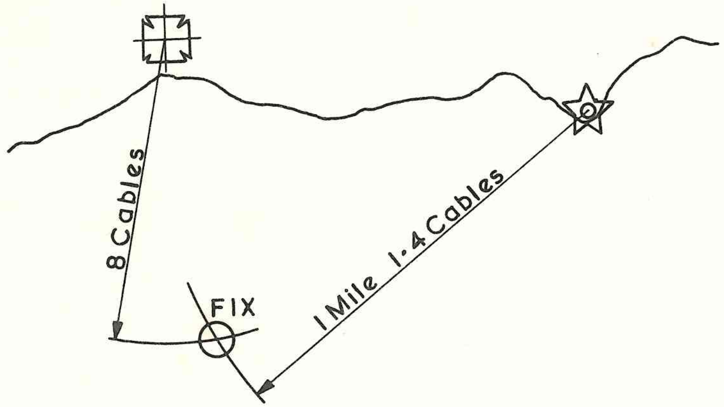

Fig 47

is to get her into the harbour. Since the tide off the harbour entrance runs pretty fast he has to make allowance for this when going in. This is where the pilot's guide and tidal atlas will be of great help.

I want to mention two other methods of obtaining a position fix when coastwise cruising, both of which are accurate and easy to do. The first involves the use of a rangefinder which is a useful instrument to have aboard – not difficult to obtain, but a bit on the expensive side. For this method the compass is not needed at all. One simply obtains the range of two objects which are recognisable on the chart. With each object as centre, the ranges as radii, two arcs are drawn as in Fig 47. The point at which the arcs intersect is the boat's position. There is however one slight snag; some rangefinders are only calibrated in cables up to $1\frac{1}{2}$ miles so they can only be used if one is sailing fairly close inshore, and with a fairly large-scale chart on which to work. One very useful purpose rangefinders do serve is when dodging super tankers and large container ships. The navigator keeps an eye on the compass bearing of the ship, and when she seems to be about a mile away reads off the distance. If the distance then decreases rapidly while the compass bearing alters only very slowly, it is time you weren't there! Always remember that these big boys answer their helms very slowly, take a long time to slow down, and probably haven't seen you anyway. This, in my opinion, applies to all merchant ships, and I always alter course so as to pass at least one cable astern of them. The Royal Navy are very good indeed – they have probably spotted you before you see them. Nevertheless, I make a very positive alteration of course to show them what my intentions are.

There are lightships, Lanbys and various types of buoy which, providing that they can be recognised on the chart, can be used for obtaining a fix. The chart needs to be fairly large scale so that channel buoys and the like are shown. On the smaller-scale charts only the major buoys are shown, and this could cause confusion. There are plenty of navigation buoys on the East Coast but on the South Coast, where they are fewer and farther between, one has to use shoreline features practically all the way or, as on passage from Plymouth to the Isles of Scilly, one has to go right offshore and sail from the Eddystone lighthouse to the Wolf Rock lighthouse. One does get a sight of one or two headlands, and if they can be recognised, it is possible to get a running fix, but sharp eyesight is needed.

When the passage has been completed, it is a good idea to make a full tracing of planned course, dead reckoning course and actual course sailed as obtained from fixes. In the past I have used these traces to prove to the authorities that I had been where I said I'd been. Also, it is best to transfer all navigation information to the ship's log, and all in correct sequence. When arriving at the port or harbour of destination, write up the yacht's log to date and then present it to the Harbour Master for his signature and stamp.

Having dealt with coastwise passage making, it would seem logical to take a look at crossing the North Sea or the English Channel. The navigator has to plan his courses in the same way as for coastal cruising, but there is one difference; he may have to make for a point at sea, out of sight of land, where there is no mark of any kind. It is possible to choose a point, perhaps 20 miles offshore, where two lighthouses appear over the horizon at the same time. At night this presents few problems, but by day one needs sharp eyesight and good binoculars.

Let us assume that a cruise is planned to cover the Brittany coast from Morlaix westwards. The navigator gets out his planning charts, and having perused them for several hours he makes his decision. There are two lighthouses with long-range lights: the Ile de Batz, Gp Fl (4) 25 sec, 23 miles, and Les Sept Iles, Gp Fl (3) 15sec, 24 miles. This means that one light will come over the horizon when it is 24 miles away, and the other when it is 23 miles away. The navigator chooses these two lights for a number of reasons; firstly, he has planned to be about 20 miles off the coast about two hours before daybreak so that the looms of the lights and the lights themselves will be clearly visible in the dark. The second reason is because the characteristics of the lights are sufficiently different to prevent any confusion in their recognition. Thirdly, he has decided to make his point of approach to the coast from an easily identifiable point. This point is the intersection of the radii of maximum range of visibility of the two lights. But these two radii are not 23 and 24 miles respectively as shown on charts. To these must be added the distance of the horizon from the height of eye of the observer. The height of my eyes when I am sitting down is 2ft 8in. The height of my boat's cockpit above the water line is 18in. So, my height of eye above sea level is 4ft 2in

which, according to the tables, gives a horizon distance of $2\frac{1}{2}$ miles. Therefore the ranges of the two lights go up to $25\frac{1}{2}$ miles and $26\frac{1}{2}$ miles respectively.

If the navigator is using the encapsulated charts described in Chapter 1, he will already have drawn the radii of maximum range round each of the lighthouses, and he will have made a note of the geographical position of this point. In this case it works out as 49°10′N, 3°59′W. Upon examination of this point on the chart it will be found that it is exactly on the line joining the western end of Plymouth breakwater and Stolvezen Buoy or the Pot de Feu, the point of safe entry into Morlaix River: the ideal point of approach to the coast. The bearing of the entrance to Morlaix River from Plymouth is 181°M. With the prevailing winds varying between North-West and South-West, the only ones to present any navigation problems are the South-Westerlies. So, the navigator decides to kill the dragon at the earliest opportunity. He therefore draws a 10° line to the West of the rhumb line and then draws a line at 270°M to clear Rame Head by about 1 mile. His Compass Deviation Card shows 2° West deviation for a bearing of 270°, so his first course will be noted as 272° Compass 16 miles. This brings him roughly off the mouth of Fowey River but a mile offshore. Depending on the time of start, he makes due allowance for tidal effect and orders his course accordingly. When the boat reaches a point 1 mile South of Pencarrow Head, he puts the boat about and orders a course of 169° Compass. This will take him on to the intersection point of two lighthouses 60 miles distant.

On this point of sailing he is well up to windward of the rhumb line and sailing fairly free. If the wind backs, which in our part of the world is unlikely, he is in a good position with something in hand before he has to think about taking another tack. In a Force 4 he'll probably be making the best part of 5 knots, so that at the end of 60 miles' sailing the tides will have cancelled out. Remember that they do not always do this, and that allowance has to be made for them if necessary. If everything goes according to plan, and he gets his point of intersection, the navigator alters course on to 182° Compass and, if he can hold that without tacking, after 6 miles he will pick up the light of La Phare de la Lande, Fl 5sec, 23 miles. If he holds this course it will take him safely into the mouth of the river.

What happens, you ask, if he does not hit his point of