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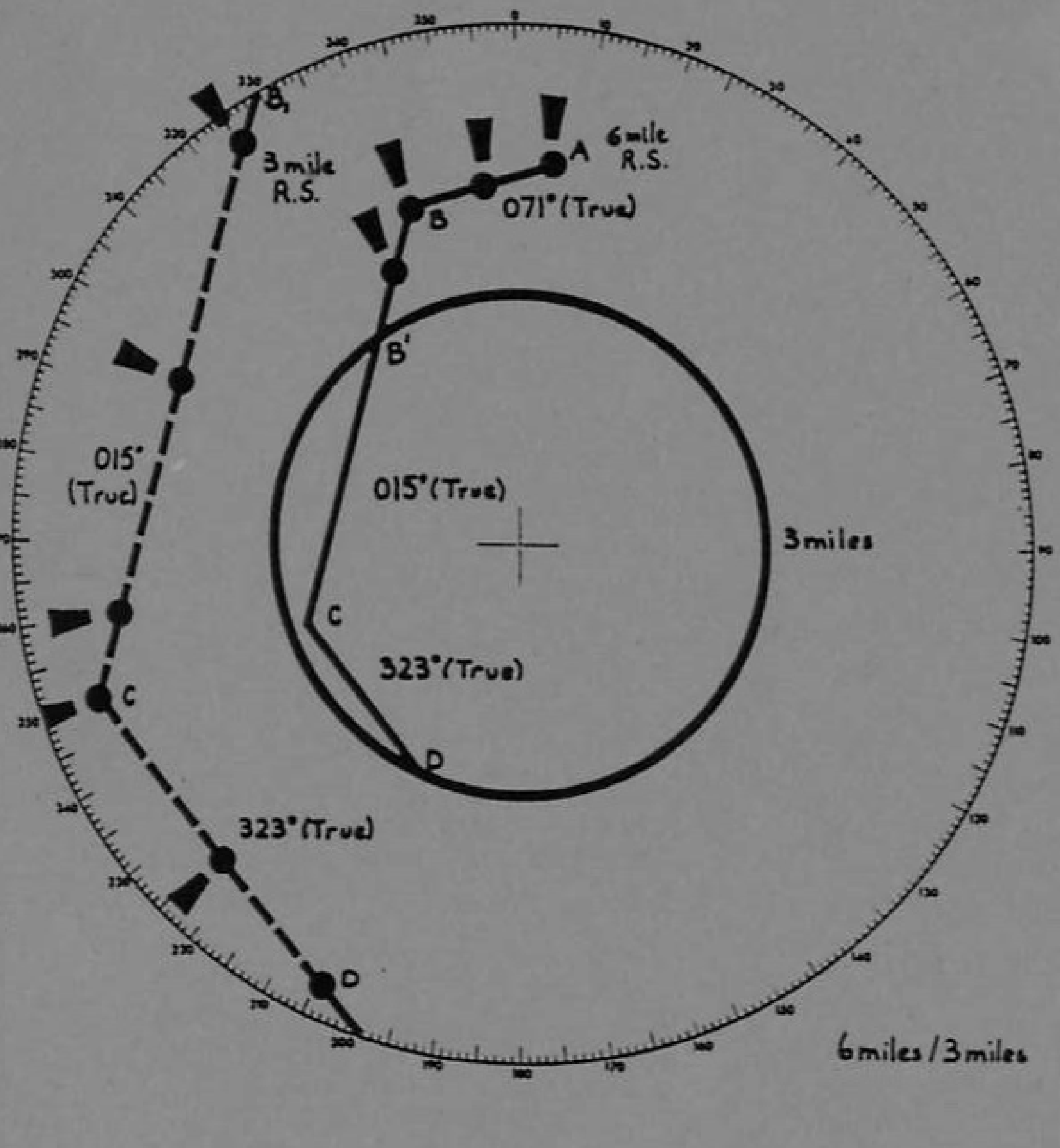
Parallel Indexing Techniques



Parallel Indexing Techniques

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Contents

1-Introduction

After careful consideration we have decided against updating the contents of this book because the principles of Parallel Indexing does not change with time.

As we approach the end of the twentieth century, many navigators are still not using Parallel Indexing to monitor their vessel's progress and their vessel goes aground simply because the bridge team does not know the position of the vessel at all stages of the navigational passage.

The majority of modern rasterscan radar/ARPA displays have electronic parallel indexing lines available for use, similar to the type described in Annex 3.

Unfortunately we have already had GPS assisted groundings because of the inability of the navigator to correct the GPS displayed position using the datum corrections required before plotting the corrected position on the chart. A jet fighter pilot recently said that the major problem with GPS is that I know where my aircraft is, but where is the position of the airfield?

Thus Parallel Indexing used in conjunction with keeping a good visual lookout and other electronic navigational aids available, will continue for many years to come to provide the prudent navigator with that critical piece of navigational information, the position of his or her vessel NOW.

Ian Smith
March 1997

2-The Use of Parallel Index Techniques as an Aid to Navigation by Radar

(extract from Merchant Shipping Notice No. M. 860)
Notice to Owners, Masters and Officers of Merchant Ships and Fishing Vessels

(i) Investigations of casualties involving the grounding of ships, when radar was being used as an aid to navigation, have indicated that a factor contributing to the grounding was the lack of adequate monitoring of the ship's position during the period of time leading up to the casualty. Valuable assistance to position monitoring in relation to a pre-determined navigation plan could have been given in such cases if the bridge personnel had used the techniques of Parallel Index Plotting on the radar display. Such techniques should be practised in clear weather during straightforward passages, so that bridge personnel become thoroughly familiar with this technique before attempting it in confined and difficult passages, or at night, or in restricted visibility.

(ii) The basic principle of Parallel Index Plotting can be applied to either (a) a stabilized relative motion display or (b) a *ground*-stabilized true-motion display.

(a) On a stabilized relative motion display the echo of a fixed object will move across the display in a direction which is the exact reciprocal of the *course made good* by own ship at a speed commensurate to that of own ship over the ground. A line drawn from the echo of the fixed object tangential to the variable range marker circle set to the desired passing distance will indicate the forecast track of the echo as own ship proceeds. If the bearing cursor is set parallel to this track it will indicate the course to make good for own ship. Any displacement of the echo from the forecast track will indicate a departure of own ship from the desired course over the ground.

(b) On a ground-stabilized true-motion display, the echo of a fixed object will remain stationary on the display and the origin of the display (own ship) will move along the course made good by own ship at a speed commensurate to that of own ship over the ground. A line should be drawn from the echo of the fixed object tangential to the variable range marker circle set to the desired passing distance. If the electronic bearing marker is set parallel to this line it will indicate the course to be made good by own ship over the ground. Any departure of own ship from this course will be indicated by the drawn line not being tangential to the variable range marker circle. (The variable range marker circle should move along the line like a ball rolling along a straight edge).

(iii) The engraved parallel lines on the face of the bearing cursor can be used as an aid to drawing the Index Lines on, say, a reflection plotter and to supplement the bearing cursor.

(iv) It should be borne in mind that Parallel Indexing is an aid to safe navigation and does not supersede the requirement for position fixing at regular intervals using all methods available to the navigator.

(v) When using radar for position fixing and monitoring, check:

(a) the radar's overall performance;

(b) the identity of the fixed object(s);

(c) gyro error and accuracy of the heading marker alignment;

(d) accuracy of the variable range marker, bearing cursor and fixed range rings;

(e) on true-motion, that the display is correctly ground-stabilized.

(extract from Merchant Shipping Notice
No. M.854, Annex)

Navigation Safety — Guide to the Planning and Conduct of Passages — Monitoring.

Paragraph 23 States:

Radar can be used to advantage in monitoring the position of the ship by the use of parallel indexing techniques. Parallel indexing, as a simple and most effective way of continuously monitoring a ship's progress in restricted waters, can be used in any situation where a radar-conspicuous navigation mark is available and it is practicable to monitor continuously the ship's position relative to such an object.

3-Relative Motion Gyro Stabilized North Up Presentation

Instruments required:

1. Reflection plotter
2. Chinagraph pencil(s) — recommended colours green, white and yellow (if only one colour available use solid, pecked or dotted lines.)
3. Ruler

Before proceeding further, a mention of the errors encountered in radar sets, which would have serious consequences for a ship using PI if they were not corrected and/or allowed for when setting up the PI plot.

(i) The radar's overall performance

(ii) Centring Error — can be corrected by X-Y plate shift

(iii) Fore and aft line of radar not coinciding with Fore and Aft line of ship

(iv) Heading marker bearing scale error

(v) Gyro Error

(vi) Azimuth stabilization error

(vii) Electronic Bearing Indicator (EBI) Index Error

(viii) Variable Range Marker (VRM) Index Error

(ix) Parallax in reflection plotter (adjust half-silvered mirror in plotter)

(x) Ensure that in true motion the display is correctly ground stabilized

It is important that the above items are checked before using PI.

Radar conspicuous marks can be found:

(i) From previous experience of radar picture of the area

(ii) Printed on charts

(iii) By studying the likely objects on the chart bearing in mind shape, size, aspect and material

Proficiency should be achieved in straightforward circumstances before using PI in more difficult conditions.

Having complied with all the requirements for accuracy, we can now look at examples of PI.

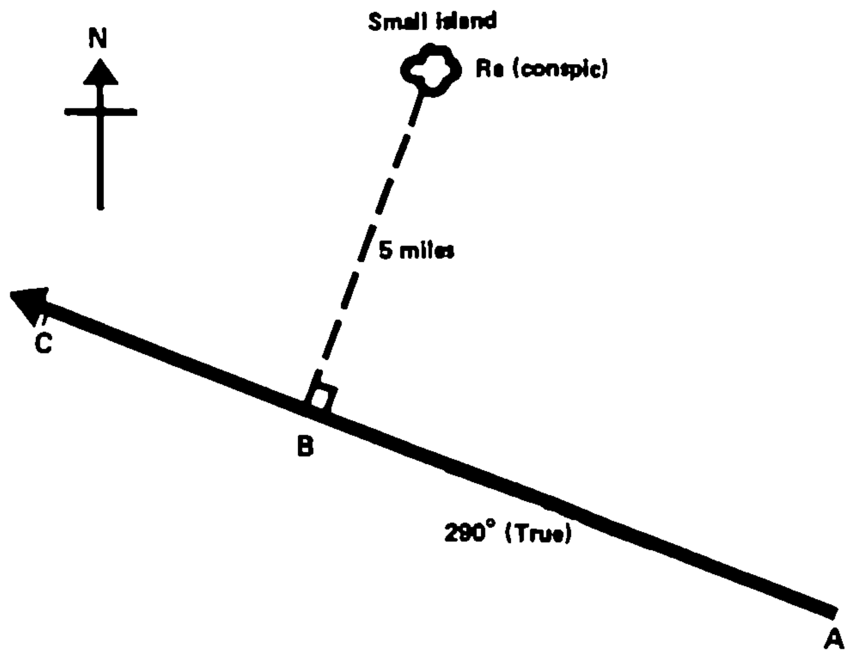


Fig. 1a

Figure 1a shows a single course line of a vessel proceeding from A to C on a course of 290° (True) to pass 5 miles off a stationary, isolated radar conspicuous target. The same situation transferred to a PPI display, figure 1b, would show the target tracking down the imaginary line ABC parallel to the course line if the vessel maintained her course line.

When the ship is at position A in figure 1(a), the echo will appear at position A in figure 1(b) and when at

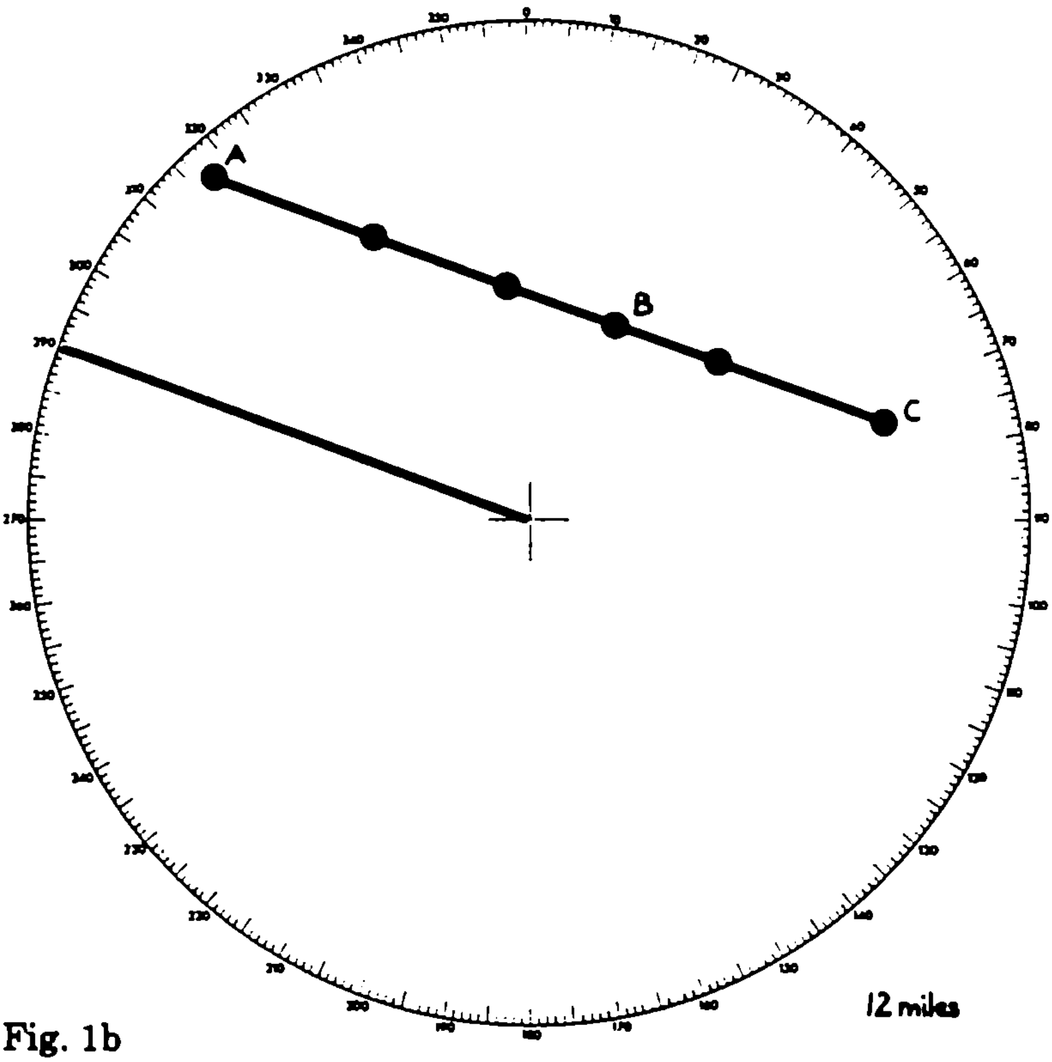


Fig. 1b

position B on the chart the echo will appear at B on the PPI, and similarly for position C. Having understood this basic principle, it should now be possible to construct the line ABC on the reflection plotter *prior* to arriving at position A on the chart.

To construct a PI line on reflection plotter

Refer to figures 1a and 1b. From position A, figure 1a, obtain a bearing and range of the target. This is found to be 317° (True) x 11.0 miles. The bearing and range are now drawn on the reflection plotter, using a Chinagraph (grease) pencil, from the centre of the PPI giving us position A, figure 1b. The methods of laying off the bearing are by (a) Mechanical bearing cursor, or (b) EBI — remembering to check the EBI first for Index Error. The method of laying off the range is by means of the VRM — remembering to check the VRM for Index Error.

Likewise from position B on the chart, a bearing and range of the target are obtained. This is 020° (True) x 5.2 miles. Position B can now be constructed on the reflection plotter, as can position C, 074° (True) x 8.8 miles. We now have points A, B and C on the reflection plotter and when these points are joined up, the direction of the line obtained will be the same as the course line, i.e. 290° (True). If this is not so, then the bearing and ranges must be re-checked in order to eliminate the error which has occurred through inaccuracy.

We now have a PI line on the plotter and as previously mentioned, if the ship keeps to her charted track, the echo of the target will keep to the line ABC and we are in a position to continuously monitor the ship's progress along its charted course.

It should be stated at this point that using PI does *not* relieve the OOW from his obligation of fixing the vessel's position on the chart by other means e.g. visual fixes, navigational aids, etc.

Action to be taken when echo departs from Index Line

When the ship deviates from its charted track for any reason (collision avoidance, leeway, set), the echo will leave the indexing line and an alteration of course will be required to counteract this, thus bringing the vessel back onto its track. When indexing without the aid of visual navigation, the question arises 'Which way do I alter?' This question resolves itself more readily on some headings than others. Let's look at the four Cardinal point headings:

Course — North

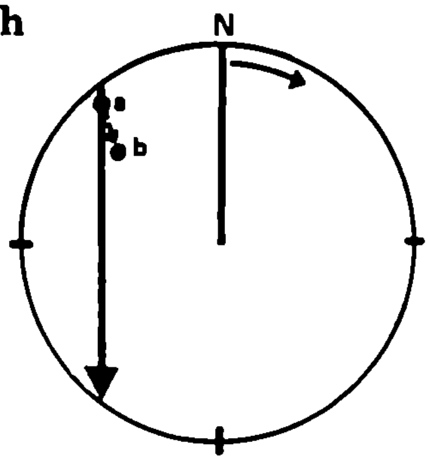
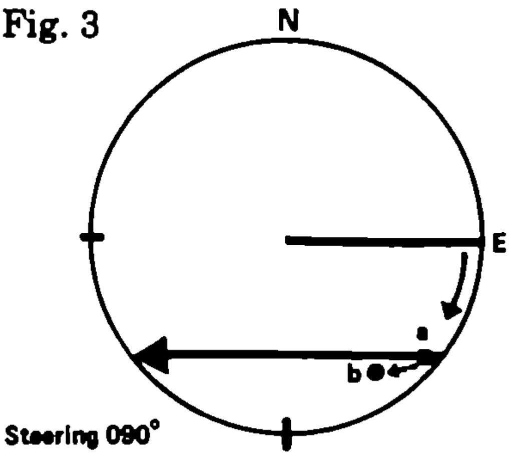


Fig. 2

PPI North up gyro stabilized

In figure 2, with the ship steering north, the point of interest should track down the index line in the direction of the arrow. It can be seen that at position 'a' it is doing so but at position 'b' the echo has left the track and is now closer to the ship, so in order to make the line and the echo coincide, the ship must alter course to starboard, the amount of the alteration depending upon the prevailing situation — the larger the alteration the more quickly the line and the echo will come together.

Fig. 3



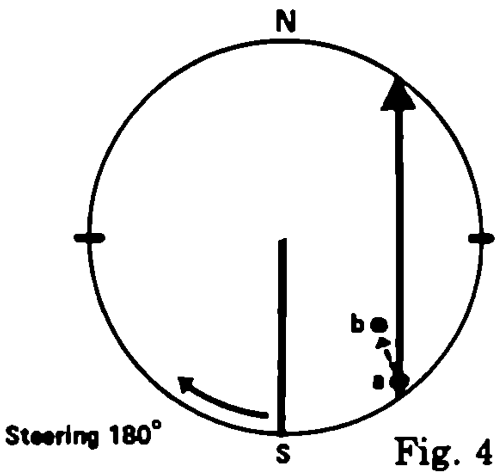
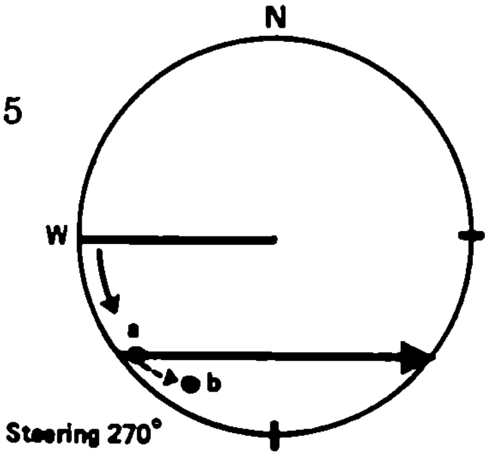


Fig. 4

Fig. 5



Course — East In figure 3, on an 090° course, the echo has come off the line at position 'b', i.e. vessel has gone further away from point of interest, so an alteration of course to starboard is required to bring vessel back on course.

Course — South In figure 4, on a 180° course, the echo left the line at 'b' so vessel is too close to point of interest and an alteration of course to starboard will be required. This situation sometimes causes problems for a new user of PI technique.

Course — West In figure 5, on a 270° course, the echo at 'b' indicates the vessel is now too far from the point of interest so an alteration of course to port is required.

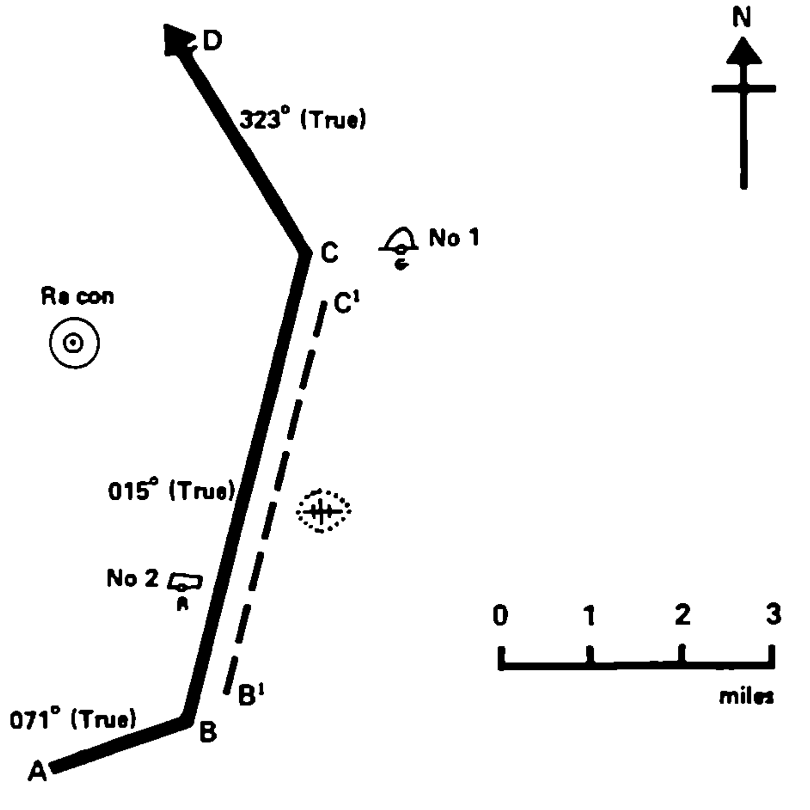
It can be seen from the 4 examples on the previous page that the alteration of course by the ship is in such a direction as to always bring the indexing line to the echo. If this principle is remembered, the alteration of course, especially when on a southerly course should raise no doubts in the user's mind. (See Annex 1 for further examples).

NB Always bring the index line to the echo

More than one course on reflection plotter

Up to now we have dealt with a situation where only one course is drawn on the reflection. Let us now consider more than one course on the chart, as shown in figure 6.

Fig. 6



Ship is steaming from A to D via points B and C and wishes to monitor her progress along the charted lines.

To construct indexing lines on the reflection plotter, before ship arrives at 'A', switch radar on, North up, gyro stabilized — 6-mile range; only the Brilliance need be turned up. Check VRM for index error. Check EBI, if used, for index error. Check centre of PPI. We have already picked off the chart, the bearings and ranges of points A, B, C and D to the points of interest. These are: A. 005° (True) x 4.4 miles. B. 342° (True) x 4.0 miles. C. 249° (True) x 2.6 miles. D. 200° (True) x 3.1 miles. Plot positions A and B on to the reflection plotter and join them up. The line joining them should be the same as our charted course line, i.e. 071°. Next plot on position C, join BC and we should get 015°. Then plot on position D and join CD which should give us a course of 323°.

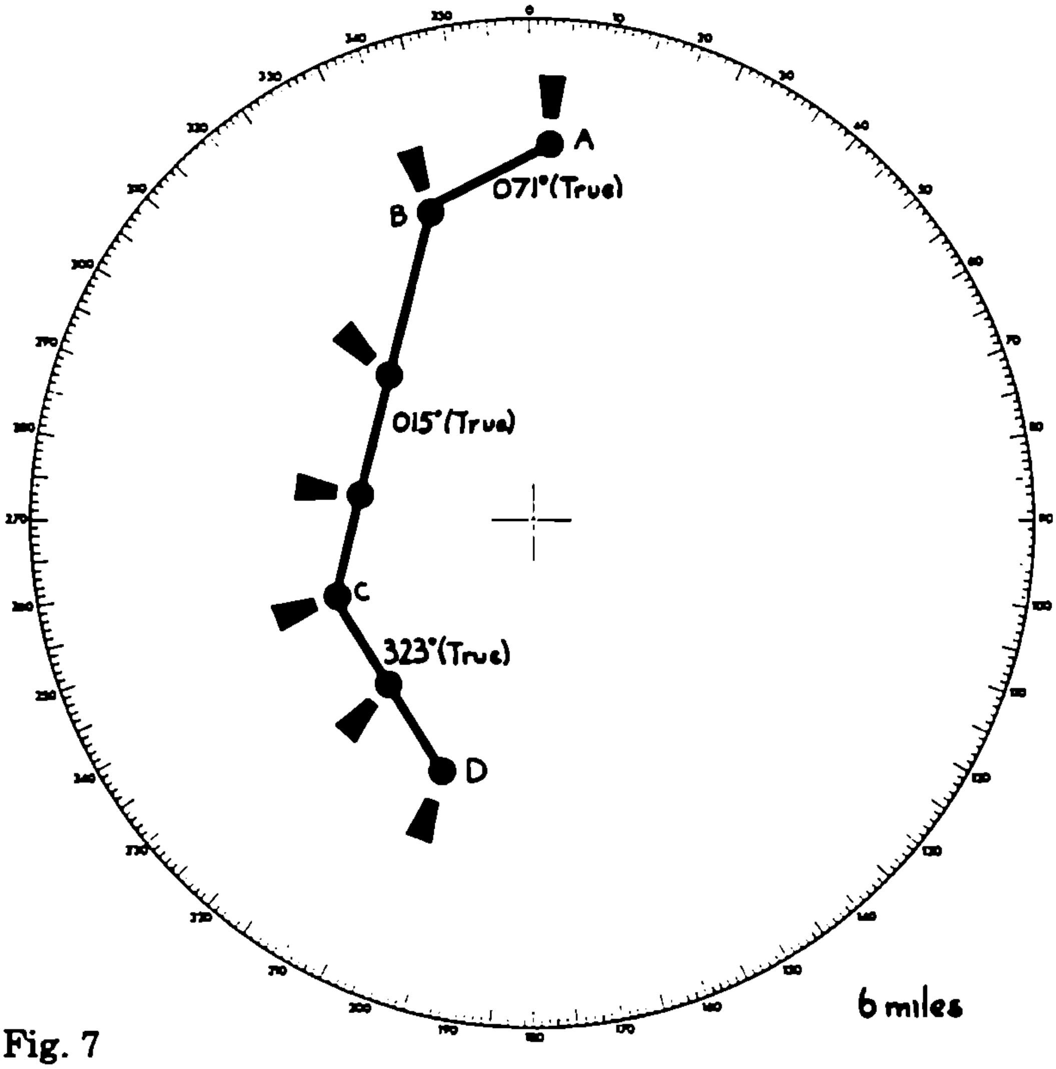


Fig. 7

The reflection plotter now looks like figure 7. When the vessel is at chart position 'A' the point of interest will be at point A. The vessel is steering 071° (True) so the point of interest will track down on the line AB. When the point of interest is at point B the vessel must be at chart position 'B' so course is altered to 015° (True) causing the point of interest to track down line BC until C is reached when course will be altered to 323° (True).

Two ranges used on the reflection plotter

Taking the previous example, where the radar range is at 6 miles, it might be desirable to reduce the range scale in use as the vessel approaches its closest point to the radar conspicuous object. (See figure 8)

When the echo reaches position B¹, select the 3 mile range scale.

Ensure that you mark each indexing track with the appropriate range scale to be used.

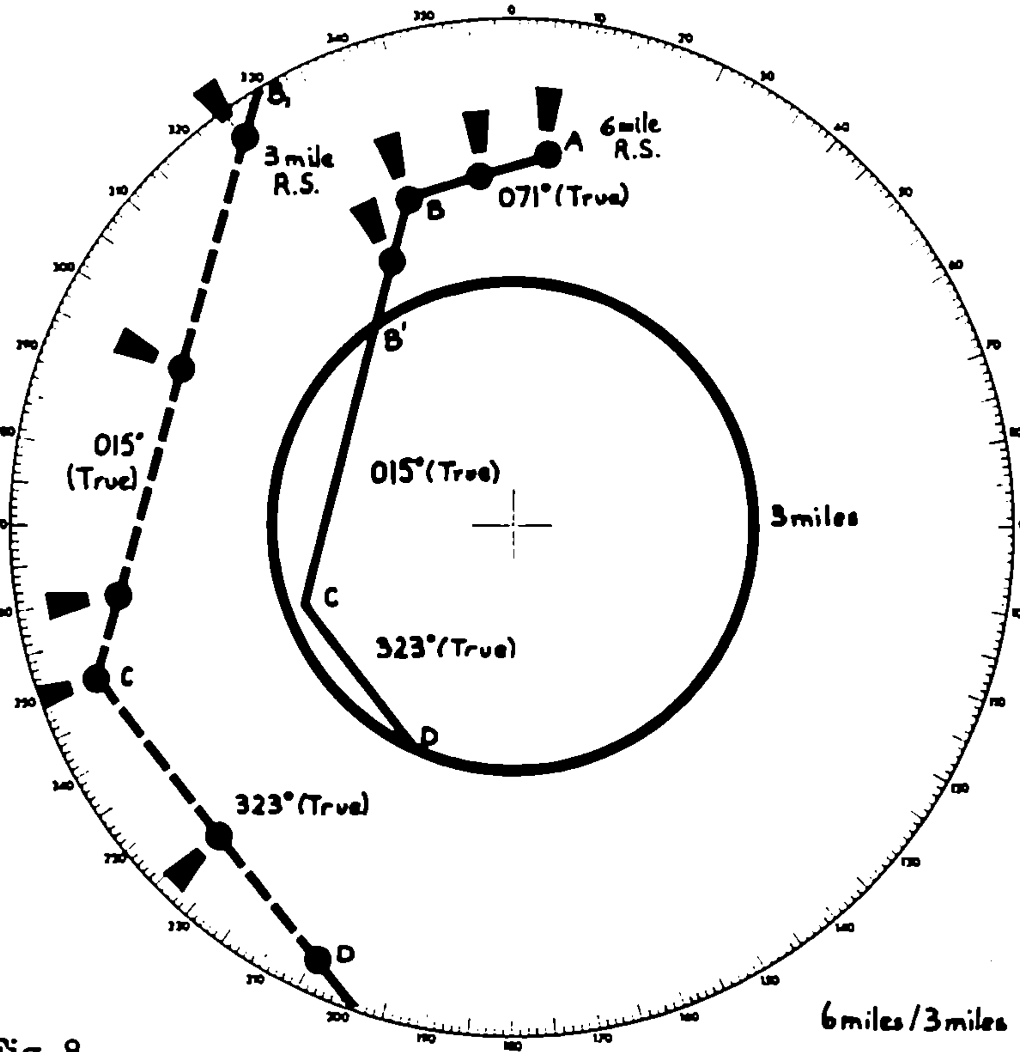


Fig. 8

Allowing for Manoeuvring Characteristics — Wheel over position (referring to figure 6)

When a ship alters course we know that an instantaneous alteration cannot be achieved. If no allowance is made for own vessel's manoeuvring characteristics, you will find when the radar conspicuous object reaches positions B and C and the alterations of course are made, the echo will track *off* the appropriate indexing lines BC and CD. In order therefore to achieve maximum accuracy when using parallel indexing the relevant wheel over position must be calculated and marked upon the reflection plotter (see figure 8a).

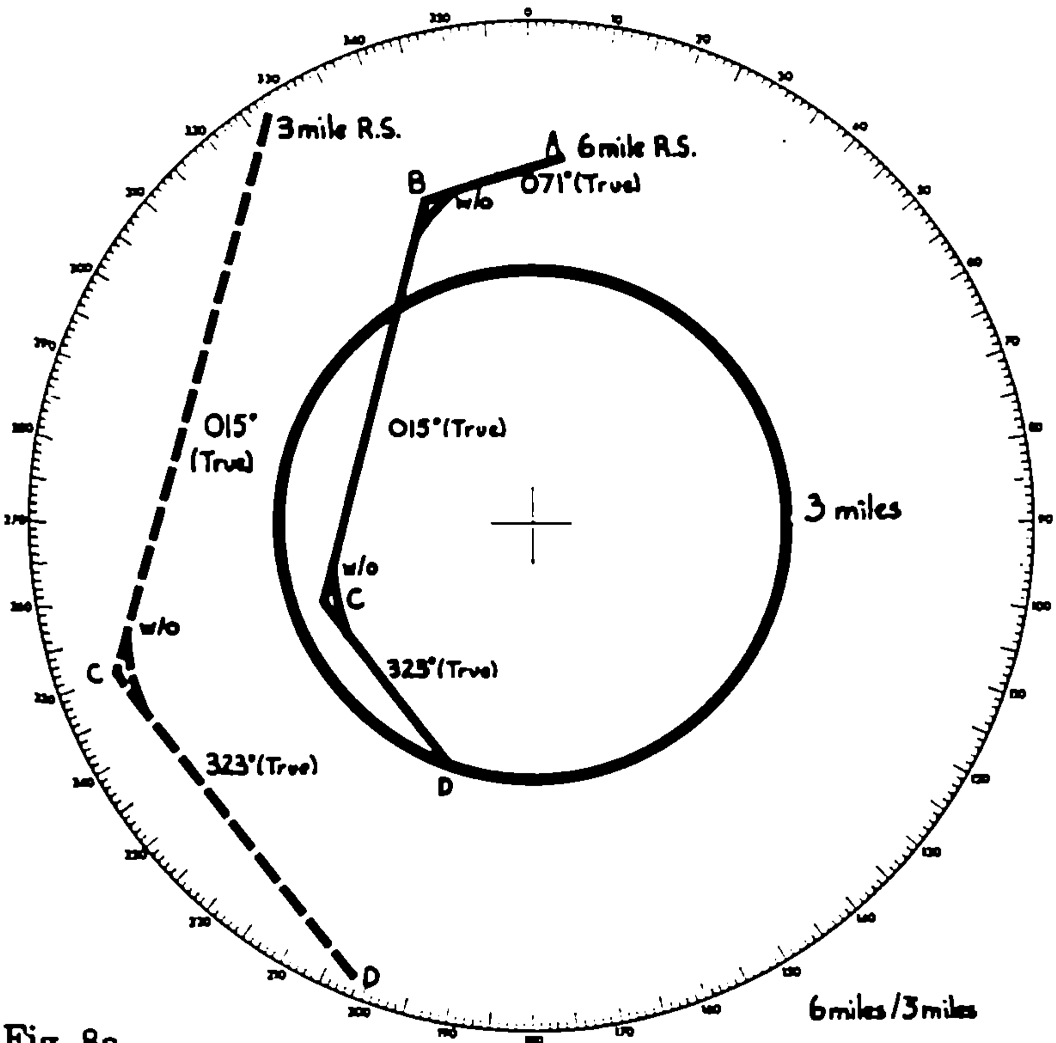


Fig. 8a

Identification of Relevant Navigational Marks (refer to figure 6)

In order to identify relevant navigational marks, buoys, bearings, etc. which are in the vicinity of intended track, indexing can be taken a stage further by indicating the navigational marks on the indexing lines on the reflection plotter. E.g, in the example you must pass No. 2 Buoy to port and No. 1 Buoy to starboard (see figure 8b). When the radar conspicuous object is on the indexing line at position X, No. 2 Buoy will be abeam to port and at position C No. 1 Buoy will be abeam to starboard.

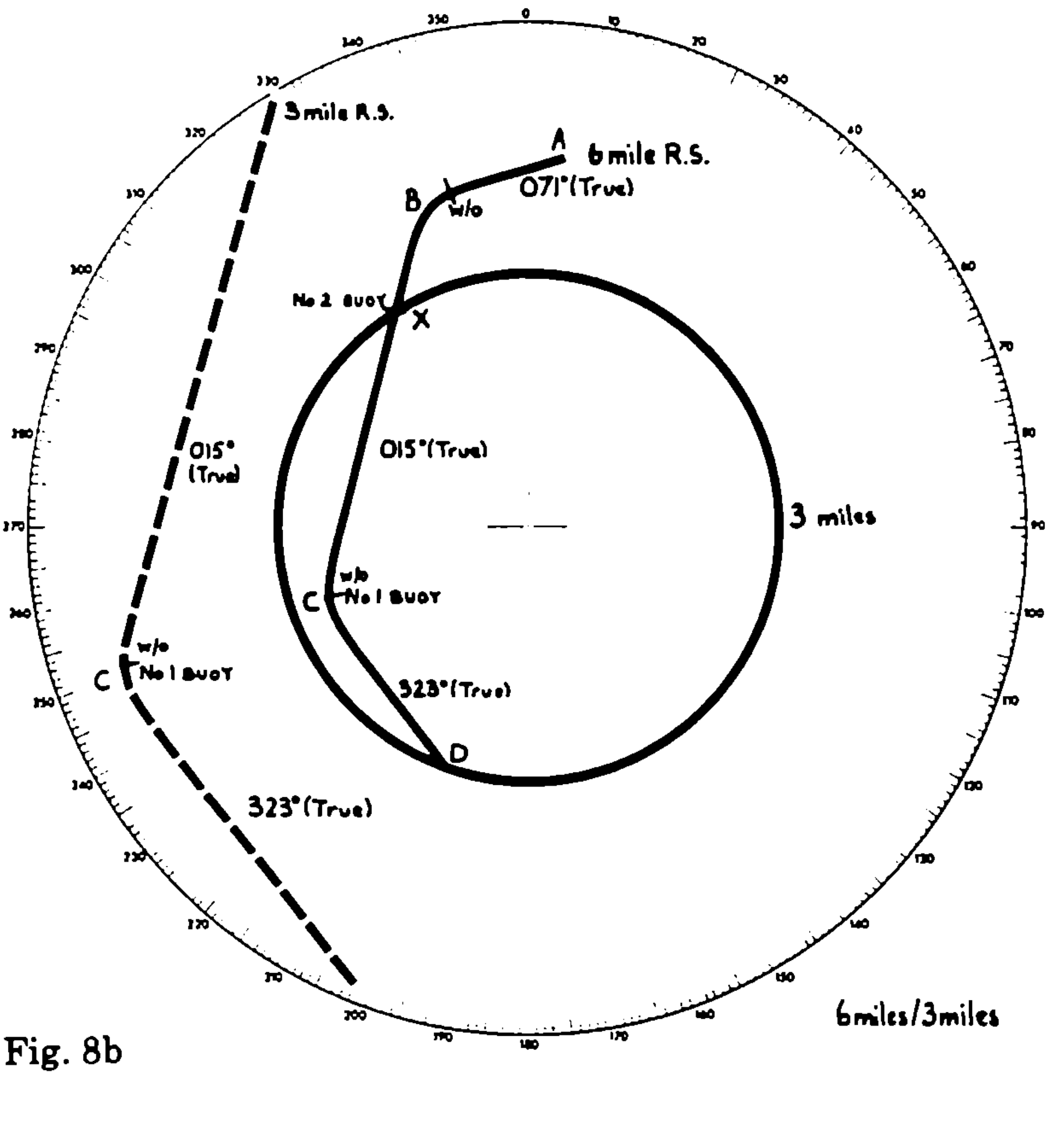


Fig. 8b

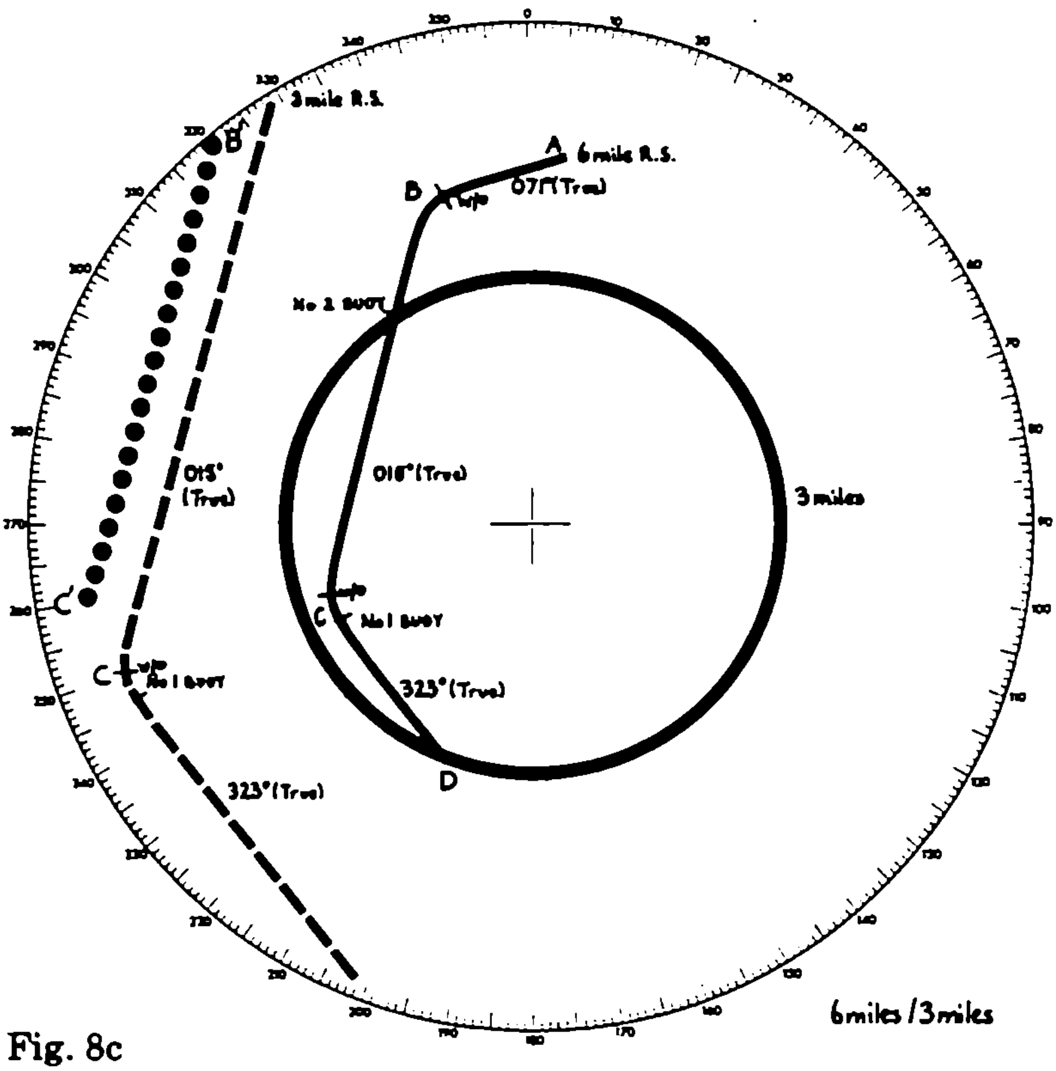


Fig. 8c

Indicating Margins of Safety (refer to figure 6)

On the 'chart' shown it would be dangerous to allow the vessel to set too far to the right on the 015° (True) course towards the dangerous wreck. Therefore the B^1 — C^1 on the chart might be considered the limit set for any deviation to the right. This line could be transferred to the reflection plotter thus indicating to the observer just how far the vessel could be allowed to set to the right. (see figure 8c).

Using two targets and two ranges

Figure 9 shows the safe courses a ship wishes to make, firstly steering 320° (True) to pass target 1 — a lightship —at a beam distance of 3 miles and then an isolated beacon at a beam distance of 1½ miles before altering course to 270° (True).

Figure 10 shows the reflection plotter set up for parallel indexing. Two range scales — 6 mile and 3 mile — and the two targets have been used. Let us examine the sequence of events as they will happen.

Using the 6 mile scale, when the vessel is at position A on the chart, the echo of target 1 will appear at position A on the reflection plotter and will track down the index line indicated as long as the vessel maintains her course line until position B is reached, which is the position when target 1 will no longer be on the 6 mile range. However, when the echo of target 1 reaches point C, the echo of target 2 will appear at the top of the screen at point C[1] and track down that index line.

We now have both targets on the screen, target 1 and target 2 tracking down their respective lines. This overlap of a few minutes gives us ample time to positively identify target 2, so that when target 1 leaves the screen at point B we are able to continue to index with target 2.

When target 2 reaches point D we can change down to the 3 mile range scale, which will cause the echo of target 2 to appear at point D[1] and start to track down the dotted line. Point E indicates the wheel over position, and when

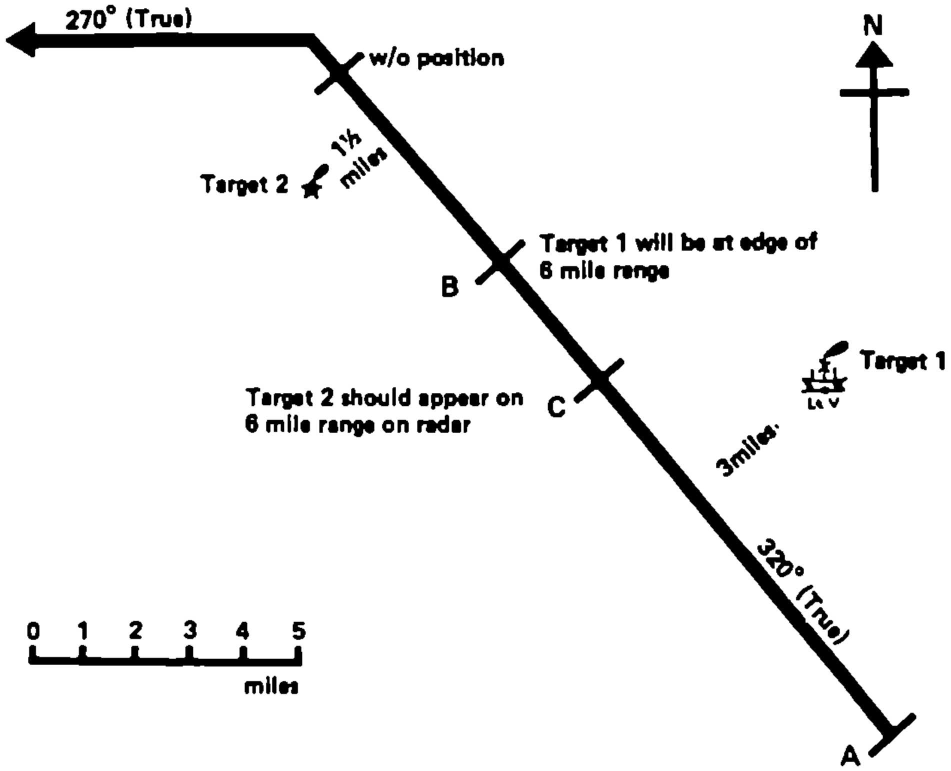


Fig. 9

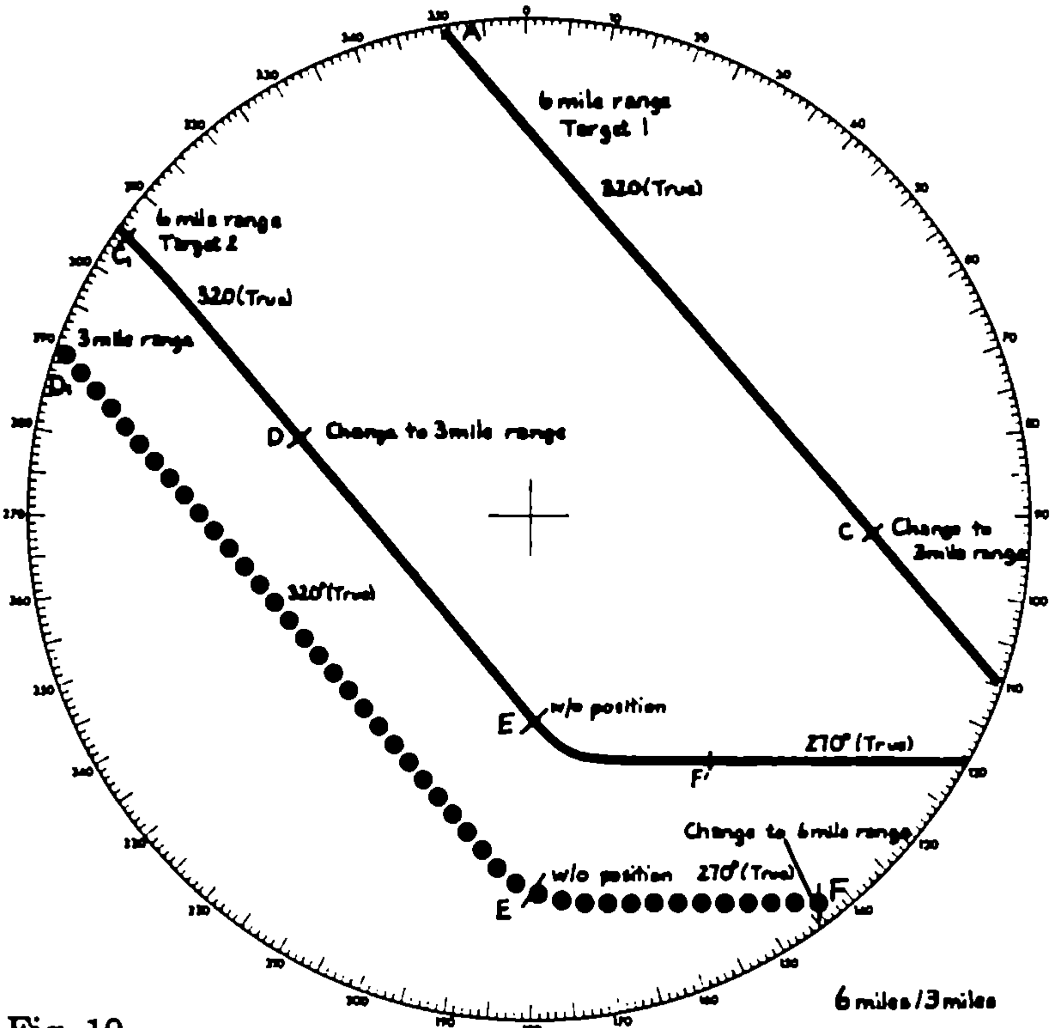


Fig. 10

point F on the 3 mile range scale is reached, we change back to the 6 mile range scale, causing the echo to appear at F¹ and we can now continue to index.

Use of PI for harbour approach

Figure 11 shows a simplified though realistic approach to a harbour. (The harbour structure East of the breakwater has been omitted.) The vessel is steaming on a course of 030° (True) and is required to alter course at point B on to the leading marks bearing 090° (True) and pass the breakwater. Other information, such as reductions of speed, change of range scale on radar and wheel over position are also marked on the chart.

Figure 11a shows the reflection plotter with all the above information drawn on to it, first having used the 1 mile range scale, then the ½ mile range scale.

When 1 mile away the point of interest (i.e the breakwater end) will appear at the edge of the screen and track down on the PI line (solid in figure 11a). When at point A, the range scale will be changed down to the ½ mile and the point of interest will now appear at A[1] and track down the dotted PI line. At the wheel over position the preplanned number of degrees of rudder are applied causing the point of interest to continue to track along the index line. Any deviation from the index line (and therefore the course line) will be immediately apparent and the appropriate action taken to rectify the situation. When at point C[1] the vessel must be equidistant from the end of the breakwaters and therefore in a safe position.

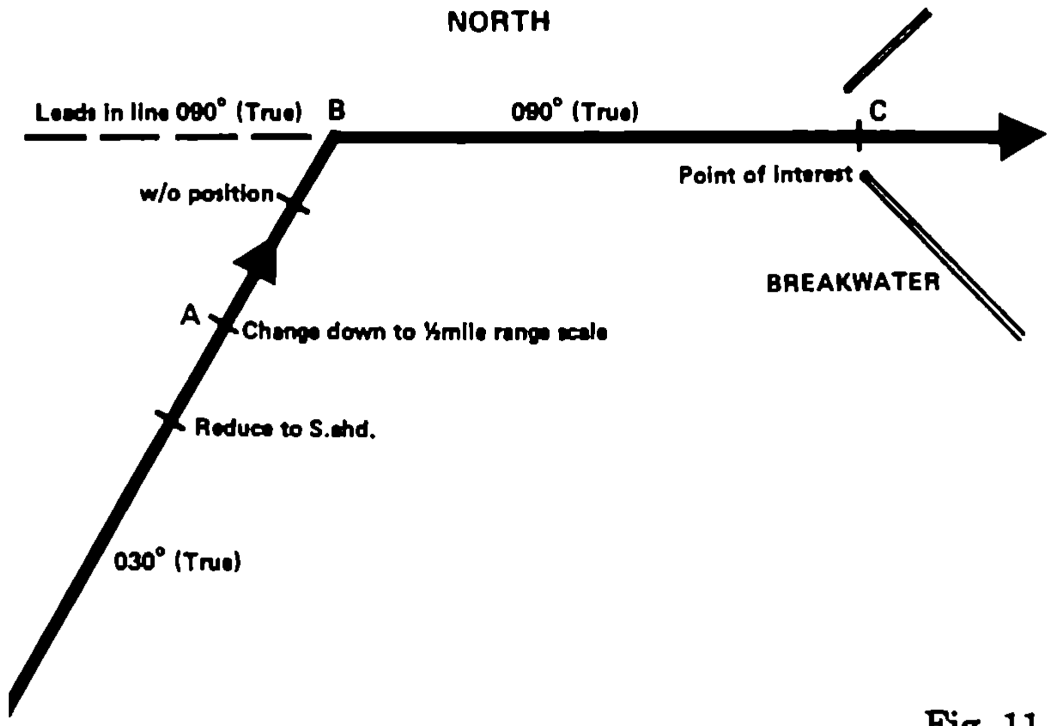


Fig. 11

Note: Radar operators must remember that targets at very short ranges may not show up on the PPI because of the radar set's minimum range.

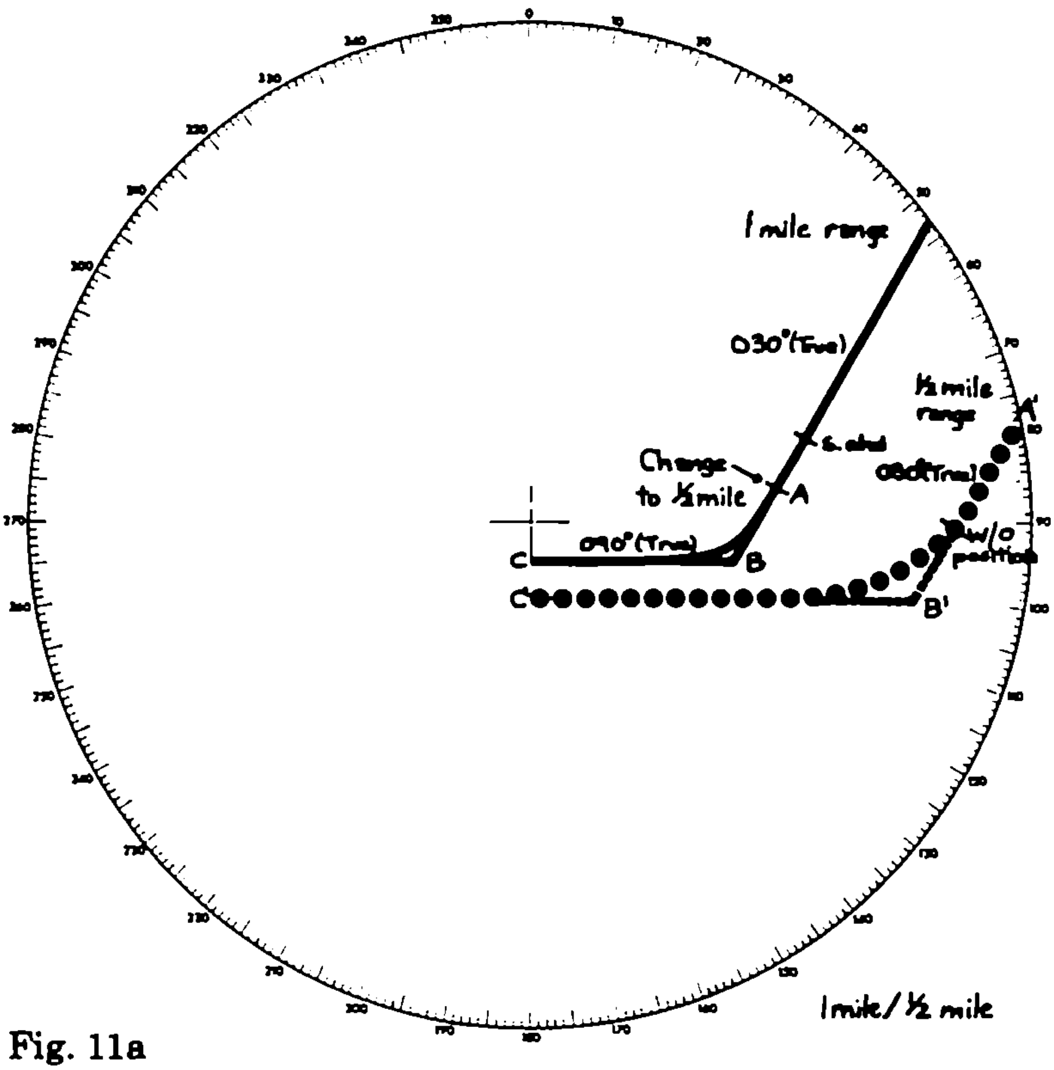


Fig. 11a

Use of PI for Anchoring

Having chosen a suitable spot to anchor, the indexing can be drawn on to the reflection plotter, in advance.

In this example we have a vessel steaming North which wishes to anchor ½ mile North West of a headland. (see figure 12). It is known that the headland is a good radar target, and a 1½ mile range scale will be suitable.

Position A on the chart is transferred to the reflection plotter and marked 'A'. Position B on the chart (the anchor position) is likewise transferred to the reflection plotter. Joining A to B should give a line 000/180° which is, in fact, the course. (see figure 12a).

The last mile to the anchorage may be sub-divided into cables giving a good check of the distance to go. Other information, such as reduction of speed can also be marked on.

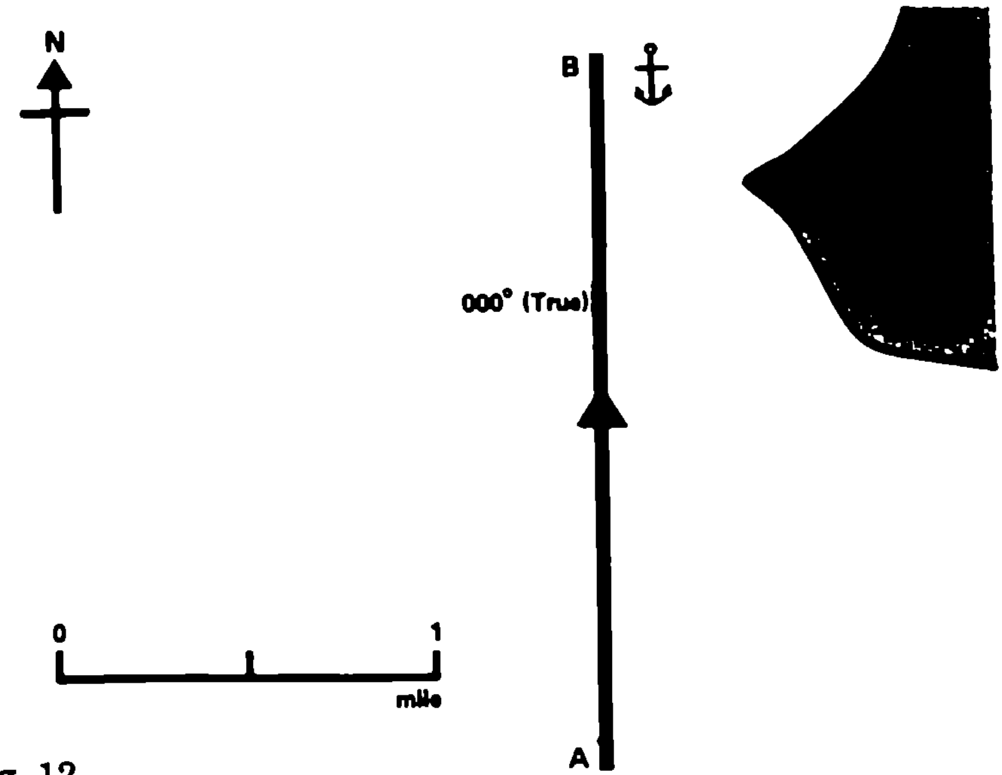


Fig. 12

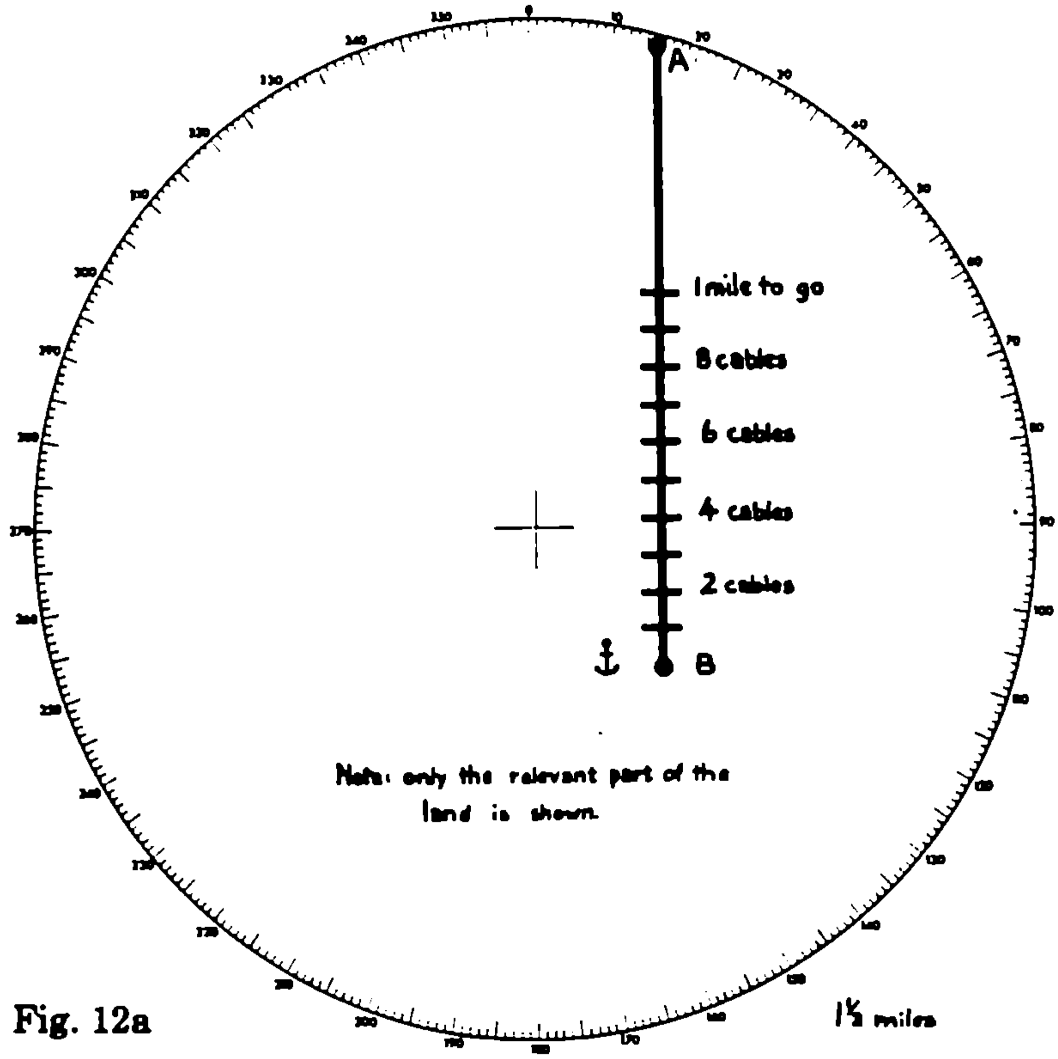


Fig. 12a

Search and Rescue

Parallel indexing can be used for monitoring the vessel position when engaged in search and rescue operations.

Using Expanding Square Search Pattern — radar conspicuous target available. No allowance being made for drift (resultant of wind, current/or tidal stream)

Example.
Approach search pattern starting point heading 000° (True) radar set on 24 mile range scale. (see figure 13). The parallel indexing lines, figure 13a, are laid off on the reflection plotter as previously explained. So long as the radar conspicuous target remains on the indexing lines, A — B, B — C, etc., the search vessel will keep position on the planned search pattern.

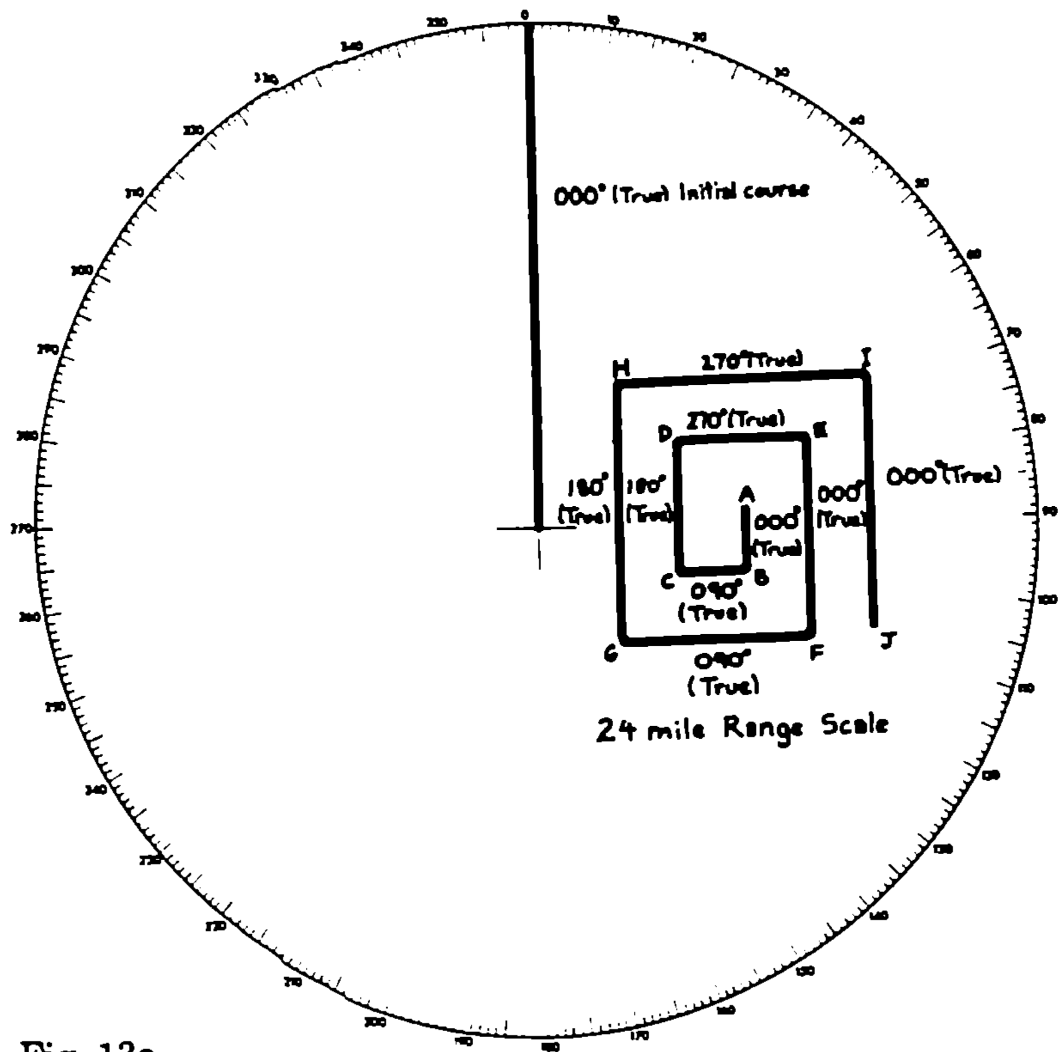


Fig. 13a

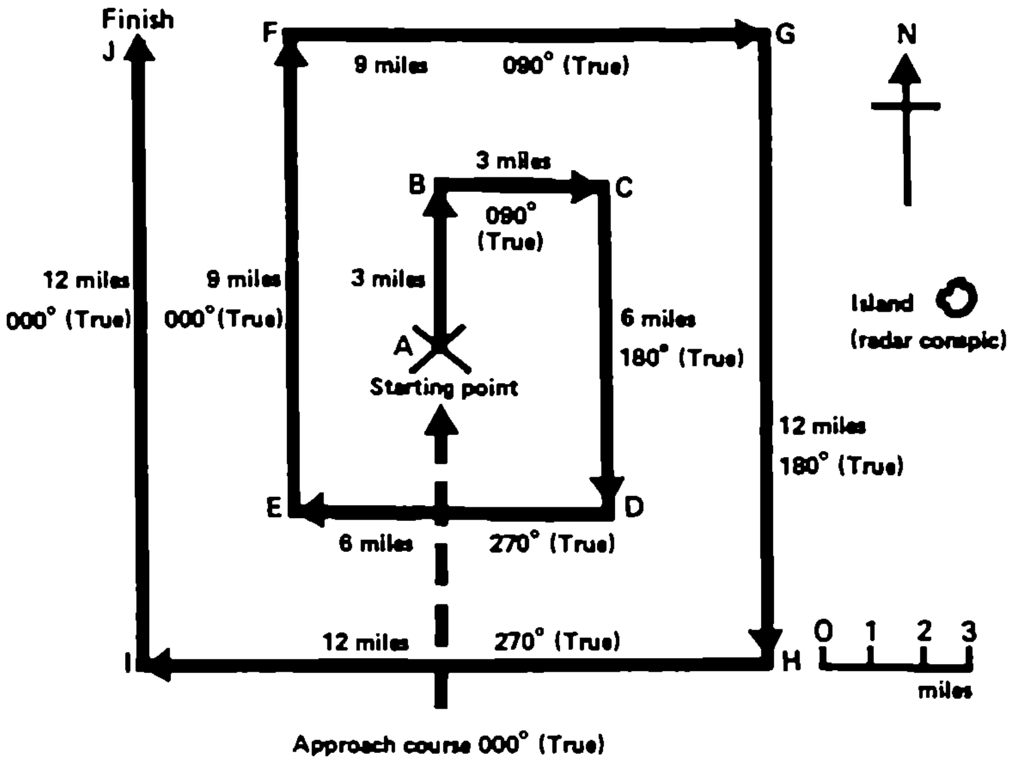

Finish
J
F
G
N
9 miles
090° (True)
3 miles
B
C
090°
(True)
12 miles
000° (True)
9 miles
000°(True)
3 miles
A
Starting point
6 miles
180° (True)
Island
(radar conspic)
12 miles
180° (True)
E
D
6 miles
270° (True)
12 miles
270° (True)
I
H
0 1 2 3
miles
Approach course 000° (True)

Fig. 13

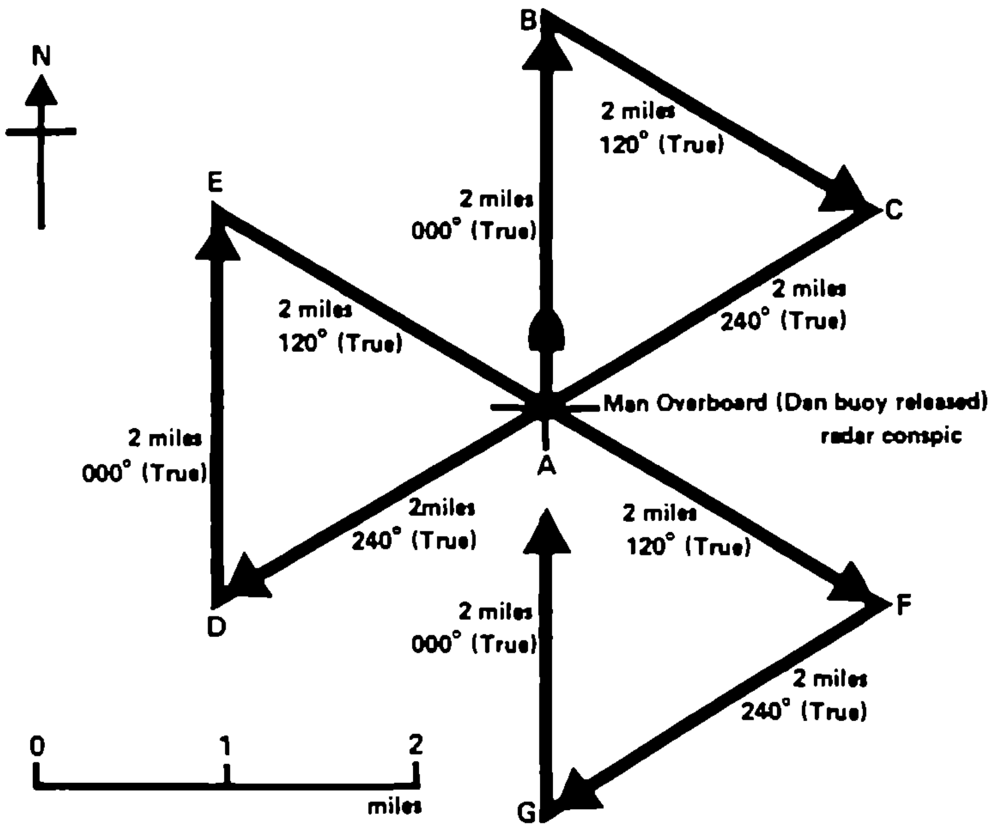

N
B
2 miles
120° (True)
E
2 miles
000° (True)
C
2 miles
240° (True)
2 miles
120° (True)
Man Overboard (Dan buoy released)
radar conspic
2 miles
000° (True)
A
2miles
240° (True)
2 miles
120° (True)
F
D
2 miles
000° (True)
2 miles
240° (True)
0 1 2
miles
G

Fig. 14

Using Sector Search Pattern with Dan Buoy for radar target. Allowance for drift (resultant of wind, current/or tidal stream)

If a vessel on passage has a 'man overboard', the sector search pattern could be carried out using a Dan Buoy fitted with a radar reflector as a floating radar marker. This marker could then be used as a datum throughout the search and would also serve as a check on the drift. Such a buoy could become part of the vessel's life-saving equipment, being released in conjunction with the statutory lifebuoy/light/smokefloat.

Example.

Man overboard heading 000° (True), radar set on 3 mile range scale (see figure 14). A pre-planned 'man overboard' parallel index, on a perspex sheet for the 3 mile range scale, is placed upon the reflection plotter. (see

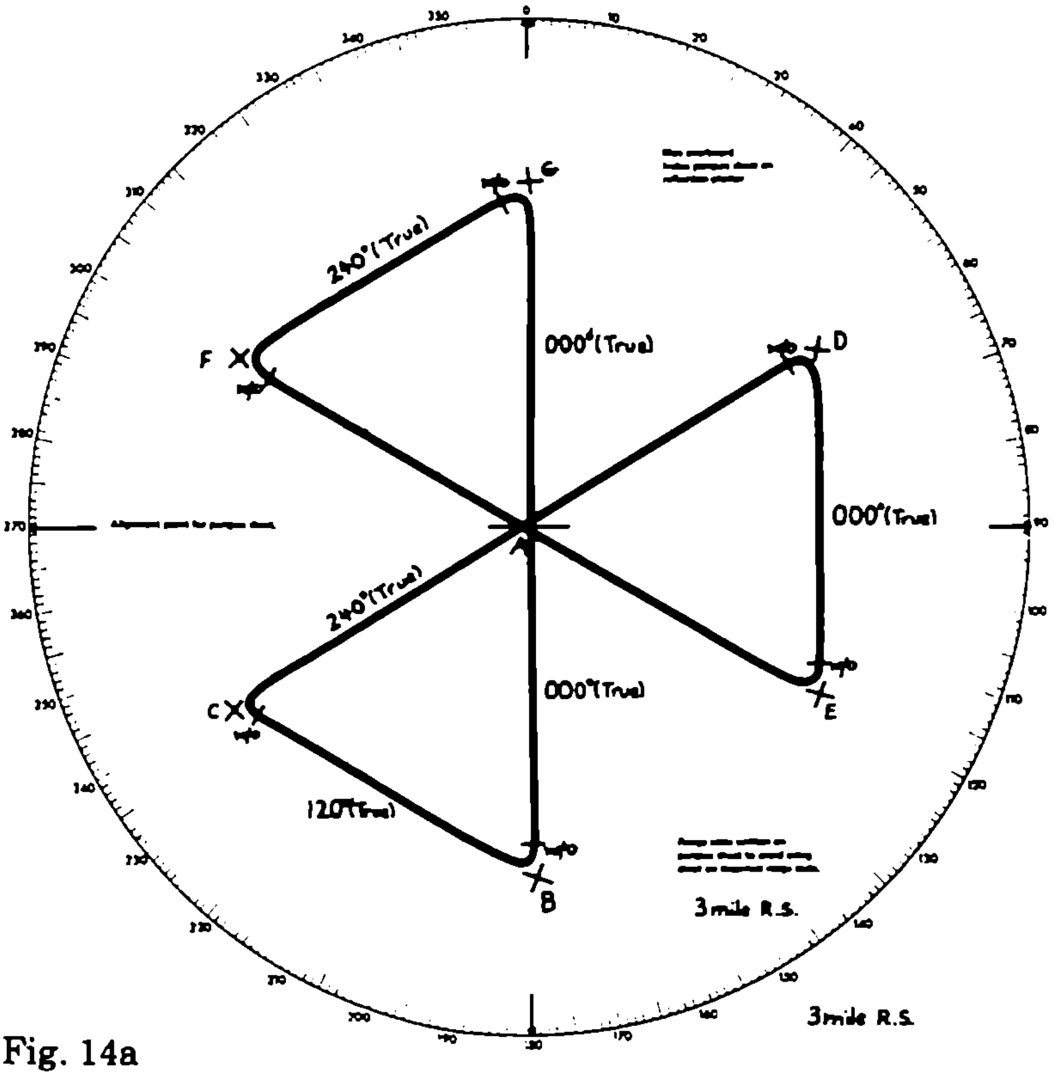


Fig. 14a

Annex 2, Preparation of Parallel Indexing in Advance). The required courses in degrees to be made good, can easily be determined and written alongside the course lines on the perspex sheet. All turns are 120° to starboard and allowance should be made for the manoeuvring characteristics of own vessel to calculate the wheel over positions (see figure 14a). So long as the Dan Buoy remains on the parallel indexing lines, A — B, B — C, etc., own vessel will keep position on the planned sector search pattern.

Note.

Radar operators will have to adjust the clutter operational controls as required and take into account the minimum range of the radar set in order to clear the buoy safely.

Approaching and Keeping Station off a Permanent Oil or Gas Installation.

When off-shore supply and/or rig safety vessels are approaching an installation to take up a pre-determined position, parallel indexing can be used to monitor such vessel's progress.

Example.

An oil rig supply vessel must approach a permanent oil

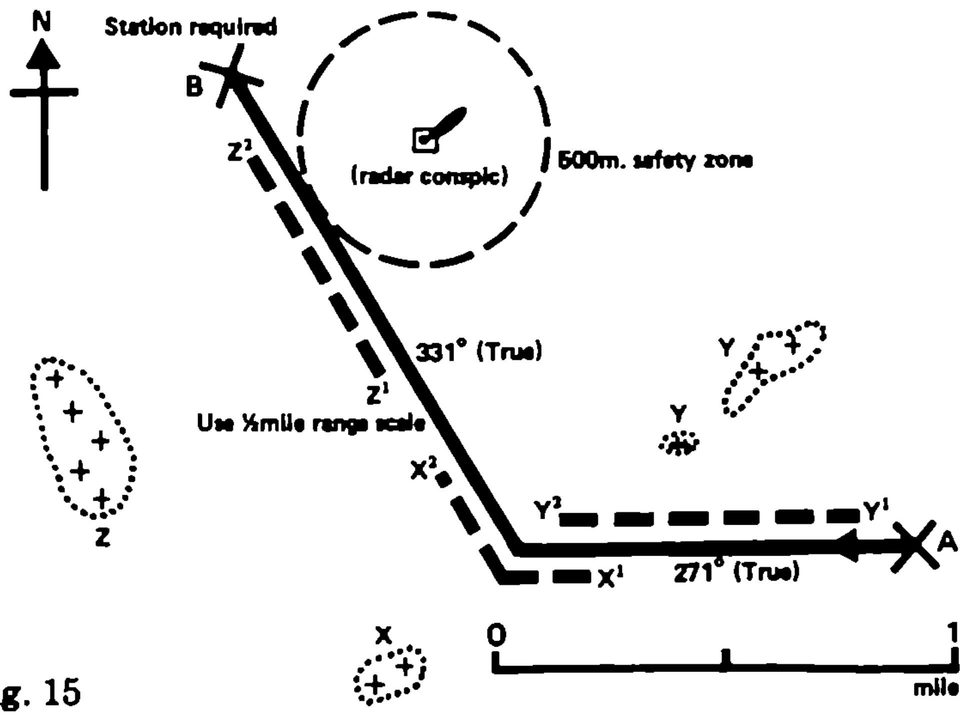


Fig. 15

installation passing through areas of shoal ground to take up station. Figure 15 represents the chart showing the installation, dangers and station required. Safe courses are laid off on the chart to the position of the station. Lines $Y^1 - Y^2$, $X^1 - X^2$ and $Z^1 - Z^2$ are the margins of safety allowed from the shoals.

Using the oil installation as the radar conspicuous target to monitor the supply vessel's progress, parallel indexing lines are laid off on the reflection plotter for the 1½ and ½ mile range scales (see figure 15a). The margins of safety are indicated by lines $Y^1 - Y^2$, $X^1 - X^2$ and $Z^1 - Z^2$. When the supply vessel, heading 271° (True) is at position A on the chart, the installation will also be at position A on the reflection plotter. So long as the echo from the installation stays on the parallel indexing lines shown and within the margin of safety lines, the supply vessel will arrive at the station required. To maintain station posi-

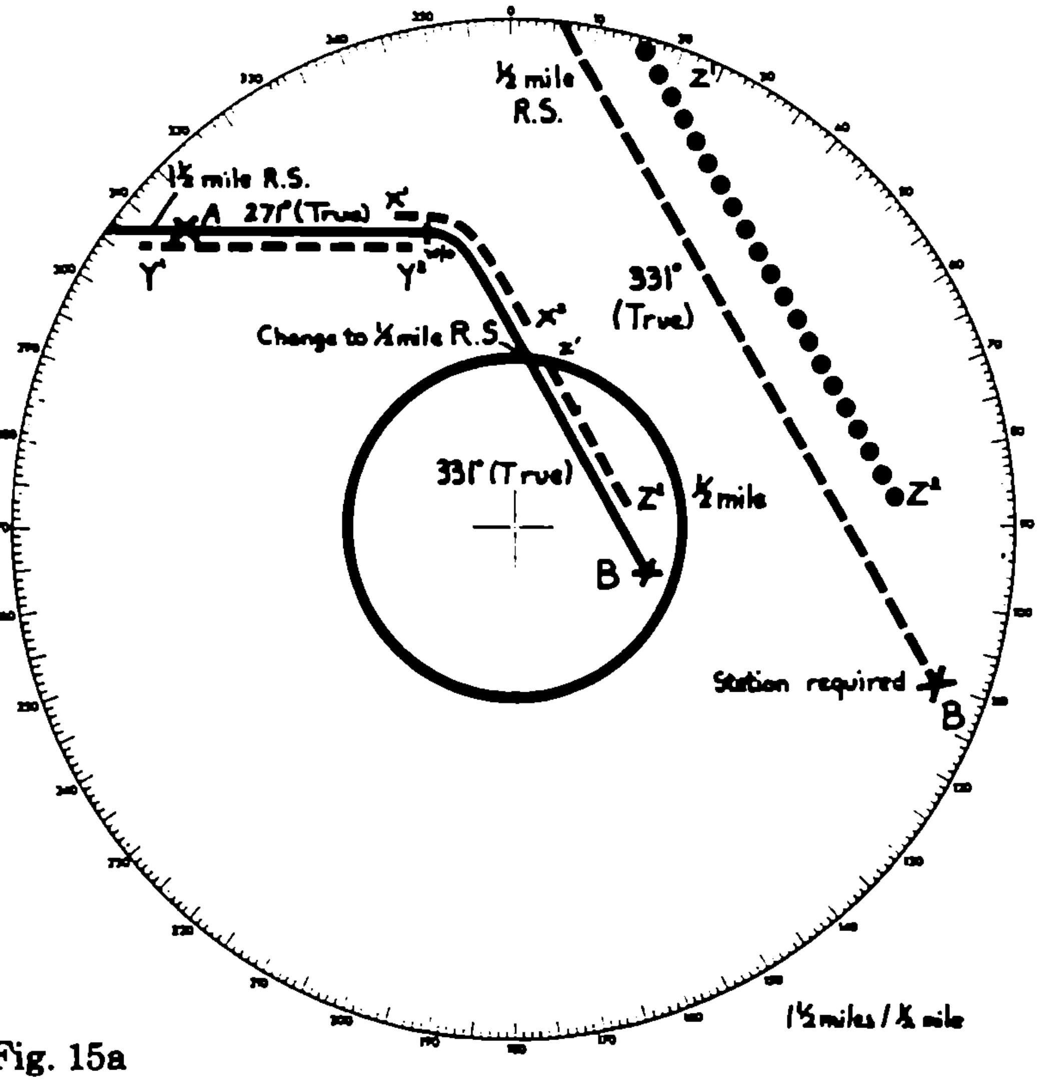


Fig. 15a

tion, the echo from the installation should be kept on position B on the reflection plotter.

Approaching a Submarine Cable

A cable ship engaged in cable repair can use parallel indexing to approach the required position. A marker buoy fitted with a radar reflector is first laid approximately 2-3 miles from the charted submarine cable position and fixed to the seabed. The position of the buoy is then determined by Long Range Navigational Aids (Sat. Nav., Omega, Loran C), and plotted on the chart.

Example.
A cable ship has laid its marker buoy near to the cable to be repaired and its position has been calculated to be 2 miles due North (see figure 16).

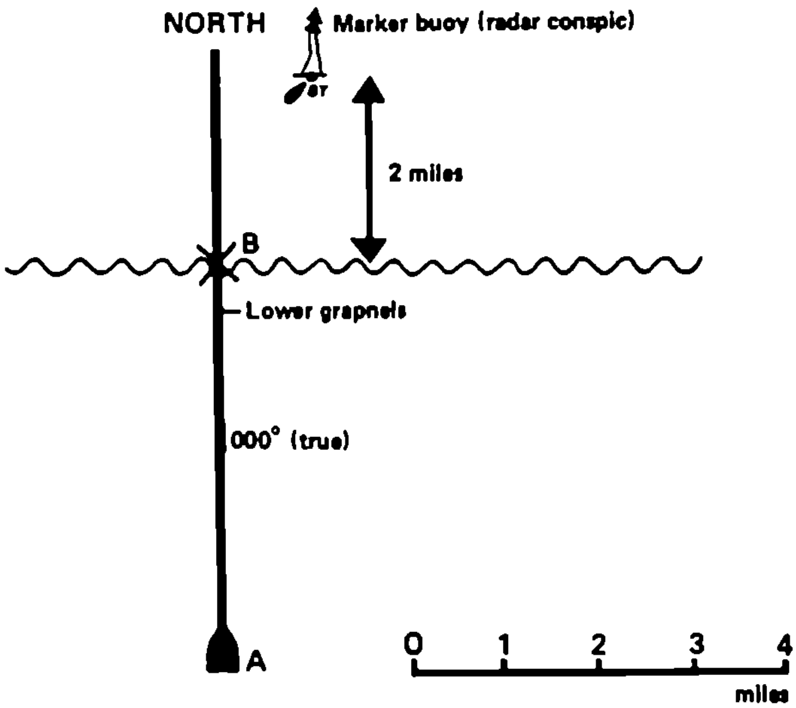


Fig. 16

Using the 6 and 3 mile range scales, parallel indexing lines are drawn on the reflection plotter. (figure 16a). When the cable ship is at position A, heading 000° (True) on the chart, the echo from the buoy will be at position A on the reflection plotter. As long as the echo from the buoy stays on the parallel indexing lines shown, the cable ship will arrive at position B over the submarine cable. Just before arrival, grapnels are lowered ready for the hoist.

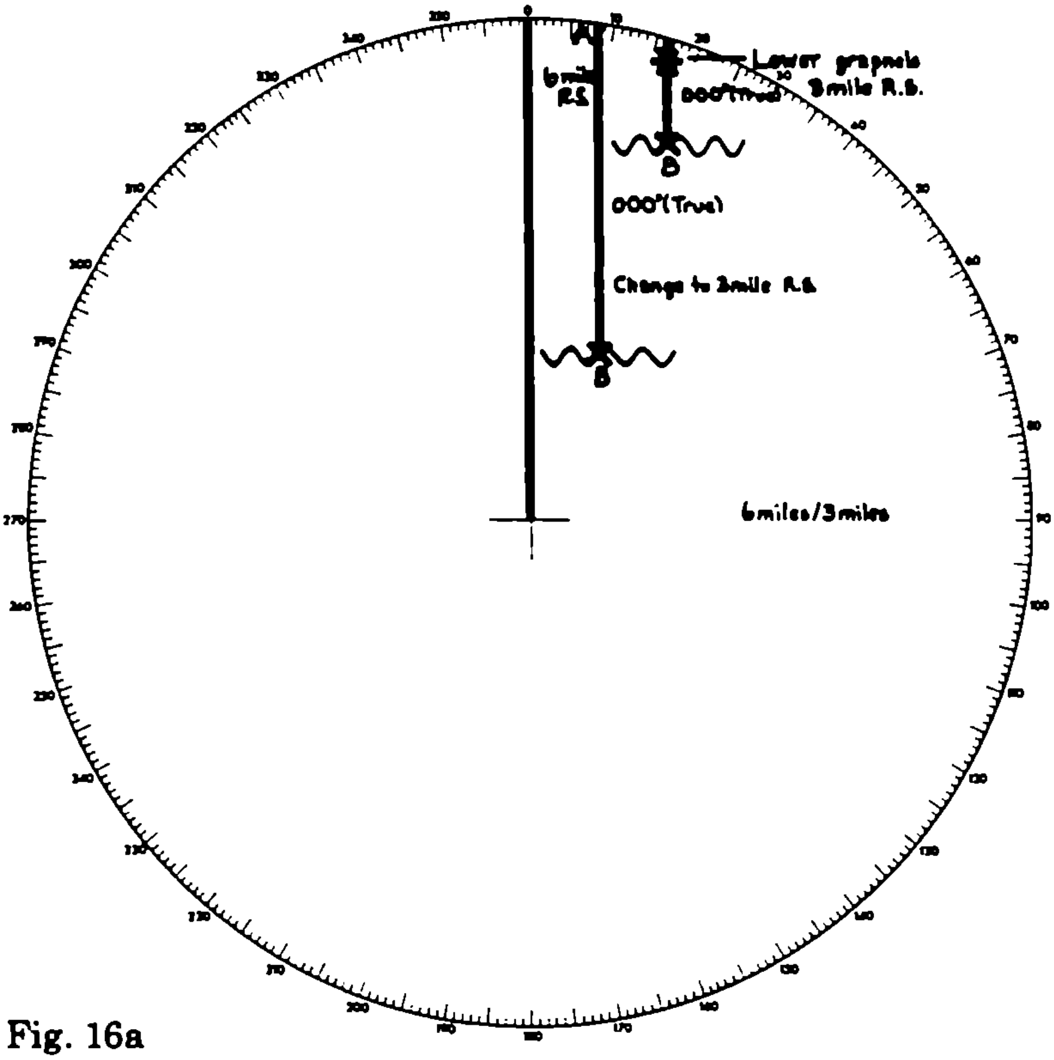


Fig. 16a

The use of PI in Traffic Separation Zones

Figure 17 shows part of a chart involving a traffic separation zone. If there is a radar conspicuous object in the vicinity then parallel indexing can be used to keep the vessel in the correct lane. In this example the small island is known to give a good radar echo and will be used as the point of interest.

The courses and the limits of the separation lane are drawn on the reflection plotter as previously explained and should now resemble figure 17a. Provided the point of interest remains within the dotted lines on the reflection plotter, the vessel will remain in the correct lane.

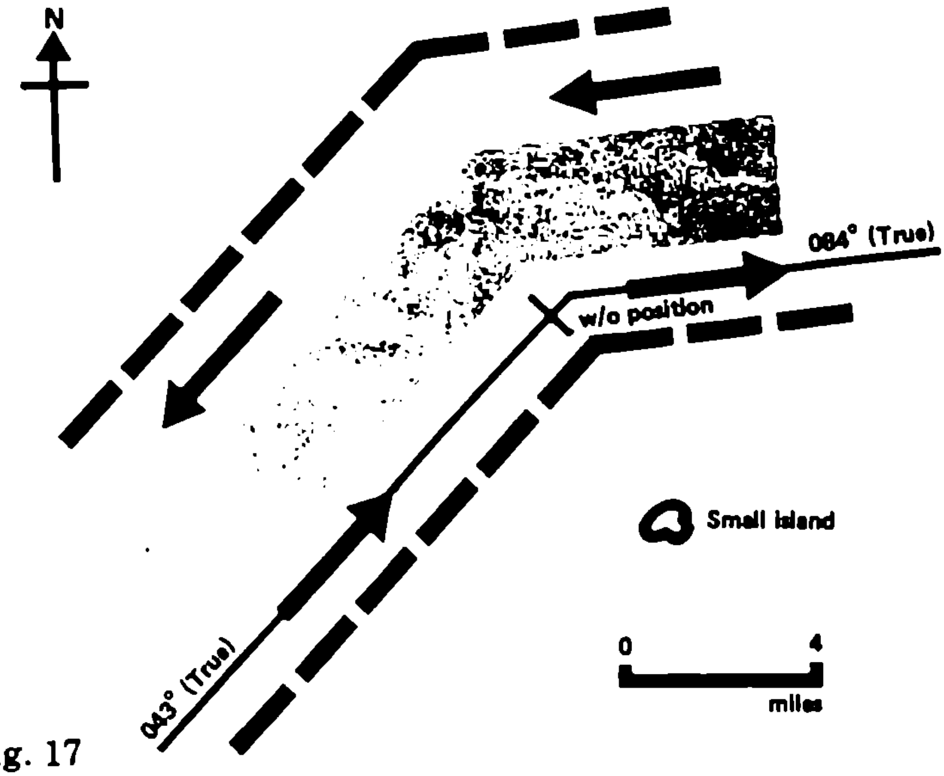


Fig. 17

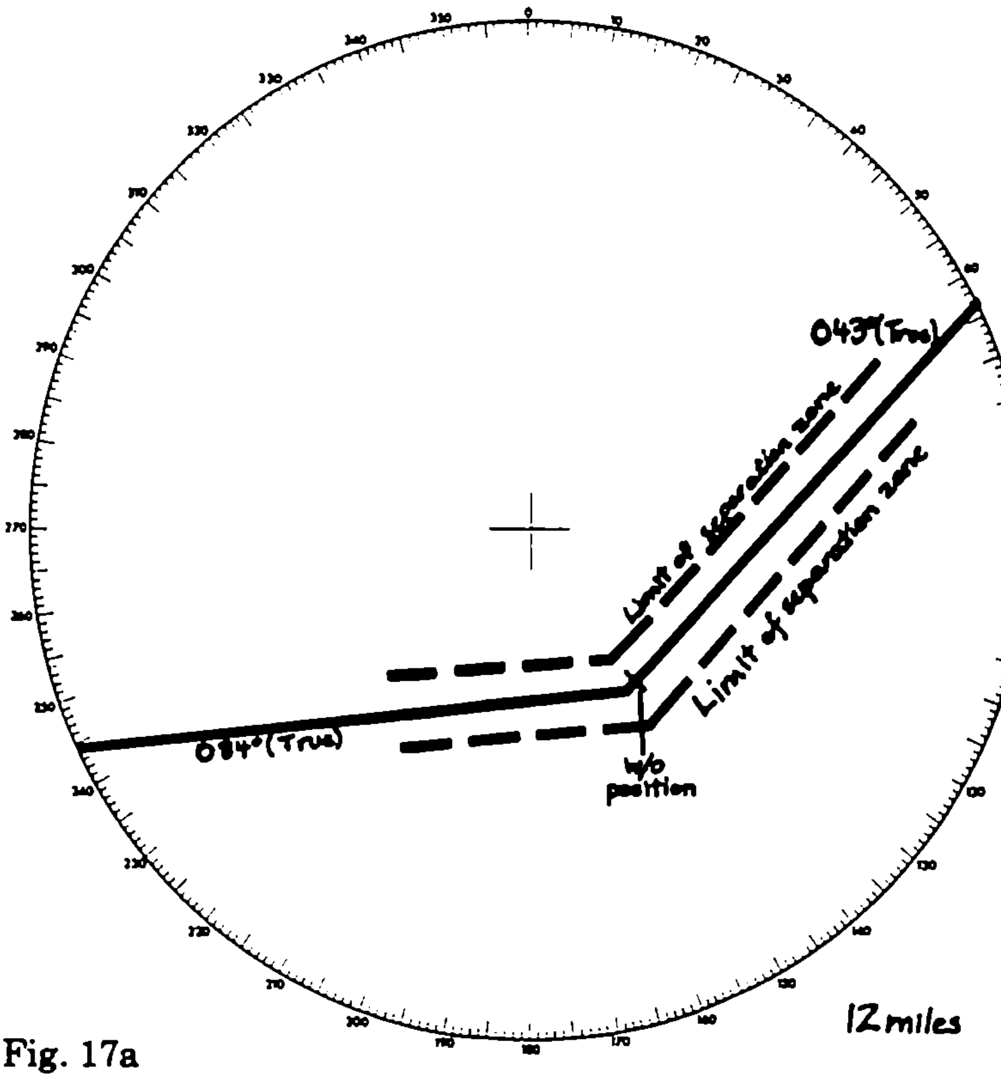


Fig. 17a

Construction of Parallel Indexing Lines using Ranging

Up to now we have constructed the parallel indexing lines by transferring the bearing and range of a radar conspicuous object from the charted position of course alterations to the reflection plotter surface. Many parallel indexing experts prefer another method which uses beam passing distances off a radar conspicuous object. When transferring these ranges to the reflection plotter, only the VRM is required.

Example (see figure 18) A — D represents the safe courses required to be made good. The beacon is radar conspicuous. Before the ship arrives at position A the indexing lines can be constructed on the reflection plotter. Switch radar on, North up gyro stabilized — 6 mile range scale. Check the VRM for index error and ensure that the PPI is correctly centred.

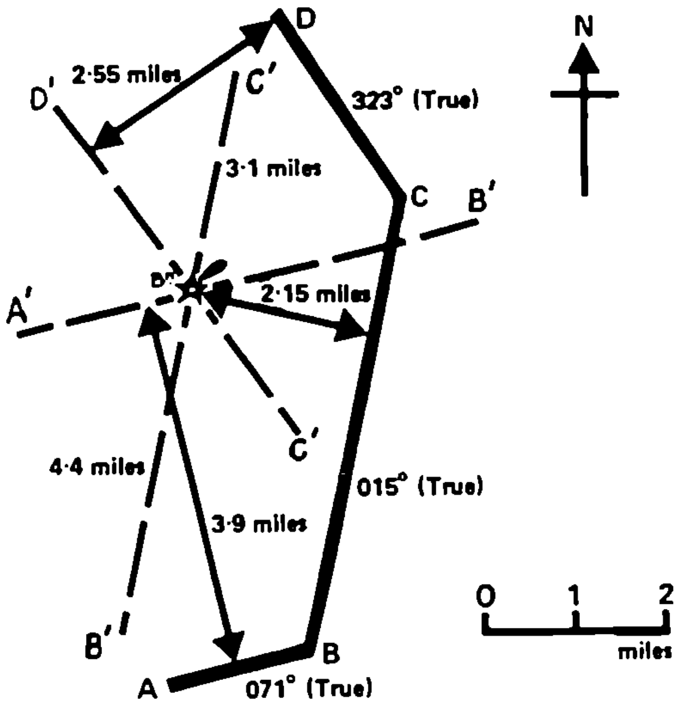


Fig. 18

Method

1. On the chart lay off, through the radar conspicuous object to be used, lines parallel to the courses to obtain the beam passing distances.
i.e. First course 071° (True) A — B; line A^1 — B^1; beam distance 3.9 miles. Second course 015° (True) B — C; line

B¹ — C¹; beam distance 2.15 miles. Third course 323° (True) C — D; line C¹ — D¹; beam distance 2.55 miles.

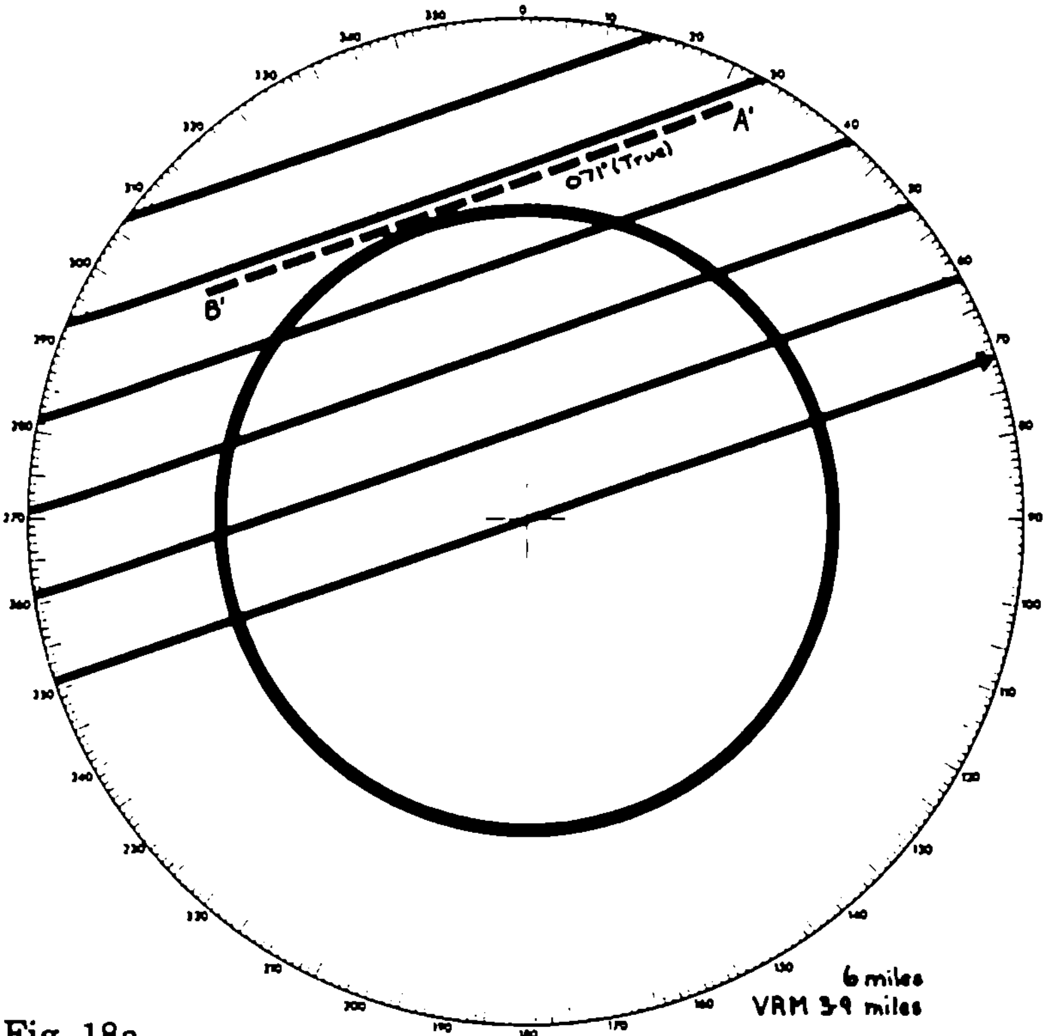


Fig. 18a

2. On the chart find the ranges of the radar conspicuous object from the starting point A and finishing point D i.e. A distance off — 4.4 miles. D distance off — 3.1 miles. We are now ready to transfer the information obtained on to the reflection plotter.

3. Refer to fig. 18a.

i) Set VRM on range 3.9 miles, beam distance of beacon when on first course 071° (True).

ii) Align mechanical bearing cursor on 071° (True), parallel indexing lines on cursor will now be parallel to 071° (True).

iii) Using Chinagraph pencil and ruler draw in indexing line A^1 — B^1 parallel to 071° line target to the VRM set at 3.9 miles on reflection plotter.

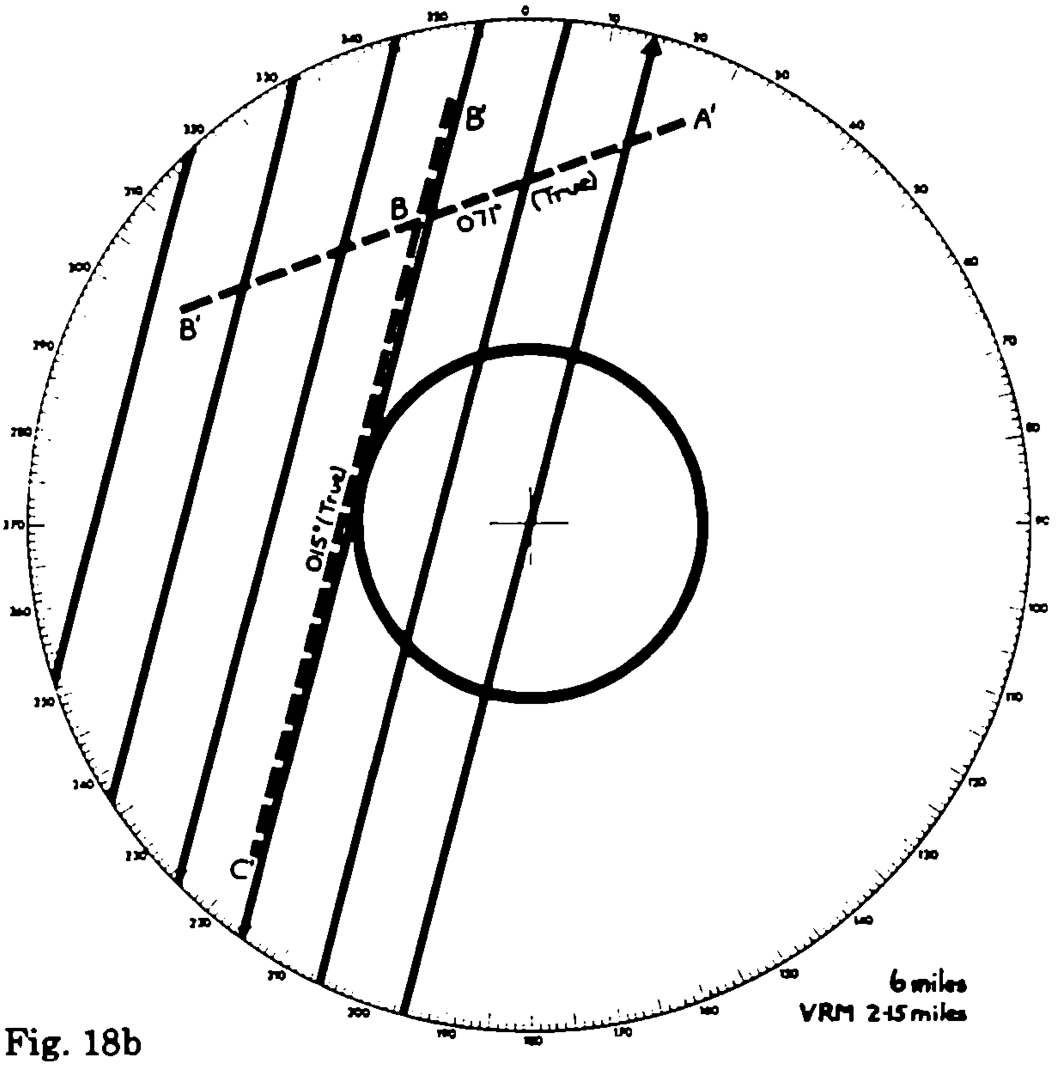


Fig. 18b

4. Refer to fig. 18b.

i) Set VRM on range 2.15 miles, beam distance of beacon when on second course 015° (True).

ii) Align mechanical bearing cursor on 015° (True); parallel indexing lines on cursor will now be parallel to 015° (True).

iii) Draw in indexing line B^1 — C^1 parallel to 015° tangent to the VRM set at 2.15 miles on the reflection plotter.

iv) Where B^1 — C^1 cuts A^1 — B^1 gives position B, the alteration of course from 071° (True) to 015° (True).

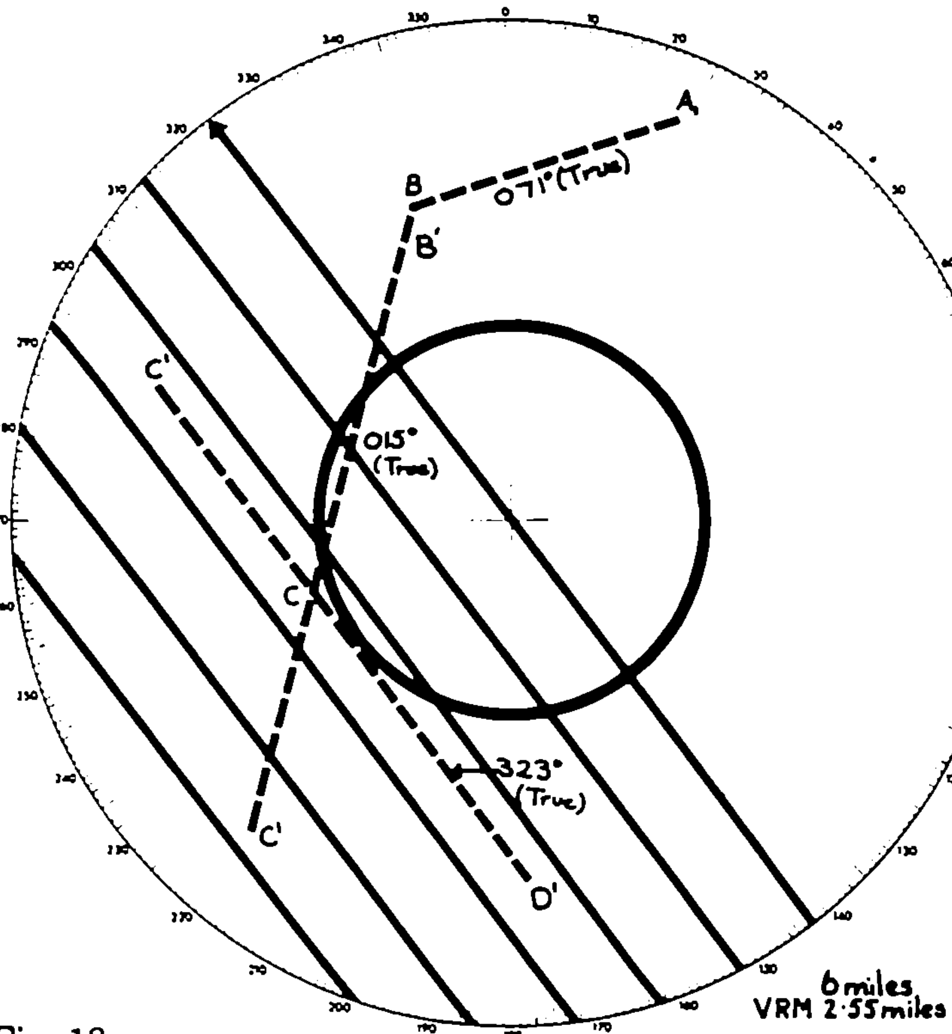


Fig. 18c

5. Refer to fig. 18c.

i) Set VRM on range 2.55 miles, beam distance of beacon when on third course 323° (True).

ii) Align mechanical bearing cursor on 323° (True), parallel indexing lines on cursor will now be parallel to 323° (True).

iii) Draw in indexing line C¹ — D¹ parallel to 323° tangent to the VRM set at 2.55 miles on reflection plotter.

iv) Where C¹ — D¹ cuts B¹ — C¹gives position C, the alteration of course from 015° (True) to 323° (True).

6. Refer to fig. 18d.

Finally, the starting point A and the finishing point D can be marked on the reflection plotter.

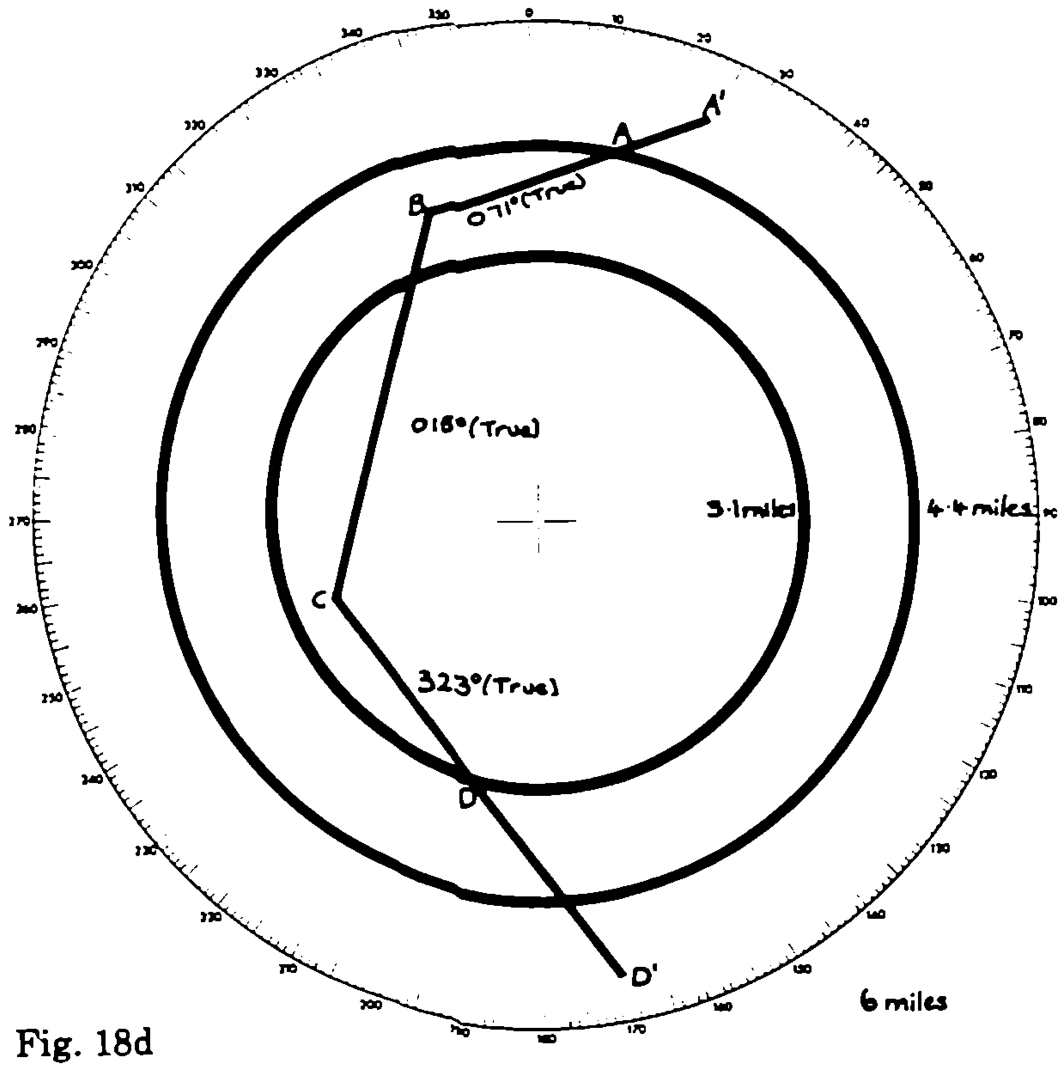


Fig. 18d

i) Set the VRM to 4.4 miles, the distance from the radar conspicuous object when at charted position A. Where this range cuts the A[1] — B index (071° (True) course) will give starting point A.

ii) Set the VRM to 3.1 miles, the distance from the radar conspicuous object when at charted position D. Where this range cuts the C — D[1] index (323° (True) course) will give finishing point D.

iii) Erase lines A[1] — A and D[1] — D to complete the indexing.

With practice this method of constructing parallel indexing lines will be more accurate and will take less time if the previous method using bearing and ranges is used.

4~Using a Ground-Stabilized True-Motion Display

When using a true-motion display for parallel indexing, it is essential that the radar is *ground-stabilized* which in practice is very difficult to achieve. In most radars at present, ground-stabilization is achieved by feeding into own ship's radar *speed through the water* in conjunction with the set direction and rate of the tide, using the appropriate controls.

A disadvantage of using true-motion for parallel indexing is that advance indexing would be difficult to lay off on the reflection plotter, due to the time base origin being off centre.

Example
Figure 19 shows a single course line of a vessel proceeding from A to B on a course of 160° (True) to pass 2 miles off a radar conspicuous target. When the vessel is at position A the radar conspicuous target will bear 136° (T), 5 miles.

Figure 19a shows the vessel's radar PPI when using true-motion, ground-stabilized presentation on the 6 mile range scale when at position A heading 160° (True).

Method
1. Set the VRM to the required beam passing distance — i.e. 2 miles.

2. Identify the radar conspicuous object to be used; bearing 136° (True), range 5 miles.

3. Draw the index line A — B through the radar conspicuous object tangented to the VRM.

As the vessel moves from position A to B the VRM will roll along the indexing line.

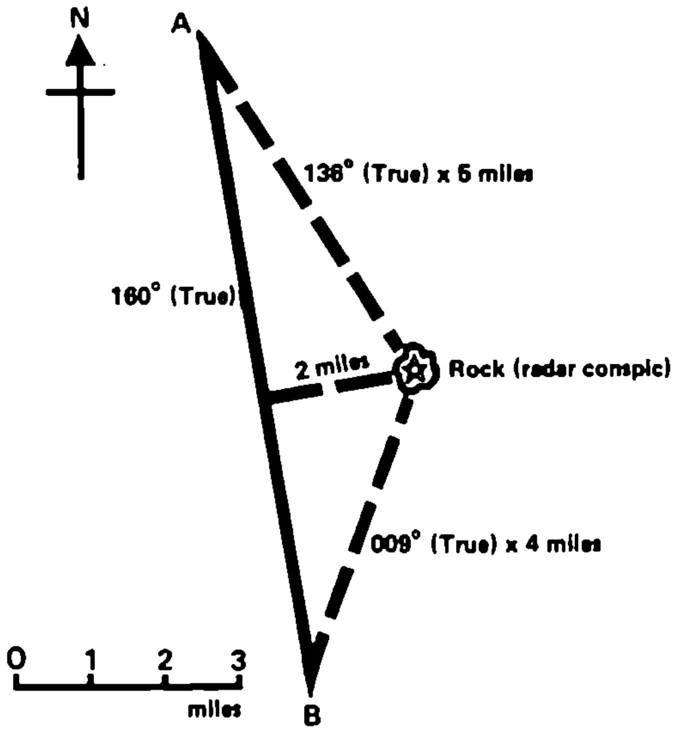


Fig. 19

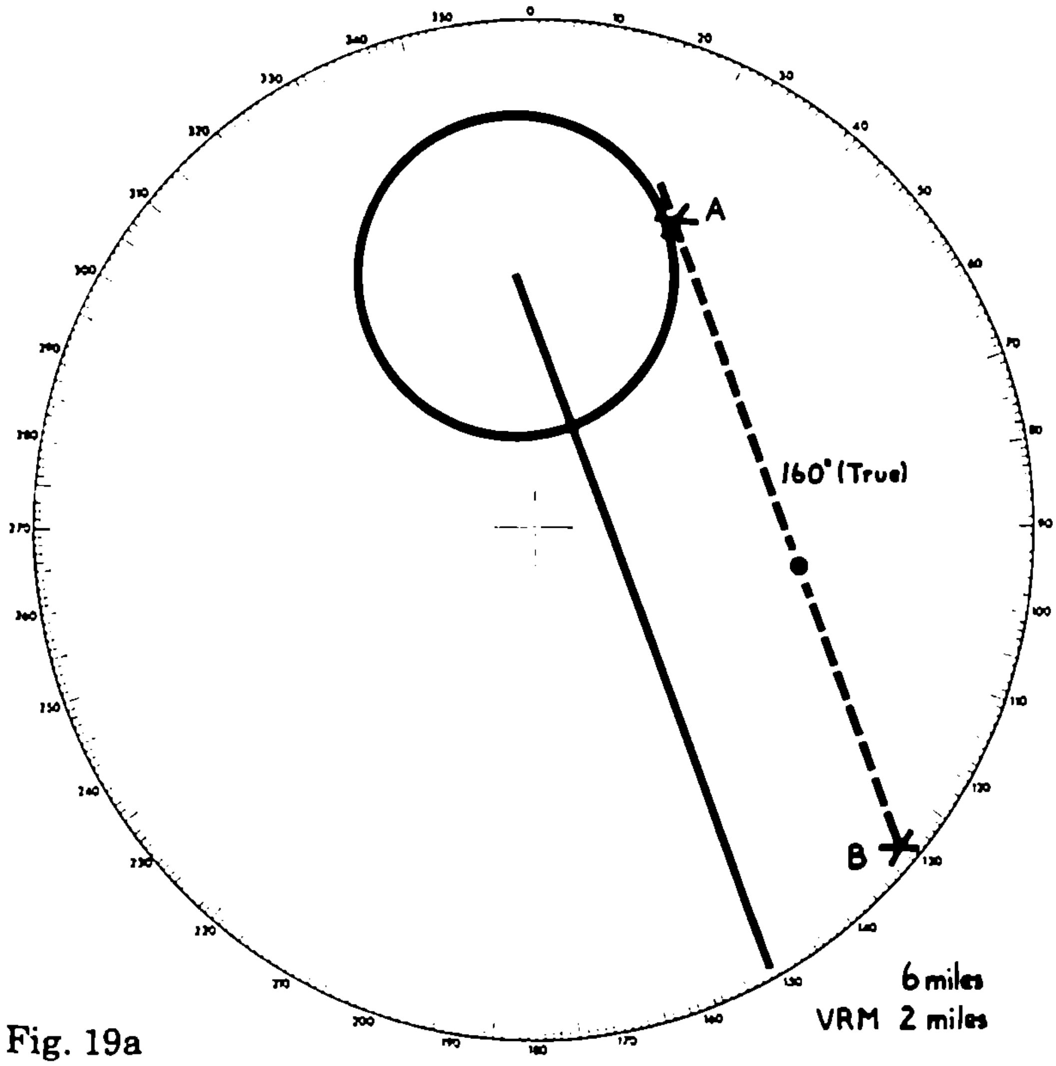
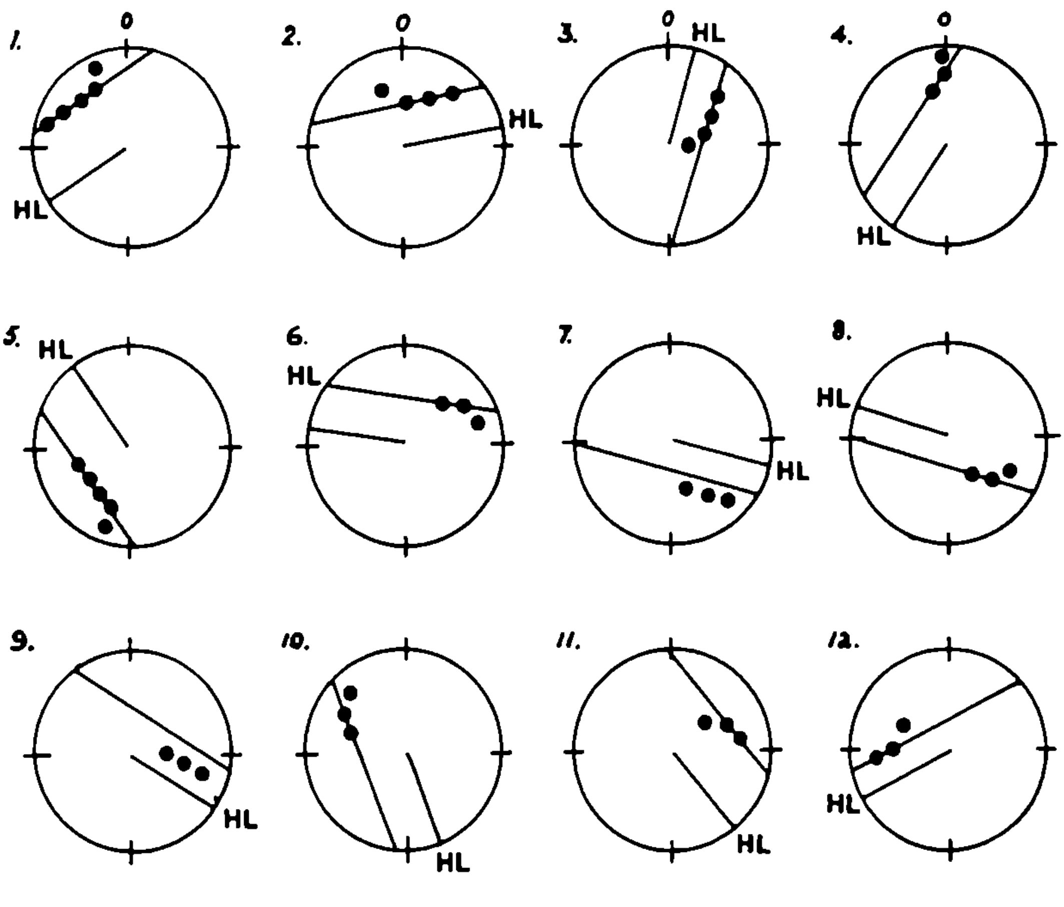
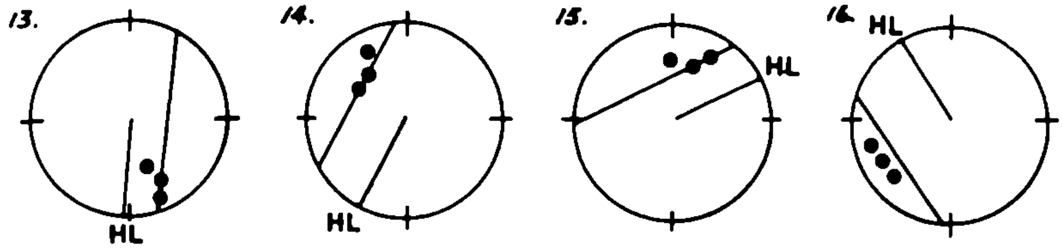


Fig. 19a

Annex1

Examples
The 16 squares indicate vessels on different headings. Each square is a PPI of a North-up gyro stabilized radar showing heading line, indexing line and echo of point of interest. Study the squares and work out which direction to alter course so as to return the vessel to her course line.





Answers

1. Starboard 2. Port 3. Port 4. Starboard 5. Port 6. Port 7. Starboard 8. Starboard 9. Starboard 10. Port 11. Starboard 12. Starboard 13. Starboard 14. Starboard 15. Port 16. Port.

Annex 2

Preparation of Parallel Indexing in Advance

Officers using parallel indexing for monitoring might wish to compile their own personal files of pre-planned indexing lines for various parts of the world in advance. This can be achieved by using perspex sheets which fit on to the surface of the plotter thus allowing the indexing lines etc to be drawn on beforehand e.g. on a deep sea passage, then filed away until required.

The dangers of using this method must be noted, however.

1. Pre-planned indexing range scales must coincide with the radar range in use at the time.

2. Centre of pre-planned indexing must coincide with the centre of the PPI.

3. The cardinal points marked on the pre-planned indexing must coincide with the PPI's.

4. In order to see the indexing lines on the pre-planned indexing, the reflection plotter lighting will have to be modified to shine from above the plotting surface.

It is hoped that in the future reflection plotters will be built with a removable top surface which should overcome the last of these problems.

Annex 3

Iotron DIGIPLOT NAV-LINE Parallel Index Navigation Option

Description

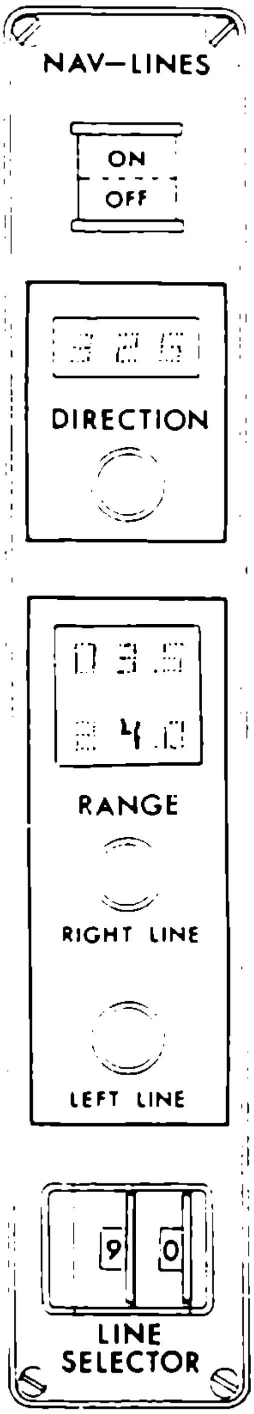
The Iotron Corporation have introduced an option called NAV-LINE to go with their well known DIGIPLOT fully automatic radar plotter which can be used in addition to the collision avoidance system. This NAV-LINE option allows the operator to establish, position and select up to ten pairs of parallel indexing lines for monitoring the vessel's position prior to entering confined waters and then display one or two pairs of lines only, as required.

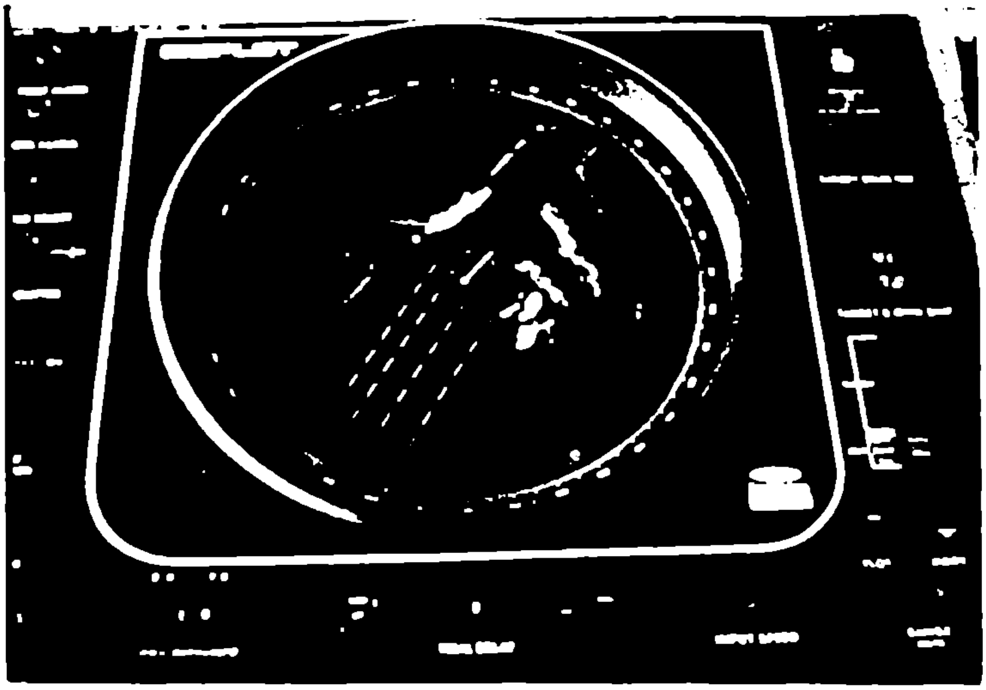
Presentation

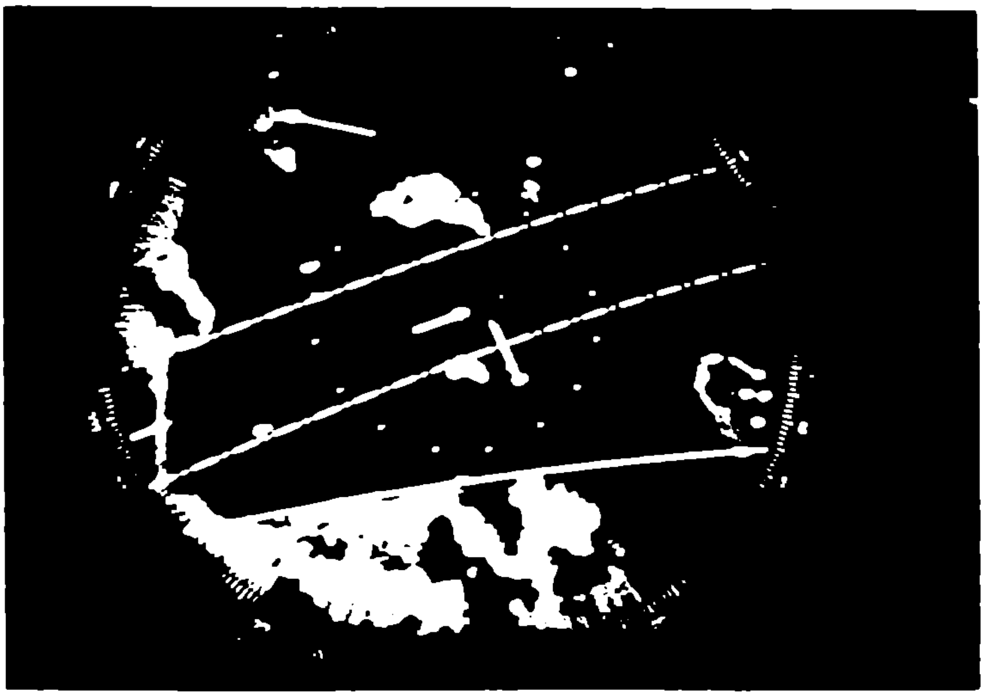
The NAV-LINE display can be used on either North-up stabilized or ship's head up presentations. For easier orientation North-up stabilized presentation is recommended.

NAV-LINE Control Box. The NAV-LINE controls and digital displays are mounted in a control box on the right of the DIGIPLOT cabinet. These allow the operator to select the pair of parallel indexing lines to be displayed, set the true direction of these lines (in degrees) and position them right and left of own ship at the required distance (in tenths of miles).

Nav-Lines Switch. The illuminated ON-OFF pushbutton switch permits the parallel indexing lines to be displayed on the DIGIPLOT PPI. The ON position activates the controls and illuminates the digital readouts and the LINE SELECTOR switch.







(top)
Iotron's DIGIPLOT, showing approaches to Valdez Arms, Alaska, on 12 mile range scale with four parallel indexing lines. (By kind permission of Iotron Corporation.)

(bottom)
Iotron's DIGIPLOT, showing San Francisco Bay, approaching Golden Gate Bridge with Angel Island to the North and Alcatraz Island to the South; on 3 mile range scale with two parallel indexing lines.
(By kind permission of Iotron Corporation.)

Direction. Depressing and turning the DIRECTION control changes the direction of each pair of 'selected' parallel indexing lines, as indicated by the LINE SELECTOR switch. Turning the control clockwise changes the line direction to the right and turning it anti-clockwise changes the line direction to the left. The line DIRECTION is continuously displayed directly above the control on the digital readout. When a line direction has been established by the operator, the selected lines are automatically retained in the DIGIPLOT memory until changed by the DIRECTION control.

RANGE Right Line. Depressing and turning the Right Line control clockwise, increases the range of the 'selected' right parallel indexing line to a maximum of 24 miles. Depressing and turning the Right Line control anti-clockwise decreases the range to a minimum of 00.0 miles.

RANGE Left Line. Depressing and turning the Left Line control clockwise increases the range of the 'selected' left parallel indexing line to a maximum of 24 miles. Depressing and turning the Left Line control anti-clockwise decreases the range to a minimum of 00.0 miles.

The actual Range setting of both the Right and Left Lines from own ship is continuously displayed on the digital readouts directly above the two Range controls. When the desired range to each line has been established by the operator, the 'selected' pair of line ranges are automatically retained in DIGIPLOT memory until changed by the Range controls.

LINE SELECTOR Thumbwheel Switch. This switch is an indicator type and is actuated by two thumbwheels in either direction. Each thumbwheel is numbered 0 to 9 and permits the control and display selection of either one or two pairs of parallel indexing lines. A pair of parallel indexing lines is selected by moving either the left or right thumbwheel to the desired line selector number. If the same number is placed on both thumbwheel switches, only one pair of parallel indexing lines will be displayed on the DIGIPLOT PPI. If two different numbers are shown, then two pairs of parallel indexing lines will be displayed. The *left* thumbwheel switch controls the specific pair of parallel indexing lines whose DIRECTION and RANGE are being displayed by the digital readouts, and also allows these lines to be positioned by turning the DIRECTION and RANGE controls. The right thumbwheel switch does not provide this capability. When adjusting each pair of parallel indexing lines it is recommended that both thumbwheel switches be positioned with the same LINE SELECTOR number in order to avoid display confusion and possible error.

For some planned courses, only one parallel index line may be required. To eliminate either the left or right line, the operator simply turns the range to 24.0 miles or to any range greater than the DIGIPLOT's PPI range scale.

The advantages of using Iotron's DIGIPLOT NAV-LINE system for parallel indexing, when compared to the manual plotting method using Chinagraph pencils are:

1. The planning is quicker and easier to execute.

2. Lines appear only when required thus avoiding the confusion of having too many lines on the PPI at the same time.

3. Duplicate lines need not be drawn for change of radar range scales.

The parallel indexing lines intersecting for an alteration of course point will not allow for the wheel over position on the DIGIPLOT, so the operator will have to estimate for this carefully before making a planned turn.

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