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RADAR BULLETIN NO. 5

(RADFIVE)

THE SURFACE PLOTTING MANUAL

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**UNITED STATES FLEET
HEADQUARTERS OF THE COMMANDER IN CHIEF**

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UNITED STATES FLEET
HEADQUARTERS OF THE COMMANDER IN CHIEF
NAVY DEPARTMENT
WASHINGTON 25, D. C.



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TABLE OF CONTENTS

100	PREFACE
1000	INTRODUCTION
2000	THE NAVIGATIONAL PLOT
2100	BASIC CONSIDERATIONS
2110	Definitions
2120	Navigation as it Applies to Surface Plotting
2130	Dead Reckoning
2140	Instruments and Accessories
2200	DEAD RECKONING EQUIPMENT
2210	Explanation
2220	Pencil Carriage
2230	Latitude and Longitude Dials
2240	Latitude and Longitude Selector Switch
2250	Component Tracking Switch
2260	Clock Light Switch
2270	Scales and Adjustments
2280	Plotting Surfaces
2300	PLOTTING ON THE DRT
2310	Positioning the "Bug"
2320	Orienting Parallel Motion Protractor to DRT
2330	Developing own Ship's Track on DRT
2340	Indicating Time
2350	Plotting Bearings and Ranges with Parallel Motion Protractor.
2360	Symbols and Abbreviations
2370	Data to be Recorded on Plots
2380	Determining Courses and Speeds
2390	Sample Plots
2400	READINESS AND PRECAUTIONS
2410	State of Readiness of the DRT at Sea
2420	DRT Casualties
2430	Reminders
2440	Primary vs. Secondary Targets

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3000 RELATIVE MOTION AND THE USE OF THE MANEUVERING BOARD

3100 INTRODUCTION

3200 RELATIVE MOVEMENT

3300 THE MANEUVERING BOARD

3310 The Relative Plot on the Maneuvering Board

3320 The Vector Diagram

3330 Scales

3340 Illustrative Problems

3350 The Torpedo Effective Range Indicator and its Use

3360 Three Minute Thumb Rule for Determining Course and Speed

3370 The Plastic Maneuvering Board

4000 SUMMARY PLOT

4100 INTRODUCTION

4200 UTILIZATION OF THE SUMMARY PLOT

4300 TYPES OF PLOTS

4400 INFORMATION TO BE PLOTTED

4500 SOURCES OF INFORMATION

4600 KEEPING THE PLOT

5000 THE PREPARATION OF CIC PROBLEMS FOR TRAINING

5100 DRILL PROBLEMS

5110 Arithmetic Problems

5120 Dead Reckoning Problems

5130 Surface Plotting Problems

5140 Relative Movement and Maneuvering Board Problems

5200 CIC TEAM PRACTICE PROBLEMS

PREFACE

100.

This Surface Plotting Manual is promulgated for the purpose of setting forth the plotting procedures, symbols, and techniques which will aid in standardizing the portrayal of the surface picture. In accomplishing this purpose you will find the background material, equipment, and aids necessary to the maintenance of the surface plot will be discussed in connection with the true and relative presentation.

The manual is written on the assumption that its readers are entering an entirely unfamiliar field and consequently introduces the necessary material in a sequence which will be most beneficial for this category of individuals. Endeavor has been made to lead the prospective plotter through the logical succession of events and explain in simple language the problems to be met and methods of solution with the following objectives in mind:

- (a) To acquaint the reader with the problem of surface plotting.
- (b) To explain to the reader how to use the plotting equipment he will be furnished.
- (c) To provide the reader with standard methods of plotting.
- (d) To acquaint the reader with standard plotting symbols and abbreviations.
- (e) To give the reader practice in laying out and completely labeling the tracks in order to present a clear understandable plot that will accurately portray the events that take place in the area within radar range of the ship.
- (f) To provide the guides for sufficient practice in the above procedure to establish proficiency.

1000. INTRODUCTION.

1010. The actions in this war have shown that the events of battle move at a tremendous pace. In keeping with this pace our every step must be positive and in the right direction. The minutes that are available in which to prepare our ships for fighting are precious. We must produce a maximum amount of combat information in a minimum of time.
1020. In order to utilize most of the information that is received in the Combat Information Center *plots must be maintained*. These plots must transpose a series of bearings, ranges, and other pertinent data into understandable pictures that portray graphically the events taking place in the area in sufficient time to be of use to the rest of the ship.
1030. In view of anticipated developments in CIC equipment which will reproduce these displays in other essential stations aboard ship, there are going to be increased demands upon plotting, plotting procedures, and plotting techniques.
1040. If the information is to flow to the display smoothly and the plotter is to develop the required neatness, speed, and accuracy the plotter *must know*:
- (1) *What* he is to do.
 - (2) *How* he is to do it.
1050. This manual is written to guide the training of surface plotters along lines that will satisfy the needs set forth in the preceding paragraphs by leading the plotter successively through all of the necessary elements and explaining the equipment to be used, the techniques to be employed, the symbols and abbreviations required, and the types of displays that will produce the desired accuracy in the portrayal of the sequence of events.
1060. Since it is the *solution* to the surface problems that is the ultimate objective, the aim of this manual is to this end: *That the plotter will be taught the means of presenting information in such a manner as to make sound evaluation possible.*

2000. THE NAVIGATIONAL PLOT.

2100. BASIC CONSIDERATIONS.

2110. Definitions.

- (a) *The navigational plot* shows by means of lines drawn on a plotting surface the successive positions of a ship's travel. Lines connecting these positions indicate direction and distance traveled with respect to the earth. This plot will, therefore, show the movement as would be observed from an airplane. (See Figure 1). This method of plotting is extremely valuable in the Combat Information Center in that it shows what is taking place with respect to the earth as well as with respect to ships in the area. It shows (as accurately as the data producing it will allow) what has already taken place and indicates trends upon which to plan future action.
- (b) *Direction of travel* is referred to as "course" and is expressed in degrees or by points of the compass. The navy always uses the former and expresses the courses by three digit numerals, i.e., 000°, 002°, 270°, etc.
- (c) *Rate of travel* is referred to as "speed" and is always expressed in knots (1 knot = 1 nautical mile per hour).
- (d) *Distance* is expressed in nautical miles. (1 nautical mile = 2000 yards). In arithmetic we have learned that rate times time equals distance. So if we travel at a rate of 15 knots for one hour we will have gone 15 nautical miles.
- (e) *Range* is the distance between two objects, usually from the ship to an object, and is expressed in yards or miles.
- (f) *Bearing* is the direction of one point or object with respect to another or to the points of the compass.
- (g) *True bearing* is the direction of a point or object with respect to the direction of true North. It is measured 360° clockwise from 000° (North).
- (h) *Relative Bearing* is the direction of one point or object with respect to the ship's bow. It is measured in degrees (or points) clockwise through 360°, 000° being the bow of the ship. (Note Figure 2)
- (i) *True bearings* are used to facilitate the positioning of an object or ship with respect to the earth (or ship if its heading is known.) These bearings are readily plotted knowing only the position at which the bearings are taken.

Relative bearings are used to locate objects with respect to the bow of a ship. To plot relative bearings it is necessary to know in addition to the point at which the bearing is taken, the heading of the ship at the time (unless automatically indicated).

Thus, it is seen that true bearings are more useful to plotters than are relative bearings. On the other hand, relative bearings are more useful to lookouts and gunners who do not have access to a gyro repeater to determine the ship's heading.

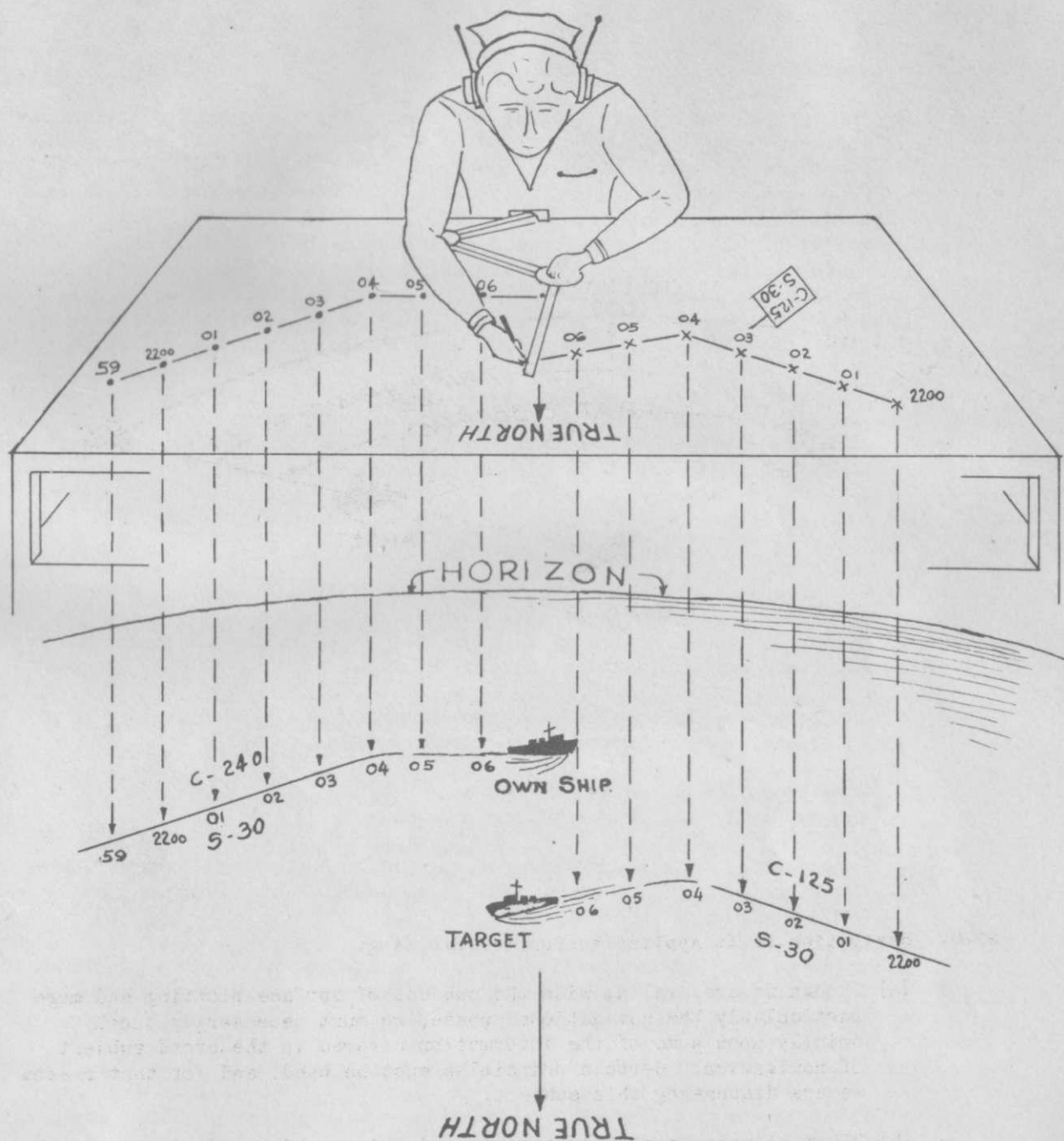
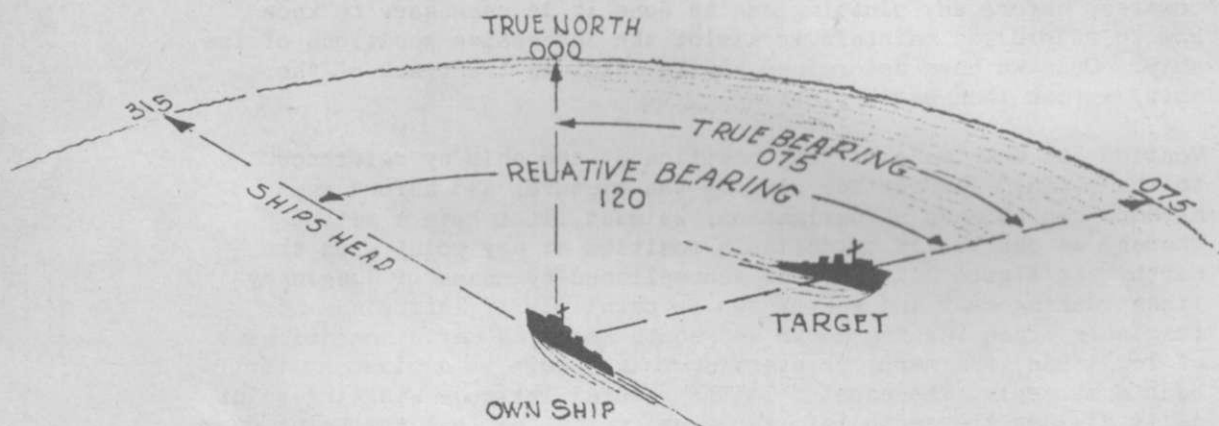


FIGURE 1



FIGURE

2120. Navigation As It Applies to Surface Plotting.

- (a) Though we are dealing with the subject of surface plotting and more particularly the navigational phase, we must necessarily touch briefly upon some of the information covered in the broad subject of navigation. Certain principles must be used, and for that reason we are discussing this subject.
- (b) "That science, generally termed navigation, which affords the knowledge necessary to conduct a ship from point to point upon the earth, enabling the mariner to determine with a sufficient degree of accuracy the position of his vessel at any time, is properly divided into two branches: Navigation and Nautical Astronomy." Since Nautical Astronomy is of little aid to plotting it will not be discussed in this manual.
- (c) "Navigation in its limited sense is that branch which treats of the determination of the position of the ship by reference to the earth,

or to an object thereon. It comprises:

- (1) PILOTING, in which the position is ascertained from visible objects upon the earth, or from soundings of the depth of the sea.
- (2) DEAD RECKONING, in which the position at any moment is deduced from the direction and amount of a vessel's progress from a known point of departure."
- (d) It is "navigation in its limited sense" that is emphasized. Some of the elements of dead reckoning are discussed in later paragraphs. However, before any plotting can be done it is necessary to know how to record and maintain in a plot the successive positions of the ship. Once we have determined how to maintain the track of the ship, we can then begin plotting.
- (e) Mention has been made of "the position of the ship by reference to the earth." To further clarify the picture, and before any attempt can be made at navigation, we must first have a method whereby we can locate or define a position at any point upon the earth (see Figure 3). This is accomplished by means of imaginary lines running east and west known as parallels of latitude, and imaginary lines running north and south known as meridians (Lines of longitude). A zero, or starting point, must be arrived at for each component. The equator is the natural latitude starting point as it divides the earth into two equal parts, so that any point on the equator is zero latitude. Proceeding north you pass 10° north latitude, 20° north latitude, and so on until you reach 90° north latitude which will be the north pole. Likewise, proceeding south from the equator the degrees of south latitude increase until you reach 90° south latitude which will be the south pole. Since there is no natural starting point for measurement of longitude, an arbitrary meridian passing through Greenwich, England was chosen. Any point on that half of the meridian which passes through both poles and Greenwich/ is zero longitude. When traveling east of Greenwich, the longitude increases until 180° east longitude is reached. Likewise, when travelling west of Greenwich, the longitude increases until 180° west longitude is reached. 180° east or west longitude will be on the half of the meridian on the opposite side of the earth from Greenwich. By means of latitude and longitude, we can now position ourselves at any point on the surface of the earth merely by stating whether latitude is North or South, longitude is East or West, and how many degrees, minutes, and seconds each contains. Examples:

Lat. $36^{\circ}-59'-06''$ North; Long. $126^{\circ}-32'-59''$ West.

Lat. $30^{\circ}-00'-00''$ North; Long. $100^{\circ}-00'-00''$ West.

(Illustrated in Figure 3)

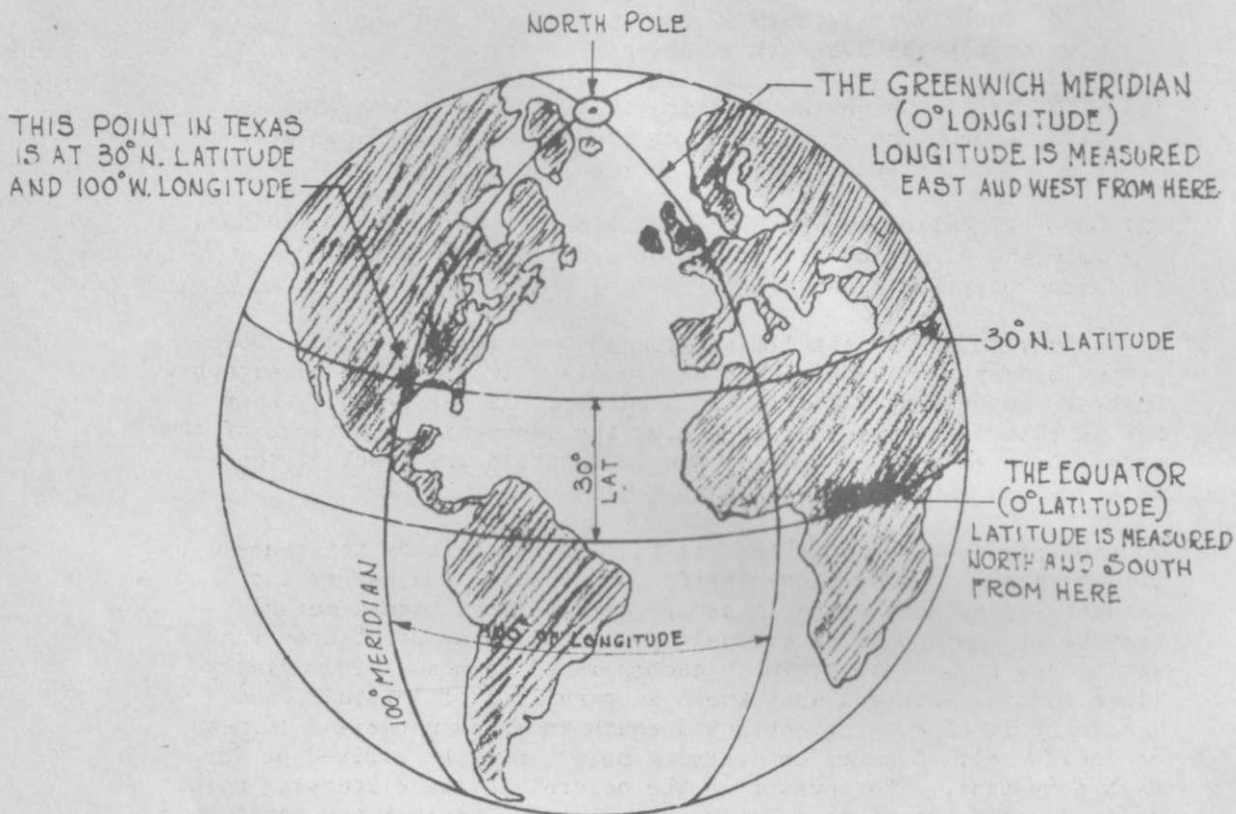


FIGURE 3

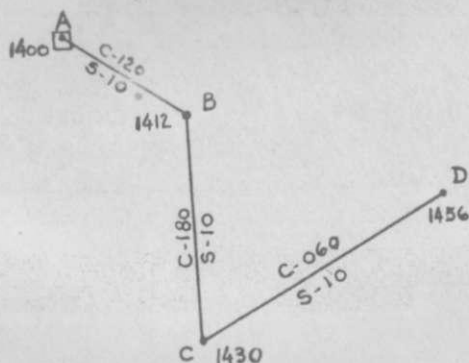
2130. Dead Reckoning.

- (a) Dead Reckoning is the phase of navigation with which the CIC plotter is most concerned. It is defined as "the process by which the position of a ship at any instant is found by applying to the last well determined position the run that has since been made, using for the purpose the ship's course and the distance indicated by the log or other means."
- (b) The course line is the direction prescribed for the ship's movement or progress over the ground. This direction may be represented on a chart by drawing a straight line, called *course line*, which forms an angle with the meridians and equals the true course. In laying out the "course line" it is customary to start the line from the ship's last known or well-determined position. This line, then, represents the path the ship would follow (or would have followed), if there were no wind, if there were no currents, and if the ship could be steered exactly at every instant. Obviously, this is rarely, if ever, the case. Along this course line the plotter may plot dead reckoning (DR) positions for any given times by measuring off distances he should travel (or should have traveled) through the water since the time of the last known position. Distance may be determined from the pitometer log or indirectly from the propeller shaft speed.

- (c) To illustrate dead reckoning, investigate the following problem and apply the directions above.

- Given: (1) Point A- Last well determined fix; 1400 position of own ship.
 (2) Initial course of own ship- 120° true.
 (3) Speed of own ship - 10 knots.
 (4) At 1412 (Point B) own ship changes course to 180° true.
 (5) At 1430 (Point C) own ship changes course to 060° true.

Required: By dead reckoning find the position of own ship at 1456 (Point D) using a scale of 1 inch = $2\frac{1}{2}$ miles.



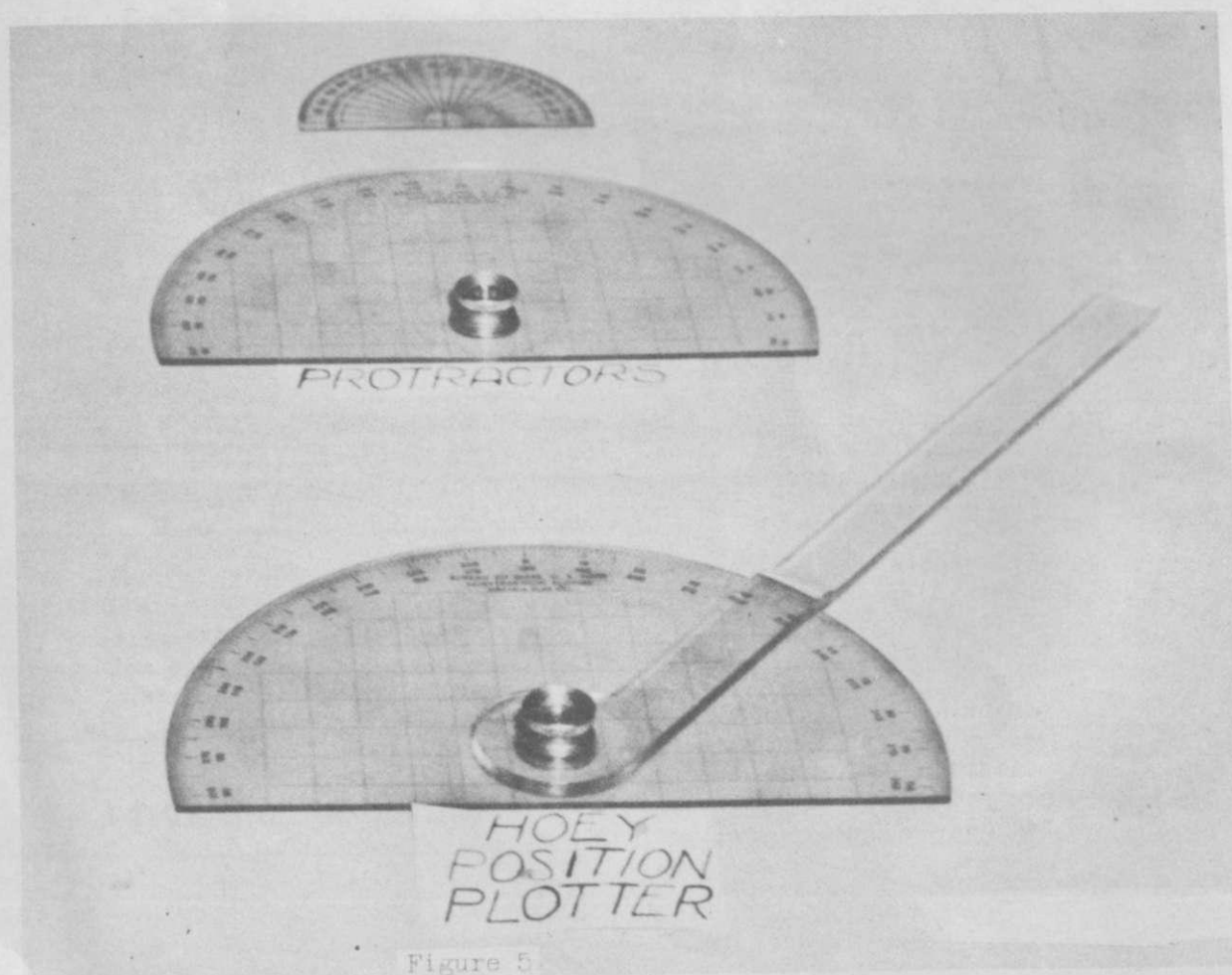
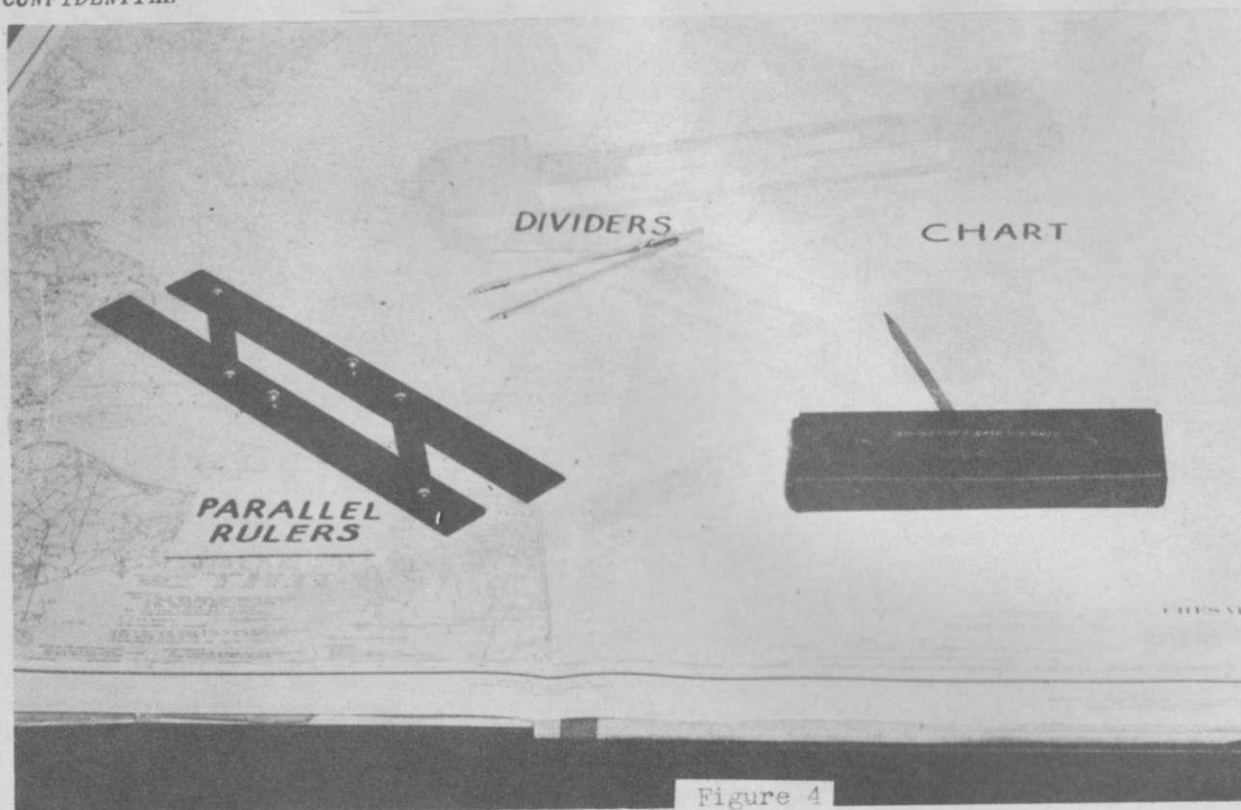
Dist A-B = 2 mi. = dist. traveled in 12 min. at 10 knots.

Dist B-C = 3 mi. = dist. traveled in 18 min. at 10 knots.

Dist C-D = 4 mi. = dist. traveled in 24 min. at 10 knots.

2140. Instruments and Accessories. (See Fig. 4 and 5)

- (a) *Dividers or Compasses* are used to transfer distances and to scribe arcs and circles.
- (b) *Parallel rulers* are used to transfer a line parallel to itself.
- (c) *The Protractor* is used for laying down angular measures upon a chart or other plane surface.
- (d) *Hoey Position Plotters*. (See Figure 5). The Hoey Position Plotter is used for plotting positions. The arm may be clamped at any angular position on the protractor and both bearing and range may be plotted from a given point, thus locating position.
- (e) *The Parallel Motion Protractor (Universal Drafting Machine)* (See Figure 6) is a protractor carried by a parallel-motion linkage which is fastened to the upper edge of the chart board. The linkage permits the movement of the protractor to any part of the chart without loss of orientation. Therefore, the instrument affords a great convenience in laying off a course or bearing from any chosen point and in the parallel transfer of a straight line to any required position. The graduated protractor rim or compass rose can be clamped as desired, and hence oriented to coincide with the North and South direction of the chart.



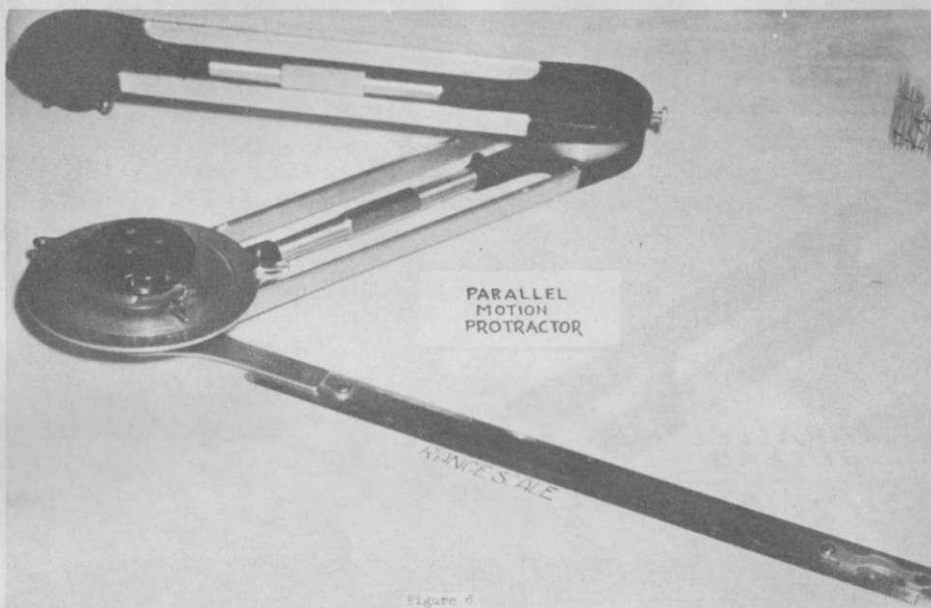


Figure 6

- (f) Scales for the Parallel Motion Protractor are being provided by the Bureau of Ships' Allowance List General Amendment Number 215, (See Figure 7). These scales are designed for determining speeds from whole minute time intervals with the exception of $1\frac{1}{2}$ minutes on the 500 and 2000 yard scales and $2\frac{1}{2}$ minutes on the 1000 yard scale. The speed scales are conveniently arranged on the range scale so as to facilitate speed determination. If the scales are to be used with odd quarter minutes of plot, estimation of whole minutes of plot will be necessary.



Figure 7

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(g) *Pantograph (Mk 1 Mod 0)* (See Figures 8 and 9)

A pantograph is being supplied to all CICs for reducing or enlarging charts or photographs.

To set the instrument for any given enlargement or reduction, dividers should be used to insure that the distances AB, CD and BE are all equal (See Fig. 9.)

To determine the divider setting in inches, the following formula is used:

$$* \frac{26}{\text{Reduction Ratio}} = \text{Divider setting.}$$

For example, if it is desired to obtain a reduction ratio of 3.5 to 1 the formula is:

$$\frac{26}{3.5} = 7.43$$

The divider setting is 7.43 inches and the pantograph should be set so that AB, CD, and BE all equal 7.43 inches. The pantograph is now adjusted for reduction (or enlargement) of 3.5 to 1.

For reduction, the pencil lead must be placed at E, and the stylus must be placed at F. For enlargement the opposite is true.

2200. THE DEAD RECKONING EQUIPMENT.

2210. Explanation.

The dead reckoning equipment consists of the Dead Reckoning Analyzer and the Dead Reckoning Tracer..

- (a) DRA - Own ship's movement is put into the dead reckoning analyzer in two components; ship's course from the gyro compass and ship's speed from the pitometer log.

(1) *The gyro compass* is a mechanical compass that receives its directive force from gyroscopic action.

(2) *The pitometer log* is a navigating instrument which indicates speed of a ship through water and registers the distance traveled.

Information thus obtained is indicated on counters to show total distance traveled, distance made good to the East or West, and distance made good to the North or South.

* When the pantograph is to form a 20" square, substitute 20 for 26 in the above formula.



Figure 8

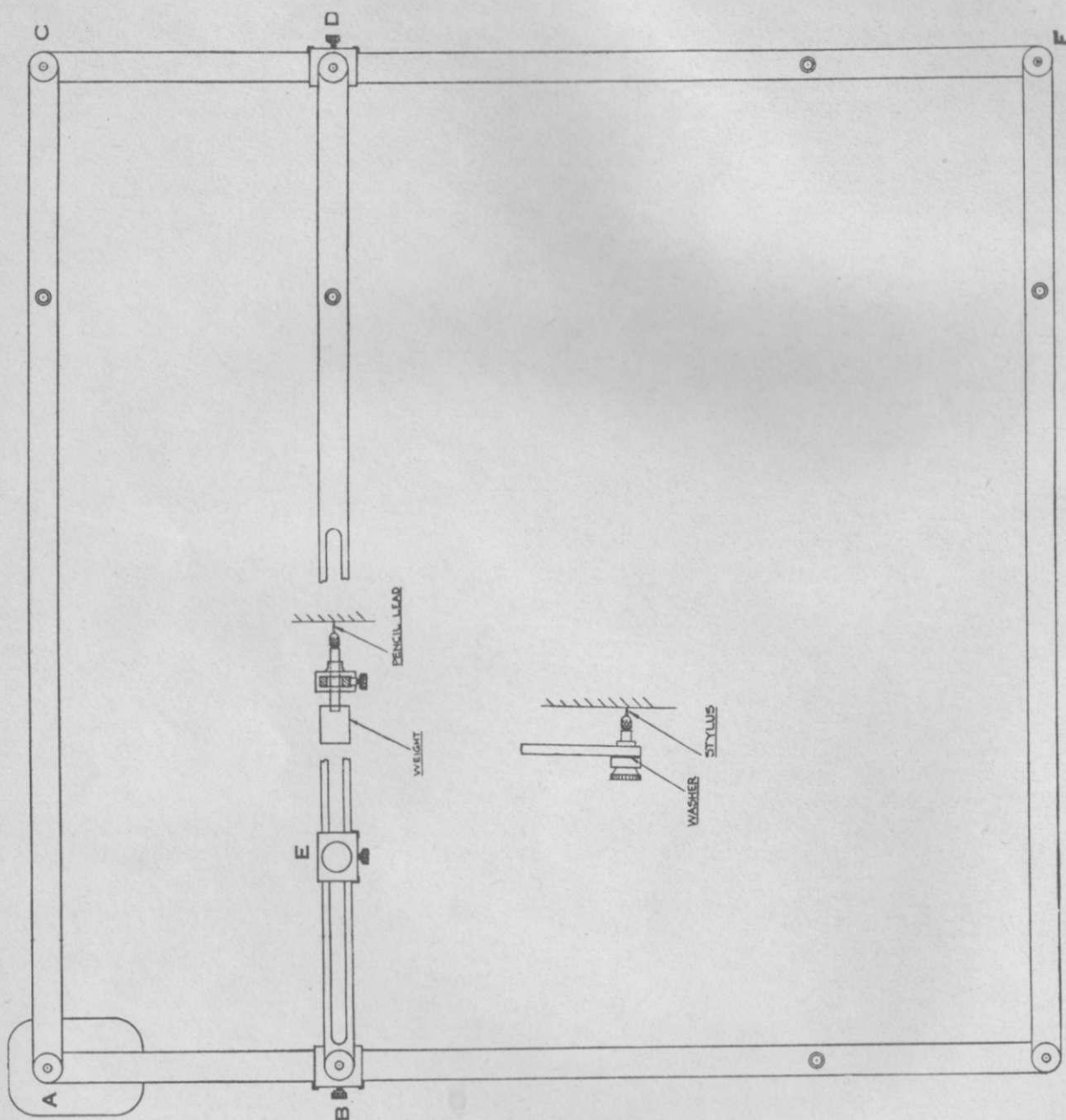


Figure 9

- (b) DRT - In the dead reckoning tracer the distance components from the analyzer actuate motors which drive the "bug" (pencil carriage) which gives a geographical plot of the ship's travel, and the dials which indicate latitude and longitude. The latitude-longitude dials must be set in accordance with actual latitude and longitude at a given time. The energy fed through the analyzer will give continuous readings thereafter. As first designed the DRT was used to provide a graphic record of own ship's track for navigational purposes. The "bug," with its projected spot indicating own ship's position at any time, and the plotting surface (the glass top) are modifications which provide plotting facilities for use in CIC. The "bug," driven by the tracer, moves under the plotting surface in direction and distance representing own ship's movements to scale. Own ship's track is recorded by manually making successive pencil dots on the plotting surface to indicate the position of the ship at the time the dots are made.

2220. Pencil Carriage.

The pencil carriage, or "bug," is composed of the following: (See Figure 10)

- (a) The compass rose, with range circles and bearing degree markings on the outer circle
- (b) The pencil clamp
- (c) The solenoid contact bar: Sliding contacts keep the pencil magnet electrically connected to the contact bar.
- (d) The light bulb under compass rose.
- (e) The light switch (should remain on "light" position for use in CIC.)

2230. Latitude and Longitude Dials. (See Figure 11)

- (a) Since a degree of latitude very nearly equals sixty miles anywhere on the earth's surface, the latitude dials are geared directly to the latitude motor. A selector switch is provided for changing the direction of rotation of latitude dials when the equator is crossed.
- (b) Since the number of miles East-West per degree of longitude varies with the latitude, a variable speed mechanism is introduced between the longitude motor and the longitude dials. The selector switch also changes the direction of rotation of the longitude dials when crossing the 0° or 180° meridian.

2240. Latitude and Longitude Selector Switch. (See Figure 11)

This is the switch referred to above. It must be set according to the earth's quadrant in which the ship is operating.

2250. Component Tracking Switch. (See Figure 11)

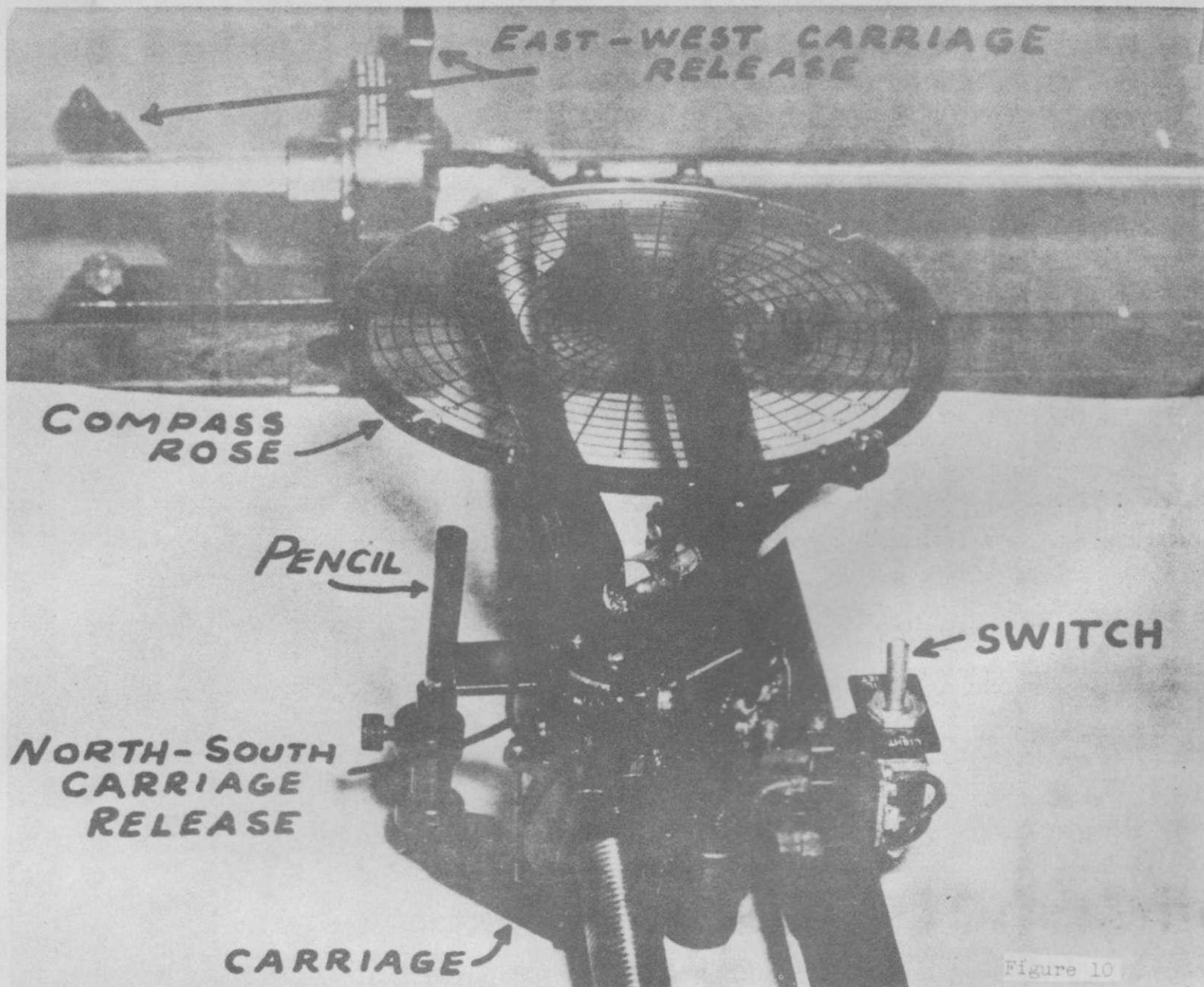


Figure 10

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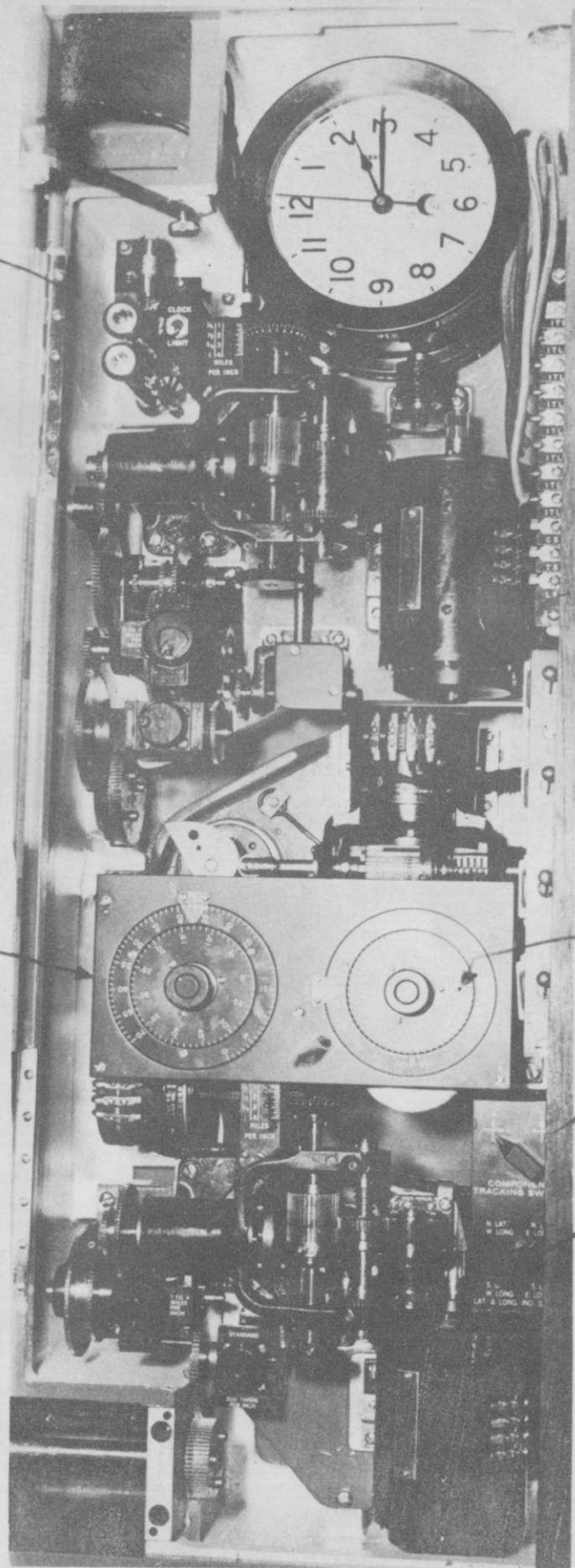
Clock Light
Switch

Latitude Dia

Longitude Dial

Component
Tracking
Switch
Lat. & Long.
Selector
Switch

Figure 11



This is provided to shift the plotting axis to accommodate the various positions in which the DRT might be installed aboard ship. Two choices are provided with directions as indicated:



2260. Clocklight Switch. (See Figure 11)

In position 1 (LIGHT) the light will stay on continuously. In position 2 (OFF) the light is off. In position 3 (CLOCK), which is seldom used in CIC, the light is on only 15 seconds of each minute.

2270. Scales and Adjustments. (See Figure 12)

- (a) The number one adjustment of the DRT scale mechanism is for either 200 yards per inch or standard setting. If set on 200 yards per inch, the tracer will move one inch for every 200 yards of ship's movement. Disregard all other scale dials for this setting.
- (b) The standard scale ranging from $1/4$ to 16 miles per inch is divided into three basic scales. (See adjustment number two Figure 12.)

Green - $1/4$ to 1 mile per inch.

White - 1 to 4 miles per inch.

Red - 4 to 16 miles per inch.

By lifting the locking pin on the setting knob, this knob is free to rotate the white line marker opposite to the basic scale desired. To complete this adjustment it may be necessary to rotate the gear train to permit meshing of the gears. When one of the three basic scales has been determined, we can proceed to adjustment number three.

- (c) Adjustment number three is a vernier dial equally divided as follows:

Green - No division, simply a green zero.

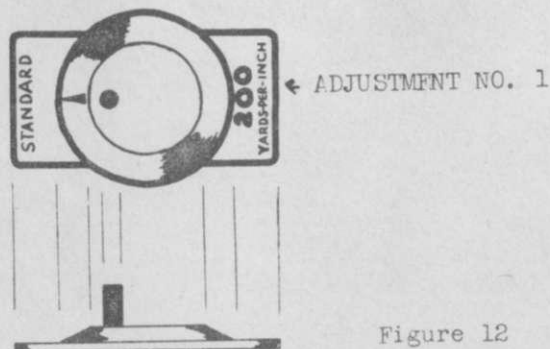
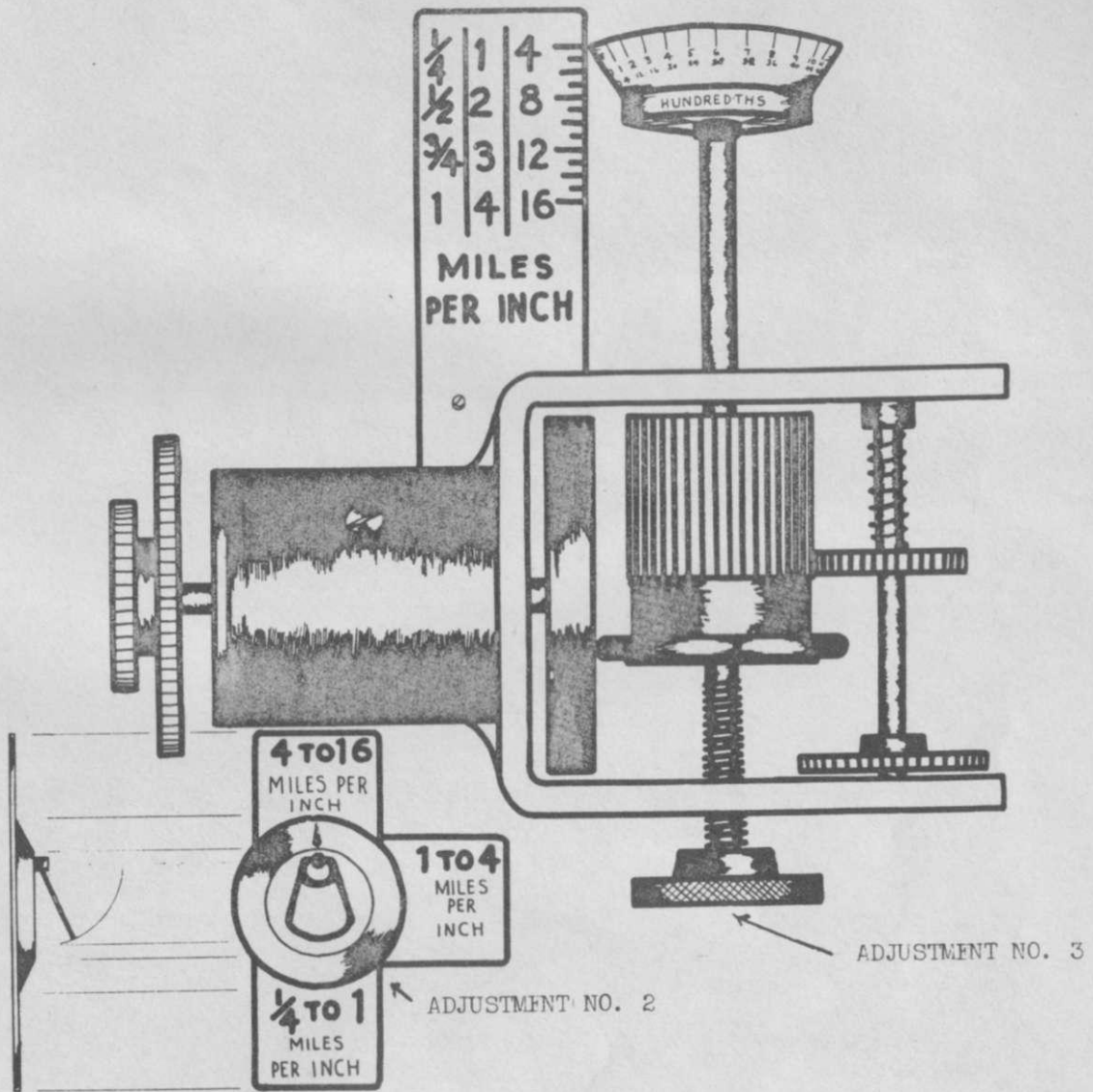
White - Zero to twenty five

Red - Zero to one hundred by four's (i.e. 4, 8, 12, etc.)

To move the vernier scale indicator one division on the miles per inch (green, white, or red) scale, requires one full turn of the vernier knob (adjustment number 3.) Therefore, to change scale from $1/4$ to $1/2$, 1 to 2, or 4 to 8 miles per inch requires four full, counter-clockwise turns of the vernier dial.

2280. Plotting Surfaces.

A glass top is installed over the tracer for plotting. Plots, however, are not made directly upon the glass surface. There are two major ways of providing a suitable surface:



D.R.T. SCALE ADJUSTMENT MECHANISM

Figure 12

TRACING PAPER

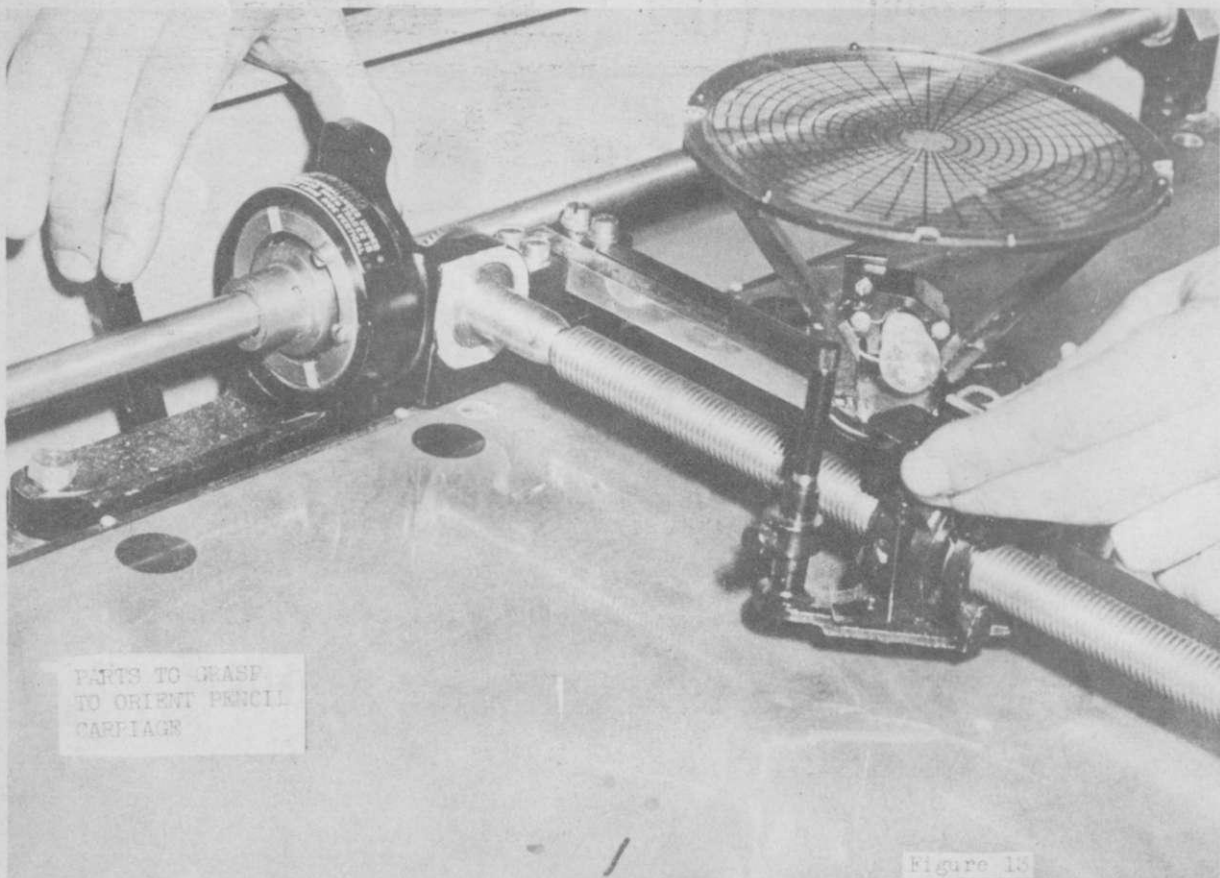
TRANSPARENT PLASTIC

- (a) When using tracing paper a desirable arrangement is to have the roll of tracing paper held in place so that the paper can be unrolled across the glass top and fastened by scotch or masking tape. A single piece of tracing paper made fast to the glass top is another satisfactory arrangement.
- (b) When transparent plastic is used have it slightly sanded to take pencil markings. To erase pencil markings, carbon tetrachloride is recommended.
- (c) Both methods are now in use in the fleet. The tracing paper method will provide a record of the plot and will provide a neater plot.

2300. PLOTTING ON THE DRT.

2310. Positioning the "BUG".

The "BUG" on the DRT is moved to any position by releasing the clutch on the carriage (See Figure 13 - right hand) and the clutch on the bug itself (See Figure 13 - left hand), and moving the bug transversely and longitudinally as desired.



2320. Orienting the Parallel Motion Protractor to the DRT.

The Parallel Motion Protractor is normally used in conjunction with the Dead Reckoning Tracer and must be oriented to the movement of the DRT bug. (See Figure 14). Orientation can be accomplished by performing the following operations in sequence:

- (a) Mark DRT bug position on the top plotting surface.
- (b) Disengage the clutch and move DRT bug 10-12 inches in a 090 direction and plot new bug position.
- (c) Position the protractor arm along the two plots and adjust the bearing indicator of the protractor so that a 090-270 true bearing line is indicated.
- (d) If desired, orientation to the 000-180 line may be accomplished in a similar manner.
- (e) A somewhat less accurate orientation can be effected by reference to the DRT bug compass rose.

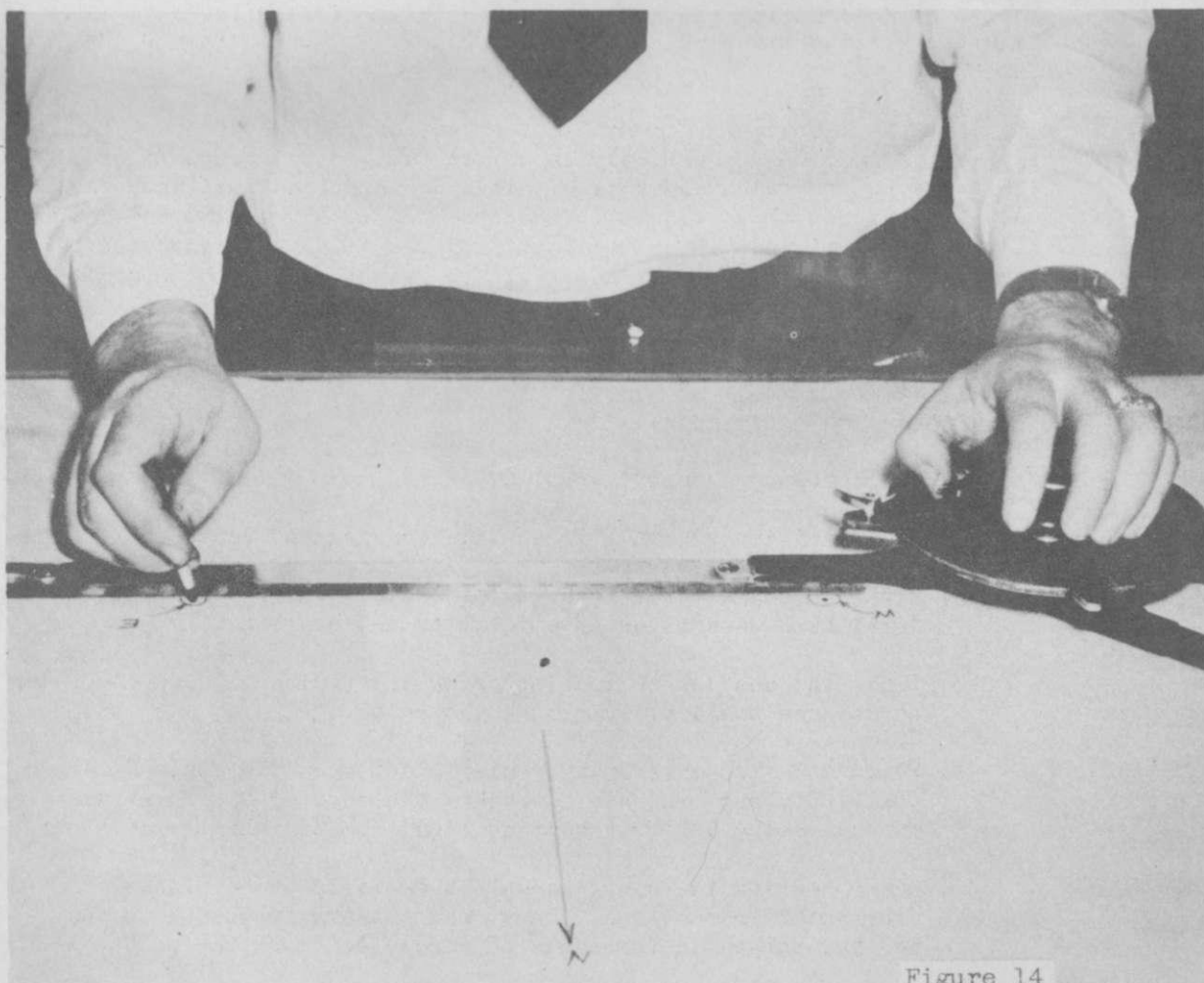


Figure 14

2330. Developing Own Ship's Track on DRT.

The DRT was originally designed as an aid to the Navigator. Using it in this capacity, a chart was placed beneath the pencil carriage on the plotting board, and the moving pencil automatically plotted own ship's track. For the DRT to be useful to CIC, it must be possible to plot bearings and ranges of surface targets, using standard plotting instruments, from the points along own ship's track at which the bearings and ranges were obtained. The recessed plotting board of the DRT is not suitable for this purpose. To provide a suitable plotting surface for tracking targets, an auxiliary glass plotting table was added to the DRT. Also a compass rose or pin-point of light was added to the bug to show its position at all times. By plotting the movement of this pin-point of light the track of our own ship is developed.

2340. Indicating Time.

On the first plot record the hour, minute, and quarter minute zone time, by a four digit number, with an exponent to indicate the quarter minute. For succeeding positions on the same "track" record time using only two digits and quarter-minute exponent until the next hour. Then record four digits to indicate the hour to which minute figures refer. In this manner the time will be amply recorded for evaluating purposes. The system of designating the quarter-minutes is as follows. To illustrate: the time indicated by the clock of Figure 15A and 15B is 12².

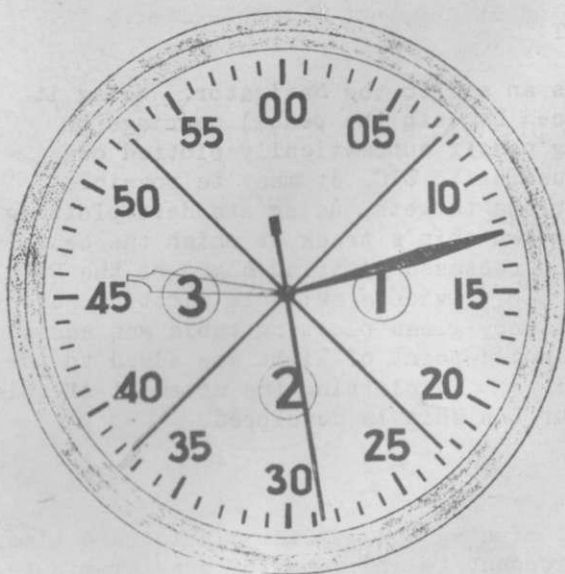
Thus, if the second hand is within the 1st, 2nd or 3rd quadrant, an exponent 1, 2 or 3 respectively is written after the minute figure. If, however, the second hand is within the unnumbered quadrant, record only the nearest whole minute. The clockface of Figure 15B and 15C illustrate particular types of simplified clockfaces designed for CIC plotting. For clarity it is desirable to "phantom" out the hour hand as in 15A and 15B.

2350. Plotting Bearings and Ranges using the Parallel Motion Protractor (PMP).

Two methods are outlined:

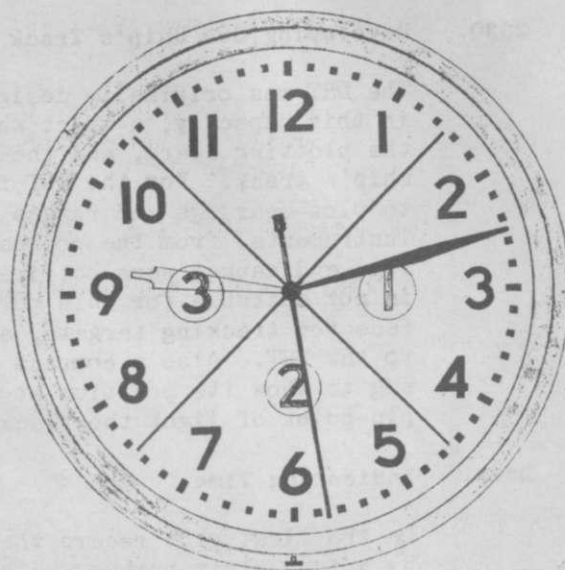
(a) Direct Plotting. (See Figure 16A).

- (1) Plot position of own ship at time bearing and range is taken.
- (2) With the range ruler free to rotate, set ruler at proper bearing (free hand uses ruler as a lever to set bearing).
- (3) Place the bearing indication arrow that points toward the ruler on desired bearing; then lock the ruler.
- (4) Place the zero mark of the ruler exactly on the desired marked position along own ship's track. The edge of the ruler now extends along the true bearing line from own ship's position.
- (5) After hearing the range repeat it mentally while placing protractor in position. Now, read outward from zero to the desired range (in thousands of yards) and mark the point.



NOTE: PAINT HOUR HAND WHITE.

Figure 15(b)



NOTE: PAINT HOUR HAND WHITE.

Figure 15(a)



Figure 15(c)

- (6) Immediately after establishing this point, release lock on ruler leaving it ready for use.
- (7) Move the PMP clear of the plot so that the evaluator will have an unobstructed view of the plot and so that the plot may be "dressed up."

(b) Indirect Plotting. (See Figure 16B).

Indirect plotting makes use of the reciprocal bearing mark to

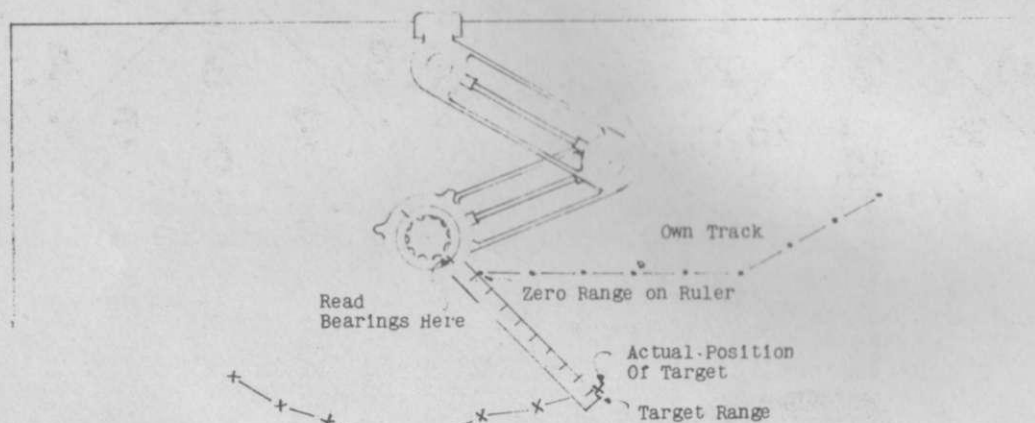


Figure 16(a)

(A) DIRECT PLOTTING

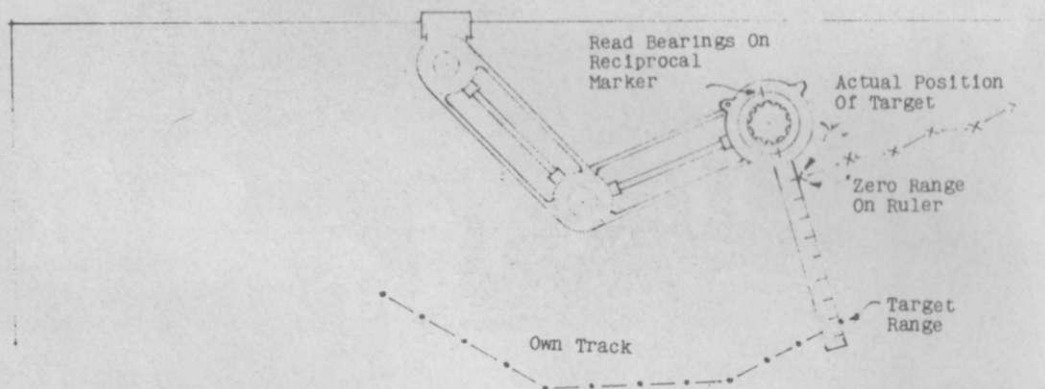


Figure 16(b)

(B) INDIRECT PLOTTING

facilitate the plotting of targets which are awkward to handle by direct plotting. The following are variations from direct plotting:

- (1) The desired bearing is read beside the arrow which is 180° from the ruler side of the PMP arm.
- (2) The desired range instead of the zero mark is placed at the marked position on own ship's track.
- (3) The target's position is then plotted at the zero mark on the ruler.

- (c) A combination of the above methods is used when plotting multiple targets. Awkwardness caused by turning the ruler through wide arcs can thus be eliminated in many cases.

2360. Symbols and Abbreviations.

The following is the list of plotting symbols and abbreviations to be used:

Symbol	Meaning
.	Own ship
X	Unidentified or enemy contact
O	Friendly ship
#3	Code number of IFF. (Figure placed beside Friendly Track at point of code identification)
////	Under fire
Ø	IFF only
Δ	Radar fix
(	Right cut-on (Sonar)
)	Left cut-on (Sonar)
⊙	Cloud or rain squall
Ⓐ	Designation of surface raids by letters A,B,C, etc.
○	500 yard circle around plot of ship dead in water.
~~~~	Off screen - target disappeared from radar screen (May be amplified to show cause of disappearance). The target could then be dead reckoned along its most probable course using a dotted line to connect D.R. fixes.
Ⓙ	Jamming symbol - placed along own ship's track at point jammed. From this point an arrow will be drawn indicating center of sector jammed.
Ⓔ	Emergency IFF
Ⓕ	Emergency IFF only
Abbreviation	Meaning
L	Large ship (prefaced by number)
S	Small ship (prefaced by number)
LAT	Latitude

Abbreviation	Meaning
LONG	Longitude
C	Course
S	Speed
MS	Make smoke
CS	Cease smoke
DC	Dropped charges
FT	Fired torpedoes
OF	Open fire
CF	Check fire or cease fire
LO	Look out report

2370. Data to be Recorded on Plots.

In addition to the above the following must be indicated alongside the track to amplify and complete the picture:

(a) Alongside own ship's track indicate:

- (1) Point of opening fire.
- (2) Point of cease fire or check fire.
- (3) Point of firing torpedoes and number fired.
- (4) Base torpedo course and speed.
- (5) Point of dropping depth charges.
- (6) Other pertinent data such as smoke screen, lookout reports, received shellfire or torpedo hits, etc.

(b) Alongside target or enemy track indicate:

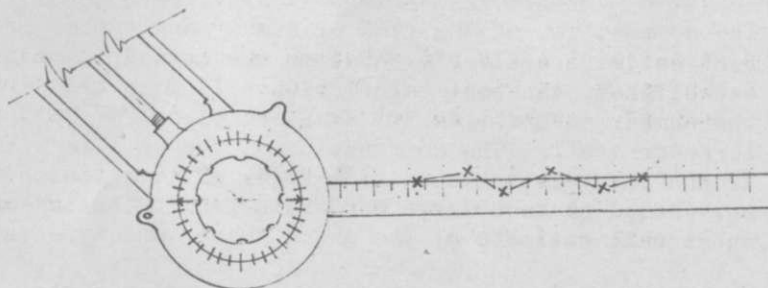
- (1) The composition of the raid by number and types, or the best estimate available. Before number and types are established, the best information will generally approximate the number as *one*, *few*, or *many* and classify the types as *large* or *small*. The composition of the raid is always boxed. If the information is only in terms of *one*, *few* or *many* the box should be made large enough to permit the insertion of a subsequent estimate of the exact number and type in the box.
- (2) Amplifying data such as "slowing," "on fire," etc. Record sources of information other than radar such as lookouts etc.

- (3) Target designation letter circled at beginning of track. If a raid splits new designations are placed at the point of the split
  - (4) The code of IFF shown by a friendly contact is placed beside the track at the point where it is reported by the operator. The symbol should be of prominent size and is not enclosed in a box.
- (c) The following additional data should be included where appropriate on the plot.
- (1) Reference points, such as Point "Z", Point "O", or geographical points.
  - (2) Wind force and direction.
  - (3) Arrow indicating true North. (place in such position as not to interfere with plot)
  - (4) Latitude and longitude of own ship.
  - (5) Scale of plot.

#### 2380. Determining Course and Speed.

##### (a) Course.

The course of a series of plots is determined by laying the ruler of the Parallel Motion Protractor along the plots, gauging by eye the best positioning of the edge of the ruler. In estimating the best position for the ruler edge, through a series of staggered plots, the higher degree of range accuracy and the lesser degree of bearing accuracy of the surface search radars must be taken into account. It will in general be found that the mean track line is the best estimate (see Figure 17). When the ruler is properly placed, the course is read from either the bearing mark or from the reciprocal bearing mark. Care must be used in selecting the mark that agrees with the direction in which the plots are developing. A simple protractor or a Hoey position plotter may be used to find the course if a series of North/South reference lines have previously been established on the plot.



COURSE DETERMINATION

Figure 17

(b) Speed.

(1) Speed by Basic Formula:  $SPEED = \frac{DISTANCE}{TIME}$

Dividing the distance traveled in yards by the time in minutes, we obtain speed expressed in yards per minute, a figure that is of little use. To convert to knots we must first multiply by 60 minutes to get yards per hour, then divide by 2000 yards to get knots.

EXAMPLE: The target has traveled 2200 yards in 2 minutes. Dividing 2200 by 2, we get a speed of 1100 yards per minute. Multiplying by 60, we change it to 66000 yards per hour. Dividing by 2000, we get a speed of 33 knots.

There are various ways of performing this arithmetic mentally to obtain speed very quickly. The easiest method is applicable when we can measure exactly three minutes of the target's travel on the plot. In every such case we find that the distance covered in yards by the target in 3 minutes, less two zeroes, equals the speed of the target in knots.

EXAMPLE: The target travels 1100 yards in 3 minutes. If we apply the Formula, we find that the speed of the target is 11 knots, a figure we could have obtained from the 1100 yards by dropping two zeroes. A target traveling 2900 yards in 3 minutes is making 29 knots. A target traveling 3350 yards in 3 minutes is making  $33\frac{1}{2}$  knots.

We can make the same easy 3-minute rule apply to cases where we have only two minutes of travel, by first converting the actual travel in 2 minutes to a figure for three minutes.

EXAMPLE: A target has traveled 800 yards in 2 minutes. This target would then travel 400 yards in the next minute, making 1200 yards in 3 minutes. Therefore its speed must be 12 knots.

A target has traveled 1800 yards in 2 minutes. This target would travel 2700 yards in 3 minutes. Its speed must be 27 knots.

By the same kind of mental arithmetic, we can stretch our 3-minute rule to cover a minute or a minute-and-a-half of travel.

EXAMPLE: A target travels 800 yards on our plot in  $1\frac{1}{2}$  minutes. Therefore it would have traveled 1600 in a 3 minute period, and must be making 16 knots.

A target has traveled 1100 yards in 1 minute. Therefore it would have covered 3300 yards in 3 minutes, and must be making 33 knots.

(2) By Mechanical Aids:

(a) The Speed-Time Nomogram (See Figure 18) is made up of a series of parallel lines on which are marked off the actual



distances traveled by a ship at various speeds in different intervals of time. To use the nomogram to find the speed of a target on our plot, we pick from the plot the number of minutes of travel available, using a pair of dividers. Then we lay the setting on the dividers along the vertical line on the nomogram corresponding to the number of minutes of travel, matching the lower leg of the dividers to the base line of the nomogram. The upper leg then reads speed directly. It is apparent from this that the nomogram and the plot must be to the same yards per inch scale.

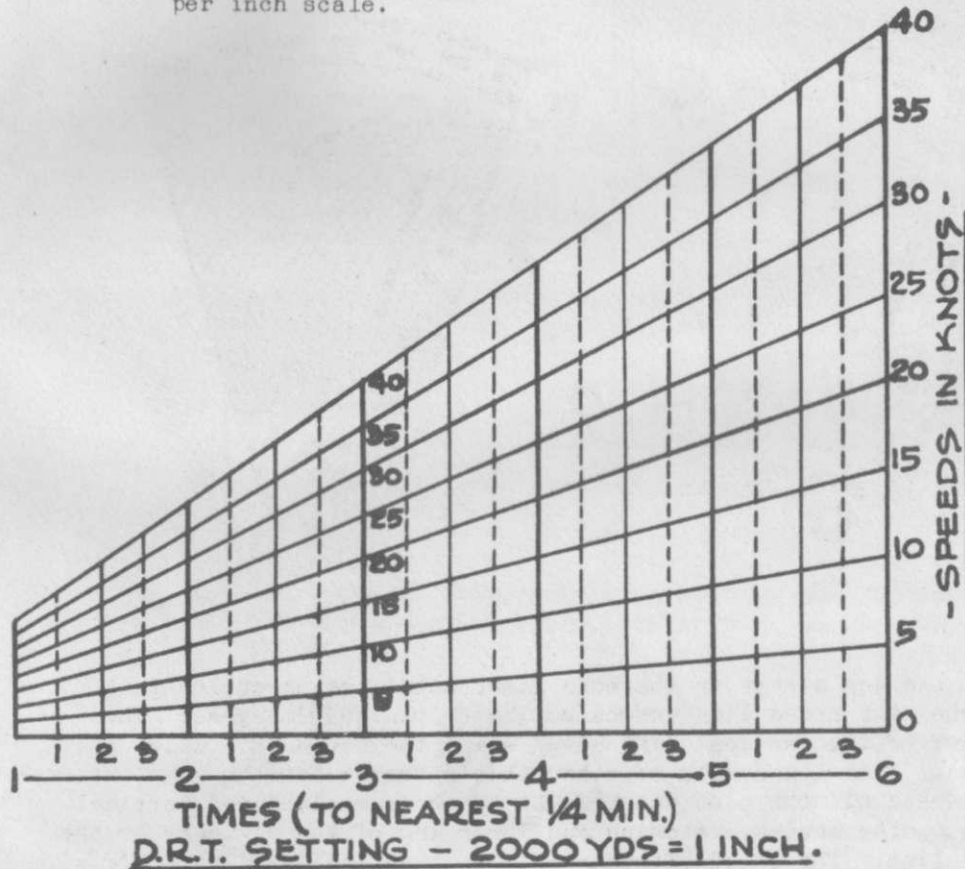


Figure 18

- (b) The Time-Speed Dividers (see Figure 19)

Place the points of the legs of the dividers on either end of a line constructed by two or more plots. Leave the dividers as they are now adjusted. To determine the speed of the plotted contact, follow the line representing the duration of the plot in minutes to the speed scale.

Note that the scale used on the plot must correspond to the scale for which the dividers were constructed. Dividers are provided designed for use with the following scales: 1000 yds/1", 2000 yds/1", 10,000 yds/1".

- (c) Universal Speed Scales (See Figure 20): They compare corresponding portions of own ship's track and the track whose speed is to be determined. Any time interval for which both own ship's travel and other ship's travel are available is used. The length of own ship's travel is first picked off the plot with a pair of dividers and the setting moved along the Universal Speed Scale

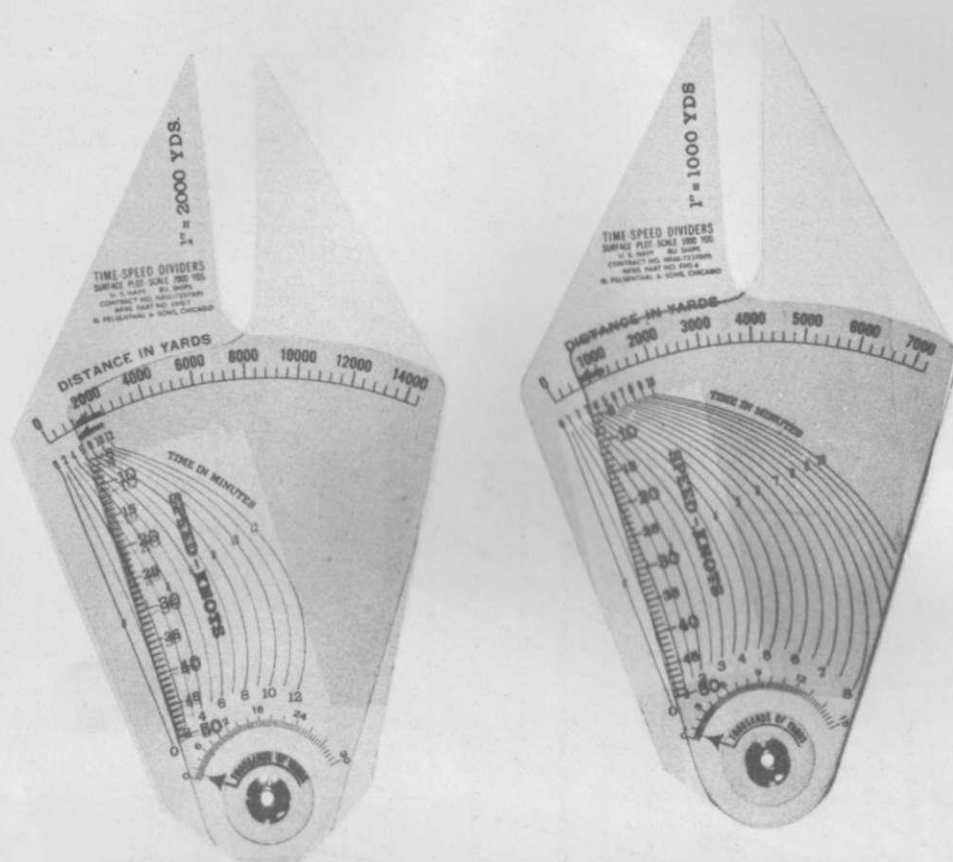


Figure 19

With one leg always on the base line, until the upper leg just matches the speed line corresponding to own ship's speed. The letter of the vertical line along which the dividers now lay is noted. Then the length of other ship's travel for the same interval is picked off the plot and brought to the same lettered vertical line on the scales, matching the lower leg of the dividers to the base line. The speed of other ship is then indicated directly by the position of the upper leg of the dividers.

#### 2390. Sample Plots.

The two sample plots (Figure 21 and Figure 22) portray the use of certain symbols and abbreviations set forth in this manual.

Particularly notice the following:

- In plotting tracks a space is left between the symbol and course line rather than making a solid track. This produces a neater plot and one that is easier to read.
- Courses and speeds are boxed and a straight line is drawn to the last position along the track from which the information was received or taken.
- The arrow indicating true North is long enough to be used in orienting your FMP.

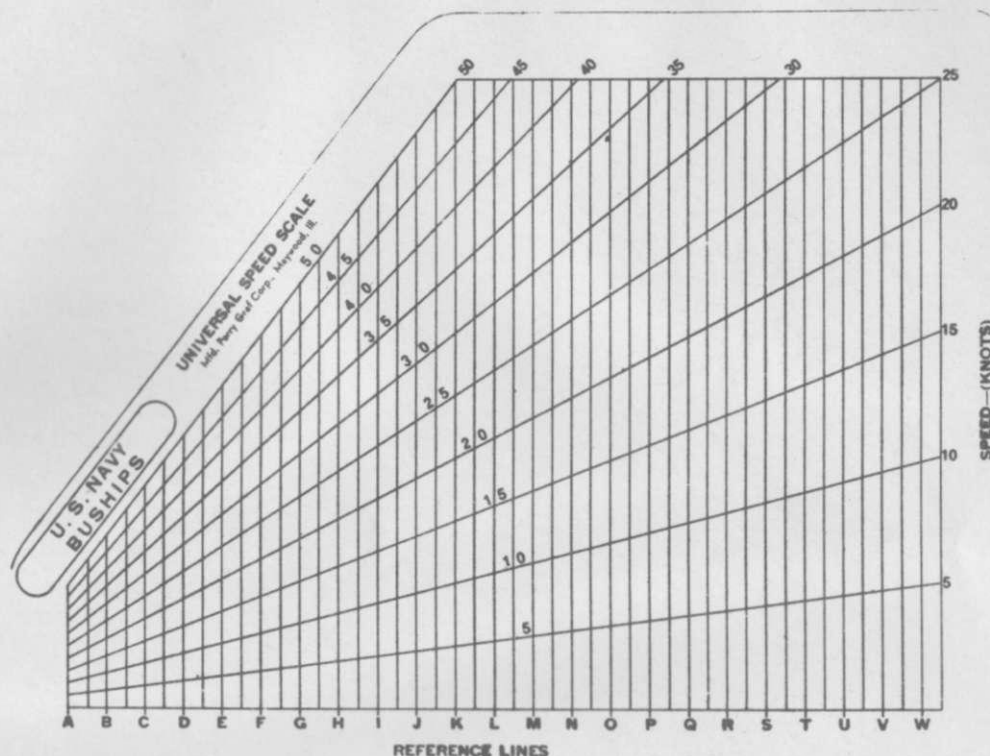


Figure 20

- (d) In figure 21 the arrows opposite the jamming symbols indicate the center bearing of the sector of the jamming. They will be useful in obtaining a fix on the jammer.
- (e) In figure 21 notice that "Joe" is dead reckoned along his course when he disappears behind land for several minutes.
- (f) Observe use of symbols for cloud, radar fix, under fire, dead in the water, emergency IFF, and disappearance of a target from the screen.
- (g) In figure 22 the torpedo track is dead-reckoned to cross the targets prospective track.
- (h) In figure 22 compare the smoothness of own track to the wavy track of the target. This is the result of own ship's course being taken from the dead reckoning tracer while the target's track is being plotted. The weaving in his track is the result of radar error. In determining his course use a "mean line" through the plots.

There is much information to learn from these sample plots. Study them. Make use of these symbols and abbreviations in your plotting. By so doing you will be presenting instantly understandable displays to your ship.

#### 2400. READINESS AND PRECAUTIONS.

##### 2410. State of Readiness of the DRT at Sea.





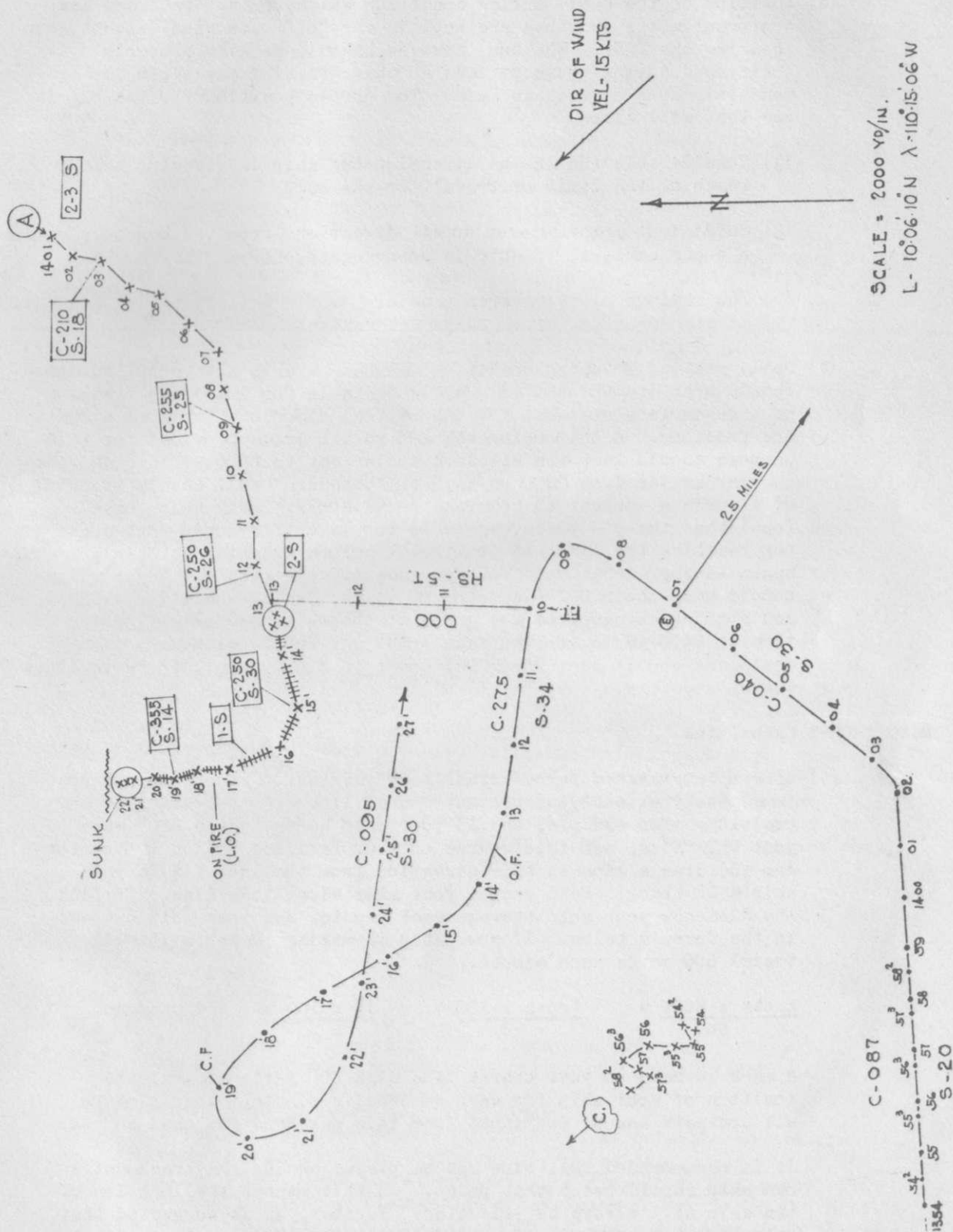


FIGURE 22

- (a) Position of the bug: During condition watches, the North and East component motor switches are kept in the "off" position (except when checking the DRT). The bug, however, should be kept properly positioned during these periods so that tracking may begin immediately if a contact is made. The proper position for the bug is one that will allow:
- (1) Considerable run in the direction own ship is steaming before reaching the limit of travel for the bug.
  - (2) Sufficient plotting area in *all* directions from the bug to plot a sonar contact, if ship is sonar equipped.
  - (3) The maximum plotting area possible, while satisfying (1) and (2), in the direction of the expected contact.
- (b) Scale setting: During condition watches, a ship with sonar equipment should keep its DRT set to a scale suitable for immediate tracking of a subsurface contact, for the initial seconds after such a contact are precious. A ship using the 200 yd/in. scale provided for this purpose should keep the standard scales set to 2000 yd/in., so that a quick switch from "200 yd/in." to "Standard" will enable tracking of a surface contact to commence immediately. Many ships have found that the 200 yd/in. scale is too large for sonar work-- the bug reaching the limit of its travel before tracking is fairly begun--and prefer 500 yd/in. for subsurface contacts. These ships should keep their DRT's set to 500 yd/in. during condition watches, and a quick change from the green to the white scales will bring them to 2000 yd/in. for surface tracking. Ships without sonar equipment should keep their DRT's set to 2000 yd/in., to begin tracking at any time.

2420. DRT Casualties.

- (a) *Always be prepared for a casualty to your DRT.* Should this happen, immediately extend your present course line from your last DR position. For example, should your ship be on course 260° when your DRT fails, set this course on your Parallel Motion Protractor Arm and draw a line in this direction from the last fix on your ship's DR track. Dead reckon your ship along this line. To find the distance your ship travels each minute, use your ship's speed in the formula below. If your ship is making 18 knots it will travel 600 yards each minute.

$$\frac{\text{Knots} \times 2000}{60} = \frac{\text{Knots} \times 100}{3} = \frac{18 \times 100}{3} = 600 \text{ yds/min.}$$

A mark is made on your course line each 600 yards to indicate position of your ship for each successive minute. Your plot on all contacts can be continued from this new dead-reckoned course.

It is recommended that time not be placed beside the track until own ship should reach that point. In this manner the location of own ship will always be indicated. Further, it is suggested that yardage not be marked off over 8-10 minutes ahead as there is the possibility your ship will change speed or course.

The reaction of your DRT to course changes of various degrees should be studied and noted so that they may be duplicated in case of casualty to DRT. This is not a difficult problem but does require regular practice and review.

- (b) A casualty to the ship's gyro compass is as serious as a casualty to the DRT itself. When the gyro goes out, the travel of the bug becomes unpredictable. Should the casualty occur it will be necessary to dead reckon your own ship through successive course changes using true headings. In most cases the headings that are passed to CIC from the conning station will not be the true headings needed for dead-reckoning because a magnetic compass will be in use. They will be either magnetic headings or compass headings. If they are magnetic headings we need apply only variation to correct to true headings. This variation can be supplied from a chart of your area and should be known at all times in CIC. If CIC is receiving compass headings, they must be corrected for both variation and deviation. The latter correction may be obtained from a curve of deviations made for the magnetic compass in use.

As the deviation correction changes with each heading, a Curve of Deviations should be kept in CIC. This can be obtained from the Navigator. When the gyro becomes inoperative, the radar operator will begin reporting contacts in terms of relative bearings. We must convert them to true bearings to continue our true plot. A bearing converter makes this conversion a simple operation.

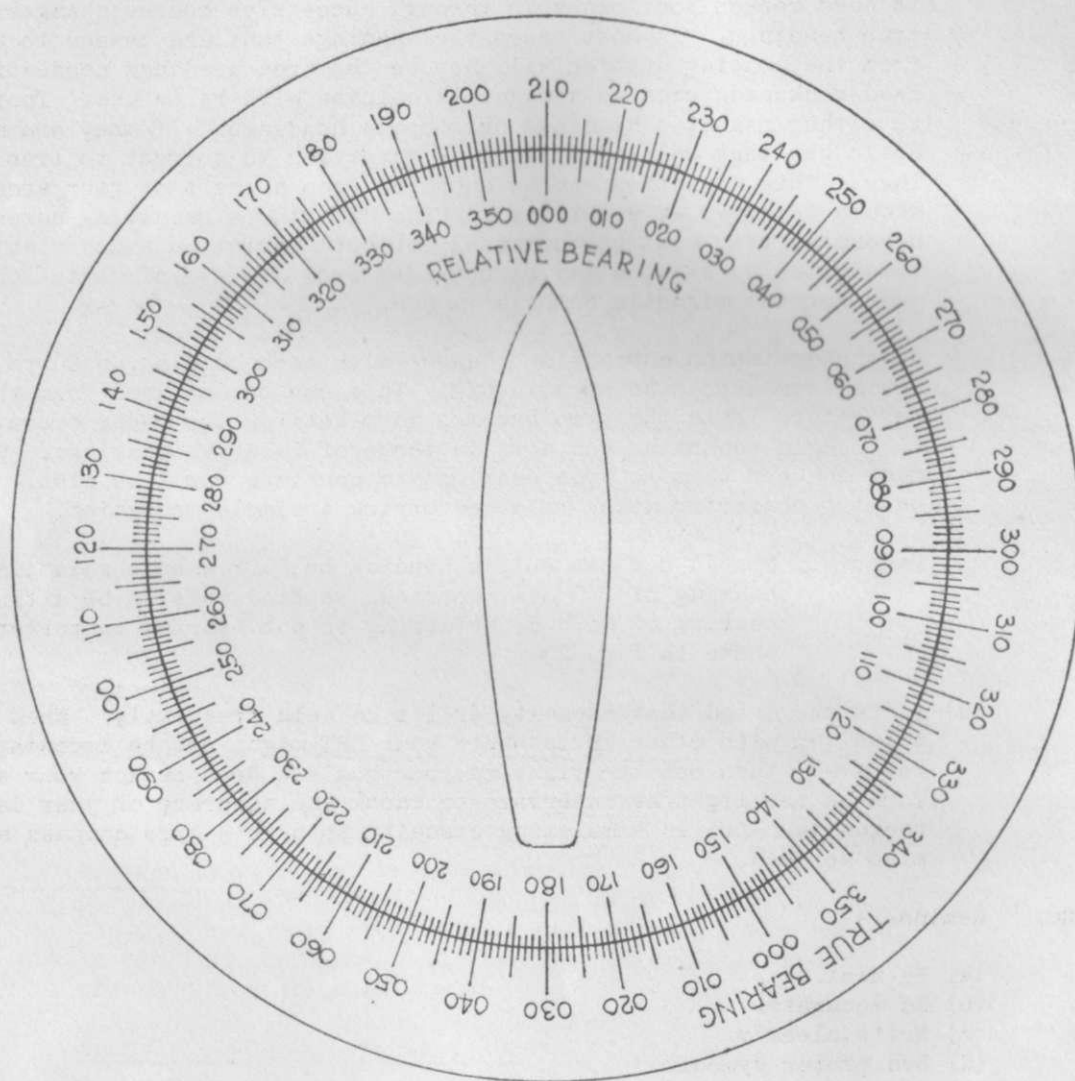
Example: Should our own ship's heading be  $210^{\circ}$  when a relative bearing of  $040^{\circ}$  is reported, we find this to be a true bearing of  $250^{\circ}$  by referring to our bearing converter shown in fig. 23.

- (c) It is suggested that casualty drills be held frequently. When traveling with other ships where your DRT might not be immediately required, turn out the light on your bug and dead reckon your ship. Turn on the light at intervals to check the accuracy of your dead reckoning. Drills simulating casualty to ship's gyro compass should also be held.

#### 2430. Reminders

- (a) Be neat.
- (b) Be accurate.
- (c) Write clearly.
- (d) Use proper symbols.
- (e) Connect plots with a solid line drawn not quite to each symbol.
- (f) Use four digits with exponent at beginning of each track and two digits with exponent thereafter.
- (g) Express time to nearest quarter minute.
- (h) Show sufficient data on the plot to make it possible to transfer the tracks to a chart later. This will require that the *scale* of the plot be shown, that the *direction of true north* be indicated, and that the latitude and longitude of at least one point on the plot be shown. (Mark clearly final position of bug and record near it the readings of the latitude and longitude dials or, if time permits, obtain from the navigator the geographical position of the initial plot).

CONFIDENTIAL



BEARING CONVERTER

Figure 23



- (i) Determine course and speed on first two or three minutes of track falling in any one general direction.
- (j) Watch track for changes.
- (k) Make information readable.
- (l) Use reciprocal bearings to best advantage (indirect method when preferable).
- (m) Keep parallel motion protractor clear of plot making the information thereon easily accessible to the evaluator.
- (n) Keep left hand on bearing knob of parallel motion protractor when possible, free hand using ruler as a lever in setting bearings.
- (o) After lining marker on parallel motion protractor at desired bearing, secure lock remembering to release it immediately upon establishing point. For experienced plotters it is recommended that the ruler not be locked but held to the desired bearing with the thumb.
- (p) If evaluator is opposite the plotter, information should be written up-side-down only if plotter is proficient in doing this.
- (q) Include all supplementary information on plot.
- (r) Remember, the travel of your bug and the readings on your Latitude-Longitude Indicator represent your approximate or dead reckoned course or position. The effect of wind and currents and your helmsman's ability to steer exact courses is not taken into consideration.
- (s) Check DRT for accuracy once each watch. The following reasonably accurate check on the DRT is readily obtainable at any time when under way. Set up DRT using a scale of 200 or 500 yards per inch. Check with the bridge for course and speed. Start DRT and run it for 8 or 10 minutes, carefully plotting in the course being followed by the bug. At the completion of the run compare the solution obtained by the DRT with the Dead Reckoning run made on the basis of true course and speed.
- (t) Do not lean on DRT. Take good care of your equipment. Leaning on the top of the DRT will cause the top to sag. This sagging may be enough to cause the compass rose or top of light cover on pencil carriage to bind with the DRT top. This binding will cause the motion of the pencil carriage to be either retarded or stopped altogether. In either case the motion of the carriage will not represent what the ship is actually doing.

#### 2440. Primary vs. Secondary Targets.

The purpose for which any target is being tracked for course and speed must be kept in mind during the tracking, for it will govern the technique that is used in taking bearings and ranges.

While with the present surface search radars, the antenna must be stopped on the target long enough to read each bearing and range if the target is a primary target (i.e., a target which for example is to be taken under fire) new developments will make unnecessary this undesirable practice.

The S.G. Modernization Kit will provide a cursor and electronic range ring with which an accurate bearing and range can be ascertained from the PPI. Therefore, it will not be necessary to stop the sweep for tracking any targets. In addition to the S.G. Modernization Kits, the VF (Precision PPI) will provide an extremely accurate means of obtaining bearings and ranges without stopping the sweep. If the sweep is stopped for tracking, not only will all-around search be interfered with, but the distribution of the radar picture through Remote PPI's Projection PPI's, and Precision PPI's will be prevented.

When the equipment is provided, all tracking should be done "on the fly" (without stopping the antenna). Even with present equipment, secondary targets should be tracked "on the fly"; courses and speeds can be obtained in this manner with sufficient accuracy to predict the tactical intentions of targets, and to insure their identification.

## 3000. RELATIVE MOTION AND THE USE OF THE MANEUVERING BOARD.

## 3100. INTRODUCTION.

Each of us is familiar with geographical movement. A man walking across the street moves geographically from a position on one side of the street to a position on the opposite side, passing through successive positions in the street while crossing. A motorist driving from one city to the next, along a winding highway or over a succession of roads and crossroads, makes the same kind of geographical movement--just a bit more complicated--as the man crossing the street. There is a second kind of movement that is as useful as geographical movement in many instances, particularly in CIC. It is the movement that takes place between two objects each making its own geographical movement. Consider the case of two motorists leaving the same point and driving North and East respectively, each performing a geographical movement of his own. If each drives at 20 miles per hour, he will travel 5 miles in the first 15 minutes. But after 15 minutes, the two motorists will be 7 miles apart, and the one who has driven East will be Southeast of the other motorist. This movement that has taken place between them--leaving the same spot and being 7 miles apart after 15 minutes--is different from the geographical movement of either motorist; it is the *result* of their geographical movements.

If they follow their respective routes for another 15 minutes, each will have traveled 10 miles over the earth from the starting point. Yet at the end of this time the two will be separated by 14 miles, with the motorist who has gone East still directly Southeast of the one who has gone North. After the first 15 minutes the two were separated 7 miles in a SE/NW line; now they are 14 miles apart, still in a SE/NW line. If they drive for another 15 minutes, they will be separated about 21 miles, although each will have driven only 15 miles. It is apparent that each, insofar as the other is concerned, is moving 7 miles farther away every 15 minutes. He is accomplishing this separation in a definite direction. Let us place ourselves in the position of the motorist who has driven North. We see the motorist who has driven East getting farther and farther away from us, always to the Southeast of us, and getting 7 miles farther away to the Southeast every quarter hour. Aside from what either of us is doing with respect to the earth, it is apparent that there is a movement occurring between the other motorist and us: he is getting 28 miles farther Southeast of us every hour. In addition to the motion of the individual cars, one to the North, the other to the East, there is also a motion existing (See Figure 24) between the two. This motion is the RELATIVE MOTION between them.

## 3200. RELATIVE MOVEMENT.

Relative motion or movement is concerned with the movement between two objects. Movement, in turn, is concerned with direction, distance, and speed. Since the movement under discussion here is relative, each of the above factors also become relative.

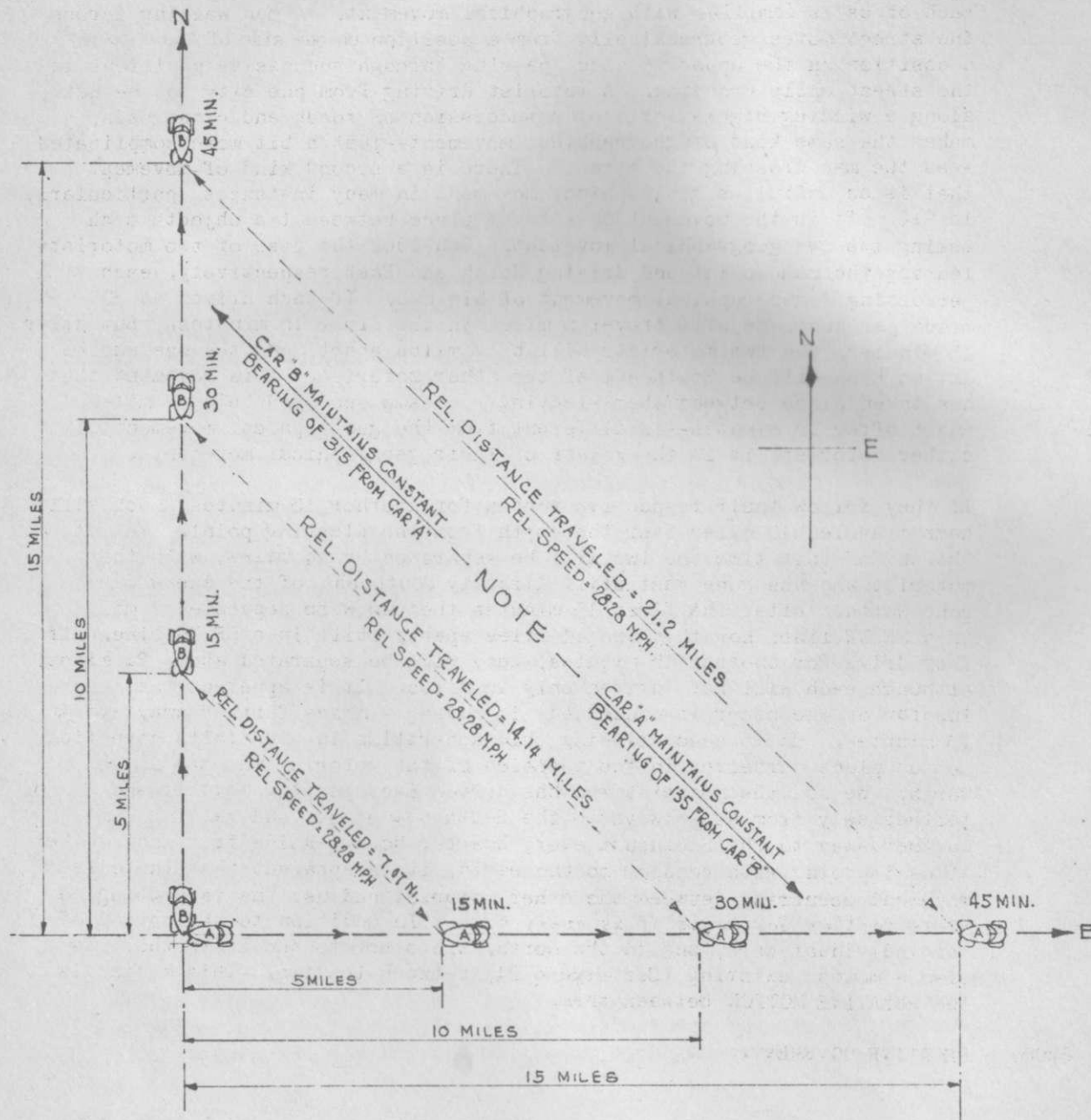


Figure 24



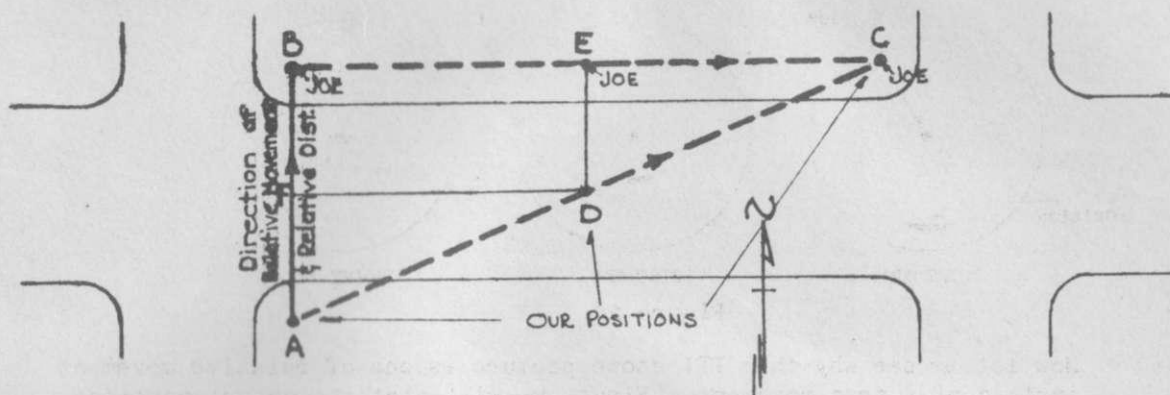


Figure 25

Suppose we wish to cross the street to join our friend Joe. What considerations must be weighed? Joe is moving on course BC and we wish to effect a meeting at C, so we will have to apply a "lead" in choosing a course. This is the same type of lead that a passer in football gives his receiver. We choose course AC, bringing us to point C at the same time Joe arrives there.

This seems a simple enough problem so let us examine the relative movement involved. Suppose this situation is happening on a dark night and we are carrying a flashlight. It will appear to Joe that we are continuously moving closer to him from the South as we move along our respective courses. He cannot determine our course as he sees nothing but a flashlight beam a little closer each time he looks. When we were at points A and B there was the distance AB between us. When Joe arrives at point E along his course, he will see a light in the street due south of him at point D. It will have moved North in relation to him since he last noticed it at point A. Since we are trying to close the distance AB, we now find, when we are seen at point D, we have shortened the distance AB by the amount AF. Not until we arrive will we have accomplished what we started out to do and closed the distance AB. Although we traveled course AC we appeared south of Joe each time he noted our flashlight. To him we *appeared* to be closing in a northerly direction until our meeting at point C. This statement might be reworded by saying that relative to Joe we moved North. North or 000° would then be our direction of relative movement. The distance AB would be the relative distance traveled or the distance we moved with respect to Joe.

This same illustration, since we are already familiar with it, can again be used. Suppose Joe was carrying a PPI scope similar to the one on your radar. Examine the illustrations that follow to see how this relative movement would appear to him on this PPI scope.

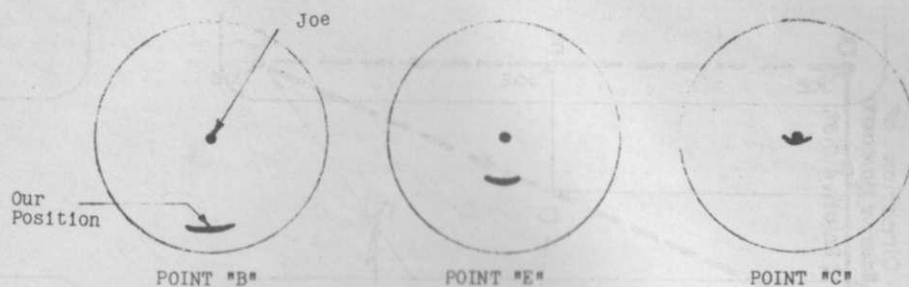
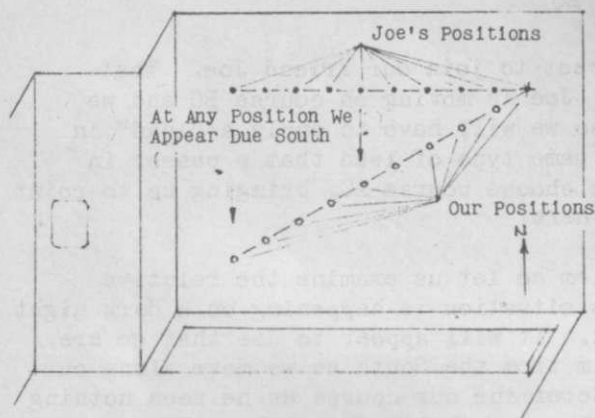


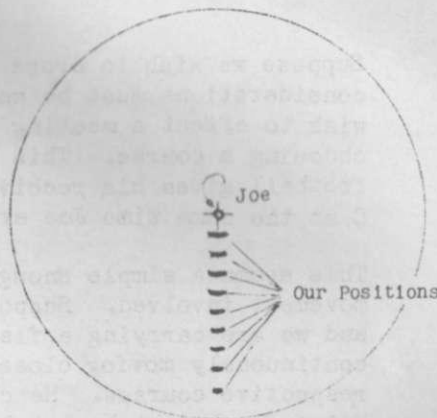
Figure 26

Now let us see why this PPI scope picture is one of relative movement instead of a true movement. First, we will plot the actual movement on Joe's DRT. (See Figure 27).



JOE'S D.R.T.

Figure 27

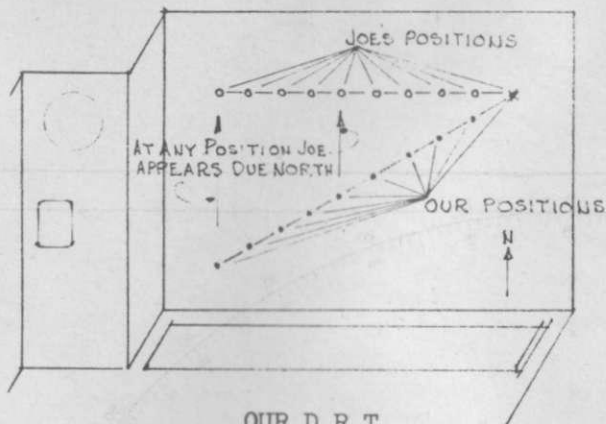


INDICATION ON JOE'S "P.P.I."

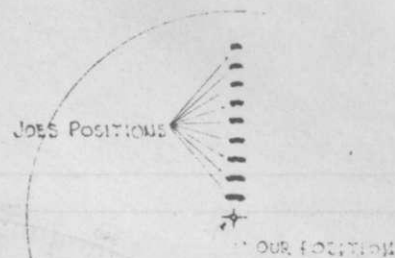
Figure 28

Since Joe is always represented as one spot (the center) on this PPI scope, he has no track on it representing his own movement. His position then is *always* at the center. Do you remember how each successive position of our flashlight appeared to Joe to be moving North and toward him? We can see now that this motion is the same as is seen on his PPI scope. (See Figure 28.)

Let us look further into this picture to see the presentation as viewed from our own PPI scope. The above examples were viewed from Joe's. There we studied our movement in relation to him; now we wish to study his movement relative to us. In the following illustration notice that our track will now be plotted with dots and Joe's with circles.



OUR D.R.T.  
FIGURE 29



INDICATION ON OUR "P.P.I."  
FIGURE 30

Whereas we appeared to be moving North in Joe's relative plot, (See Figure 28) he appears to be moving South in ours. (See Figure 30). We can draw a logical conclusion from this: If we are moving in the same area with Joe our movement as it appears to Joe is the reciprocal of Joe's movement to us. If we are moving on course  $000^{\circ}$  relative to Joe, we then know that Joe is moving on course  $180^{\circ}$  relative to us.

The two pictures (Figures 28 and 30) showing our movement with respect to Joe and Joe's movement with respect to us have been developed by placing successive PPI presentations one upon the other. These pictures are properly called plots because they show a series of positions or tracks. Since the tracks they show are lines of relative motion, they are RELATIVE PLOTS.

### 3300. THE MANEUVERING BOARD

Relative plots are used in CIC to aid in the solution of courses and speeds to accomplish certain maneuvers. Since these solutions are made frequently, while steaming at sea, there has been developed to speed this work, a standard plot form: The maneuvering board. Since a relative plot consists of successive positions plotted from a single point, the maneuvering board (HO 2665a) is equipped with bearing lines and range circles to facilitate this plotting.

#### 3310. The Relative Plot on the Maneuvering Board.

In solving any relative movement problem we must first decide which of the moving ships can best be held stationary on the relative plot. Then in placing our relative plot on the maneuvering board, we must put that ship at the center. This ship will be called the guide and will be labeled "G". (Do not confuse the guide in the maneuvering board problem with the fleet guide as they are not necessarily the same). The maneuvering ship will then be the ship whose movement we are considering. It will be at various bearings and ranges from the guide "G" at various times and will be labeled "M". Since it will be a moving ship the positions of "M" at successive times may be designated  $M_1$ ,  $M_2$ ,  $M_3$ , etc. The line joining the successive positions are lines of relative movement of "M" with respect to "G". The following

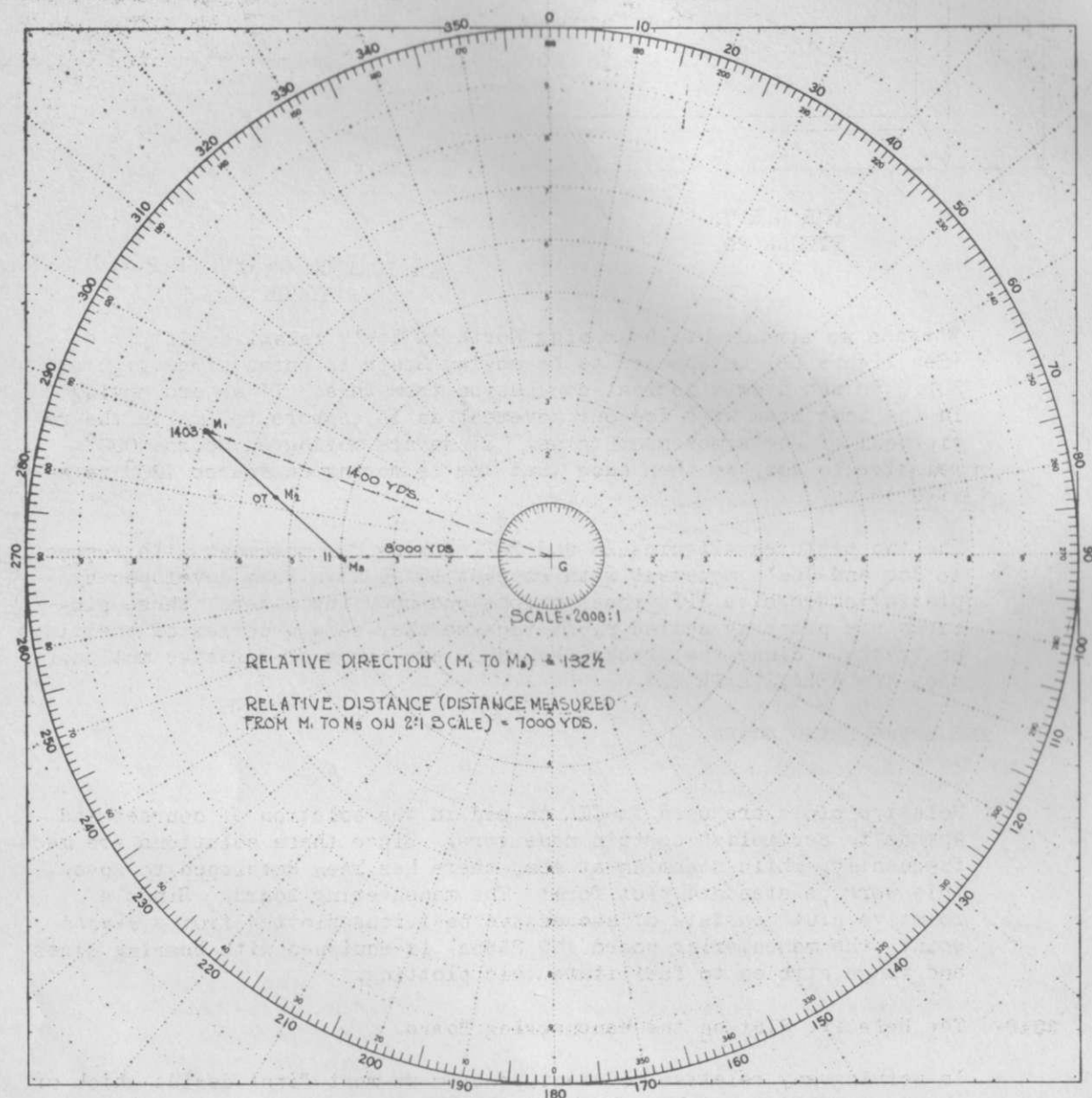


FIGURE 31



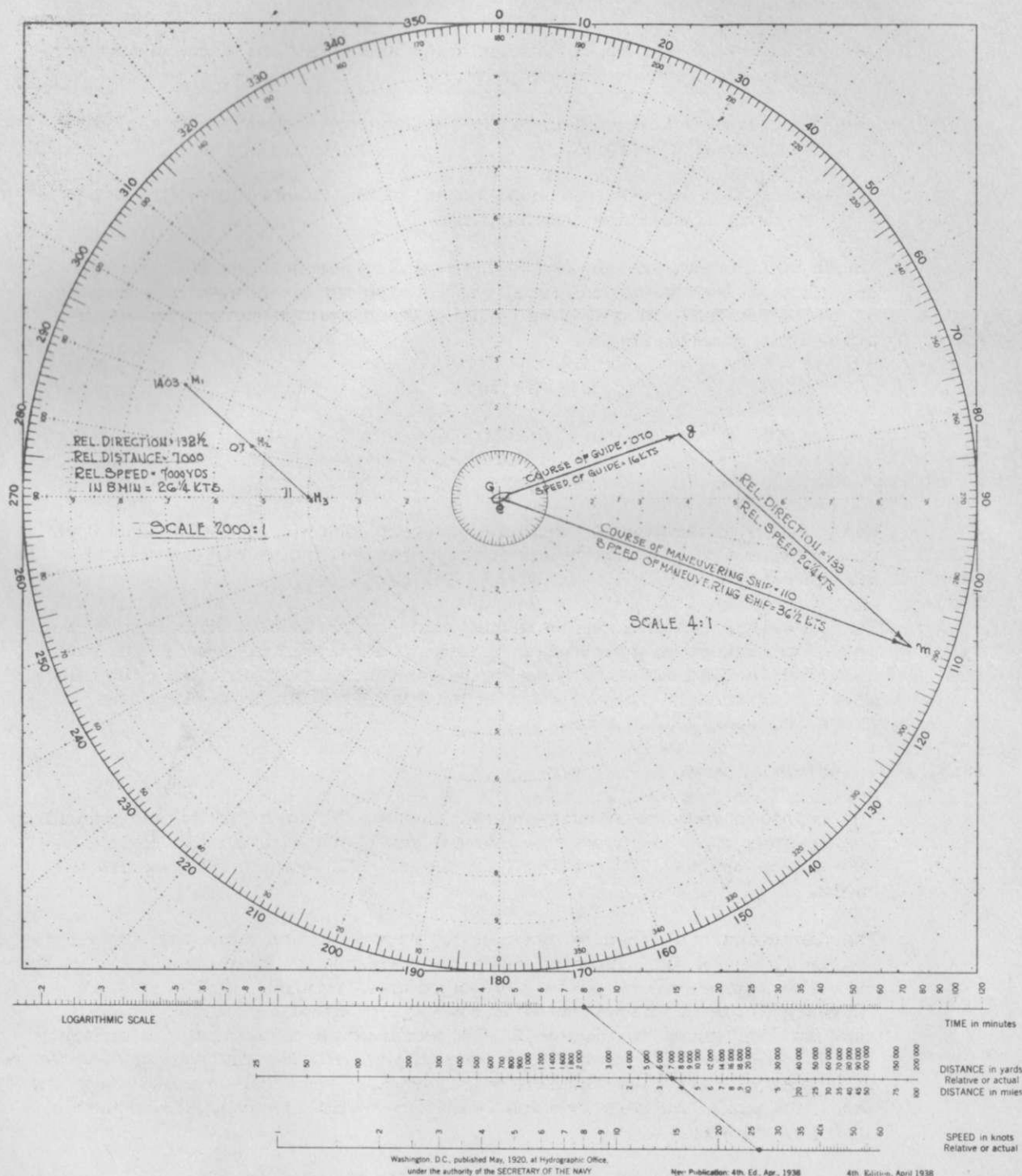


FIGURE 32

definitions involving these units best apply to our maneuvering board problems.

- (a) *Relative direction* is the apparent direction the maneuvering ship moves in relation to the guide.
- (b) *Relative distance* is distance the maneuvering ship moves with respect to the guide.
- (c) *Relative speed* is the speed at which the maneuvering ship appears to move in relation to the guide.

In the problem we are now to plot we will place our own ship in the position of the guide and label it "G". We will consider the movement of the other ship in relation to us. The bearings and ranges of the other ship from us are:

Time	Bearing	Range
1403	290	14000
07	282	10800
11	270	8000

What is the direction of relative movement and the distance the other ship travels in respect to us, i.e., relative direction and relative distance?

To solve this problem on the maneuvering board we need a pair of dividers to measure distances and a pair of parallel rulers. Check the solution in Figure 31. It can be seen from this figure that the relative plot forms a triangle two sides of which are ranges and the third is relative distance.

### 3320. The Vector Diagram.

The relative movement that occurred between "M" and "G" in the preceding problem was the result of the courses and speeds of the two ships. "M" was on course  $110^{\circ}$  making 36.5 knots. "G" was on  $070^{\circ}$  making 16 knots.

The direction and speed of each ship's movement can be represented by a single line the direction of which corresponds to course and the length of which represents speed to some convenient scale. Such a graphic representation of direction of movement and speed is called a *vector*, such as "eg" shown in figure 32. A combination of vectors is called a *vector diagram*. It can be seen from figure 32 that the vector diagram like the relative plot is also a triangle. It should be noted that the two triangles, the relative plot and the vector diagram, are separate, distinct figures.

Analyzing the three sides of each triangle we find in the:

- (a) Relative Plot.

- (1)  $G-M_1$  - Initial bearing and range of maneuvering unit from guide.

- (2)  $G-M_2$  - Later bearing and range of maneuvering unit from guide.
- (3)  $M_1-M_2$  - Relative direction and relative distance.
- (b) Vector Diagram.
- (1)  $eg$  - True course and speed of guide ship.
- (2)  $em$  - True course and speed of maneuvering ship.
- (3)  $gm$  - Relative direction and relative speed.

It will be noted that " $gm$ " and " $M_1-M_2$ " are parallel and drawn in the same direction, as each represents the relative direction that the maneuvering unit travels.

### 3330. Scales.

Ordinarily, the distance between circles on the maneuvering board will represent from 1000 to 5000 yards in the relative plot and 2 to 5 knots in the vector diagram. Scales for measuring these values are drawn on each side of the HO 2665a chart. Use them to prevent errors and speed up your work. Once a scale is chosen for one side of a triangle the same scale must be used for the other two sides. This does not say, however, that both triangles must be drawn to the same scale. It will be found convenient in most instances to choose one scale for the relative plot and another for the vector diagram (one represents distance and the other represents speed). A set of three logarithmic scales, called a nomogram, is provided below the plot on the maneuvering board to aid in the solution of time/speed/distance relationships. The three scales are so arranged that by marking off any two known values in the formula:  $\text{DISTANCE} = \text{SPEED} \times \text{TIME}$  and laying a straight-edge through the points so marked, the correct value of the third quantity will be cut through the third scale. If, in the above formula, the distance that is known is a relative one, then the speed obtained will also be relative.

$$\text{RELATIVE DISTANCE} = \text{RELATIVE SPEED} \times \text{TIME}$$

EXAMPLE: Having a known time of 10 minutes and a *relative* distance of 10,000 yards, we find the *relative* speed to be 30 knots. (See Figure 33).

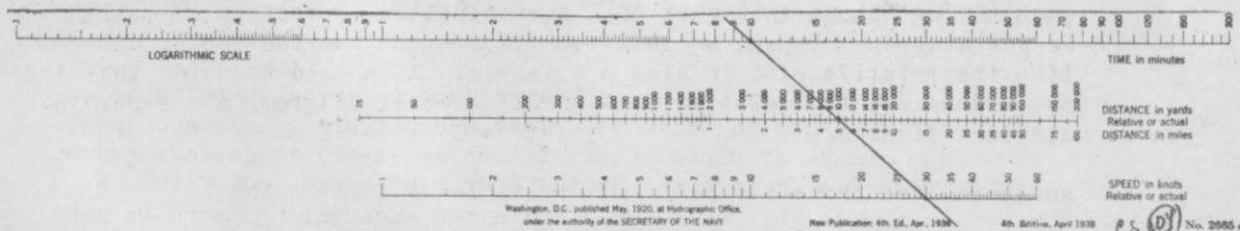


FIGURE 33

## 3340. Illustrative Problems.

(a) *The Course and Speed Problem.*

If you have in mind the above definitions, you are ready to solve the following course and speed problem.

- (1) Our ship is on course  $120^{\circ}$ , speed 16 knots.
- (2) Radar gives us the following bearings and ranges on a surface contact:

Time	Bearing	Range
1802	333	13600
04	339	14100
06	345	15000
08	350	16000

- (3) Determine course and speed of contact.

Check the solution in Figure 34.

(b) *Determining How Close a Contact Will Pass.*

Next, you are ready to determine how close a contact will pass to your ship provided neither ship changes course or speed.

- (1) Your own ship is traveling on course  $310^{\circ}$ , speed 18 knots.
- (2) A contact is tracked to be on course  $240^{\circ}$ , speed 21 knots.
- (3) The present radar bearing and range on the contact is  $024^{\circ}$ , 18000 yards.
- (4) Assuming neither ship changes course or speed:
  - (a) How close will contact pass to you?
  - (b) At what bearing?
  - (c) How long before he will be nearest you?

Check the solution in Figure 35. Had the contact in Figure 35 been on such a course as to have brought him ( $M_1-M_2$ ) through point "G", our two ships would have been on collision courses. On a collision course the bearing would be the same each time we checked, with the range decreasing. To prevent a collision, it would, then, be necessary to change our course, speed or both in such a manner as to bring the relative movement line away from point "G". You can detect collision courses on your radar by noting each successive trace to be on an identical bearing from your ship at the center.

(c) *The Change of Station Problem. (Same as Course, Speed and Time to Attack Position.)*

- (1) In the event you wish to change your position in relation to another ship you must take into account his course and speed. The amount of "lead" that will be necessary is dependent upon these two factors and on the amount of speed you will be able to use on this maneuver. Again the maneuvering board is used in deciding a course to take. In this case we do not wish to determine the course and speed of a contact; we now wish to determine a course for our own ship to travel. We will be represented as "M," the maneuvering ship. The other ship, therefore, must be "G", the guide ship. "G" is always placed at the center of our chart so our ship is not at the center as in the previous two problems.



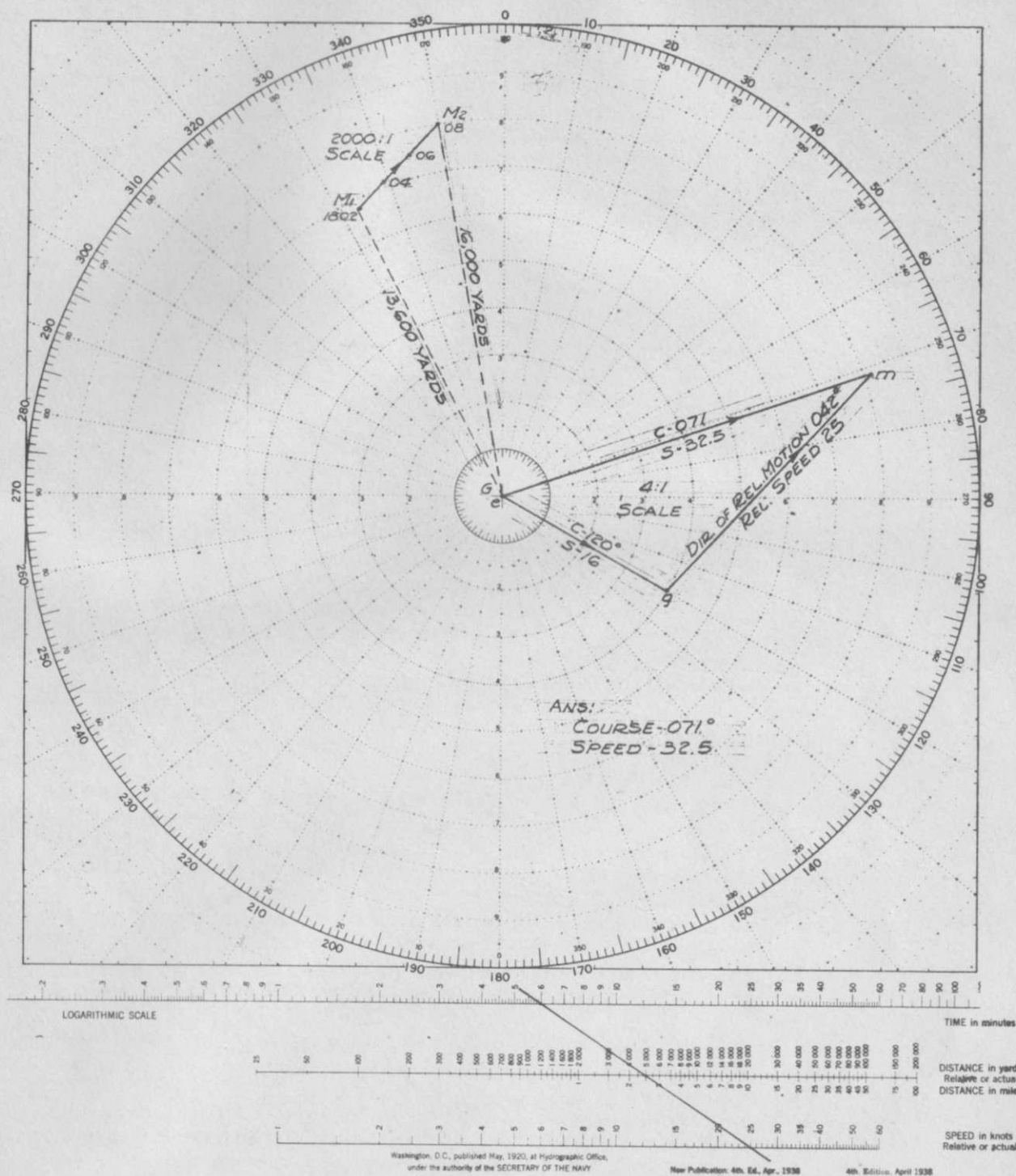


FIGURE 34

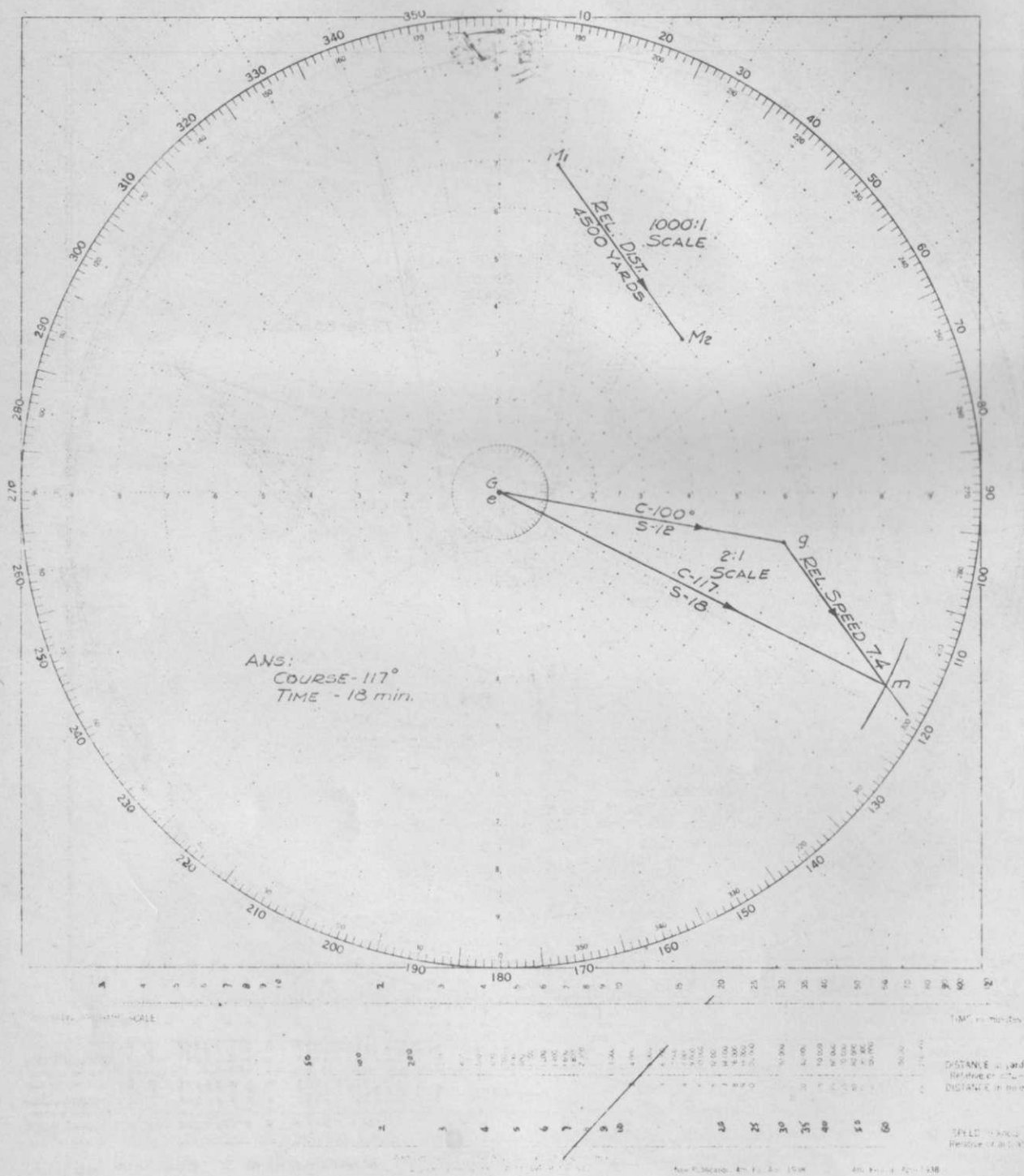


FIGURE 36

- (2) First, draw the relative plot. Let "M" represent your present bearing and range from "G". "M₂" will be the desired position, or where the maneuvering ship is to go relative to the guide. By connecting these two points, the relative direction and relative distance are found. To travel from M₁ to M₂ we must find a true course to steer which takes into account the guide's movement.
- (3) His movement, since he is at "G," will be represented by vector "eg." The "gm" line may be drawn starting, of course, at "g" as it always parallels M₁-M₂. Now, either the time allowed to complete the maneuver must be known (as in a course and speed problem) or the speed to be used by the maneuvering ship must be known. In the latter case the speed of "M" (maneuvering ship) is represented by the length of its vector "em". As yet we still do not know the direction of "em." Since "m" is known to be on "gm" in the direction from "g" of the relative movement, and since "m" is also a distance from "e" equivalent to the speed of "M", their intersection definitely locates point (m).
- (4) The following is a solution of the change of station problem:
  - (a) The USS NORTH CAROLINA is on course 100°, speed 12 knots.
  - (b) She bears 190°, 7000 yards from us. (Use reciprocal bearings).
  - (c) We wish to move to a position where the NORTH CAROLINA will bear 230°, 5000 yards from us.
  - (d) What course will we steer if we use 18 knots?
  - (e) How long will the maneuver take?

Check the solution in Figure 36.

(d) *Finding Base Torpedo Course*

- (1) Plot a line from the point at which torpedoes are to be fired to the center of the maneuvering board (target). (By keeping a reciprocal plot of the target up to date, this line can be drawn at any instant it is decided to fire torpedoes.)
- (2) Move this line (parallel to itself) to the end of the line representing target course and speed. The BTC can then be read at the intersection of this line with the circle representing speed at which the torpedoes are to be fired.

The most useful problems for your daily work in CIC have been presented. To develop your ability to think in terms of relative motion, study the movement on your PPI scope. Take every opportunity to work "live" problems as your ship changes station. It is necessary to work problems regularly for the principles of maneuvering board are rapidly forgotten.



## 3350. The Torpedo Effective Range Indicator and its Use.

The TERI is used as an overlay on the maneuvering board during a torpedo approach to determine when you come within effective range for your torpedoes.

## (a) Assumptions:

## (1) That the torpedo speeds to be used are:

1. High - 45 knots.
2. Intermediate - 33.5 knots.
3. Low - 27 knots.

## (2) That the effective range * of the torpedo varies with speed setting, or:

1. High setting - 6000.
2. Intermediate setting - 9200.
3. Low setting - 14000.

## (3) That this particular scale of torpedo effective range indicator be used with the 10" maneuvering board (H.O. 2665a), using a distance scale of one (1) division equals one (1) mile which is one (1) inch equals 4000 yards.

## (b) Description. (See Figure 37).

On a piece of transparent plastic  $8\frac{1}{2} \times 8\frac{1}{2} \times 0.1$ " three concentric circles are drawn. The largest circle has a radius that represents 14000 yards on a scale of one inch equals 4000 yards. This circle is red. The next largest circle has a radius that represents 9200 yards on the same scale as the large circle. This circle is black. The small circle has a radius equal to 6000 yards on the same scale and is colored green.

Two diameters of the largest circle are inscribed 90 degrees apart. The circles so inscribed represent speed as well as range. Hence, three speed scales are placed on three of the four radii formed by the perpendicular diameters. The scale marked "L" representing low speed and 27 knots (the large circle), is divided into five knot divisions. The scale marked "I" represents intermediate speed and divides the thirty-three and one half knots into five knot divisions. The scale marked "H", representing high speed and 45 knots, is divided into 5 knot divisions.

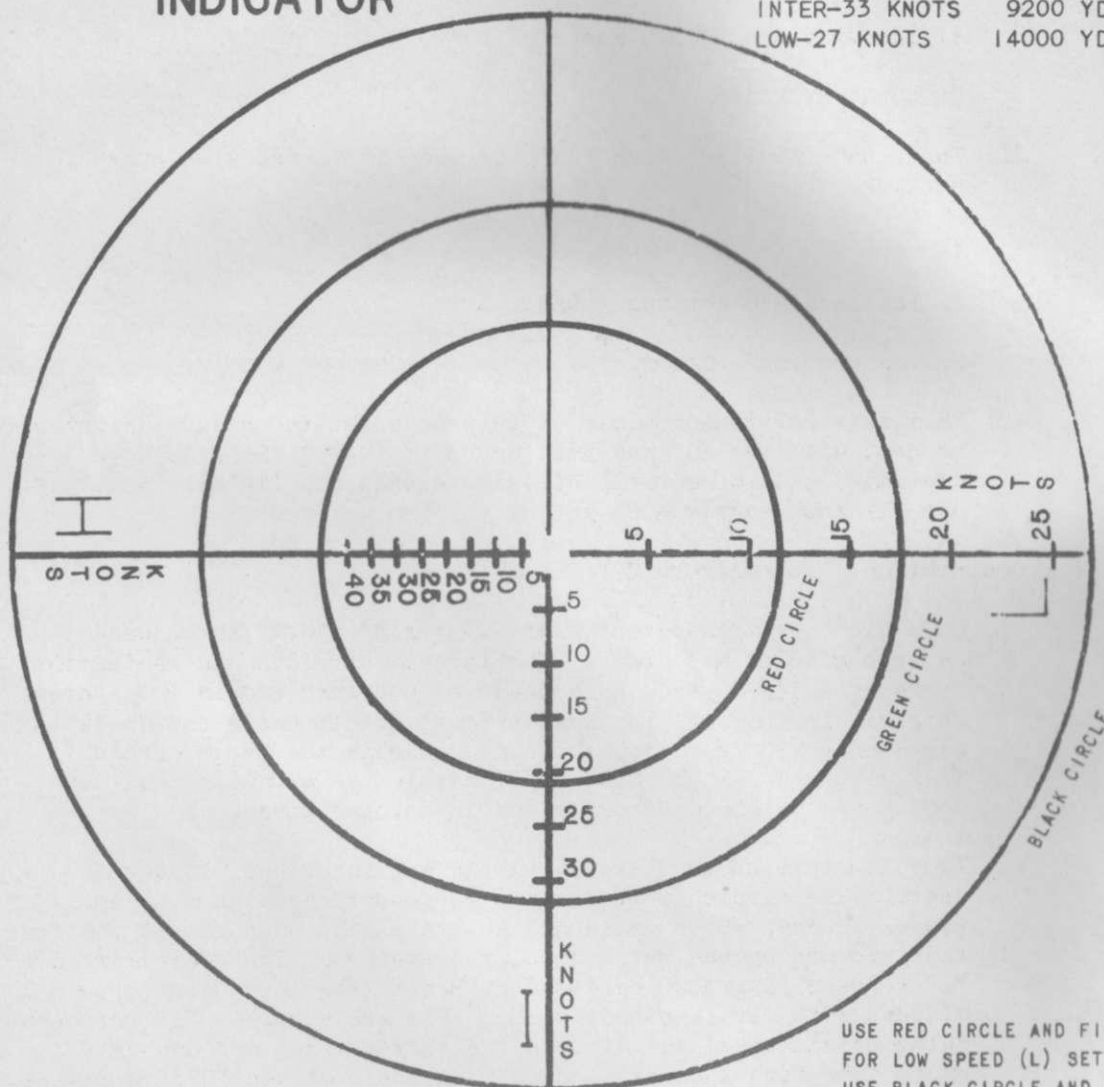
## (c) Use.

For example, let our ship be destroyer "M". At 1600 "M" came to course 242(T), speed 24 knots, to close target "G" (course 000 (T) speed 10) on a collision course in order to make a torpedo attack on "G". At 1600 "G" is bearing 225(T) range 2600 yards from "M". (See Figure 38).

*The effective range to be used may be changed to conform with doctrine.

# TORPEDO EFFECTIVE RANGE INDICATOR

SPEED	TORPEDO RANGE
HIGH-46 KNOTS	6000 YDS.
INTER-33 KNOTS	9200 YDS.
LOW-27 KNOTS	14000 YDS.



USE RED CIRCLE AND FIGURES  
FOR LOW SPEED (L) SETTINGS  
USE BLACK CIRCLE AND FIGURES  
FOR INTERMEDIATE (I) SETTINGS  
USE GREEN CIRCLE AND FIGURES  
FOR HIGH SPEED (H) SETTINGS

SCALE: 1 INCH=4000 YDS.

FIGURE 37

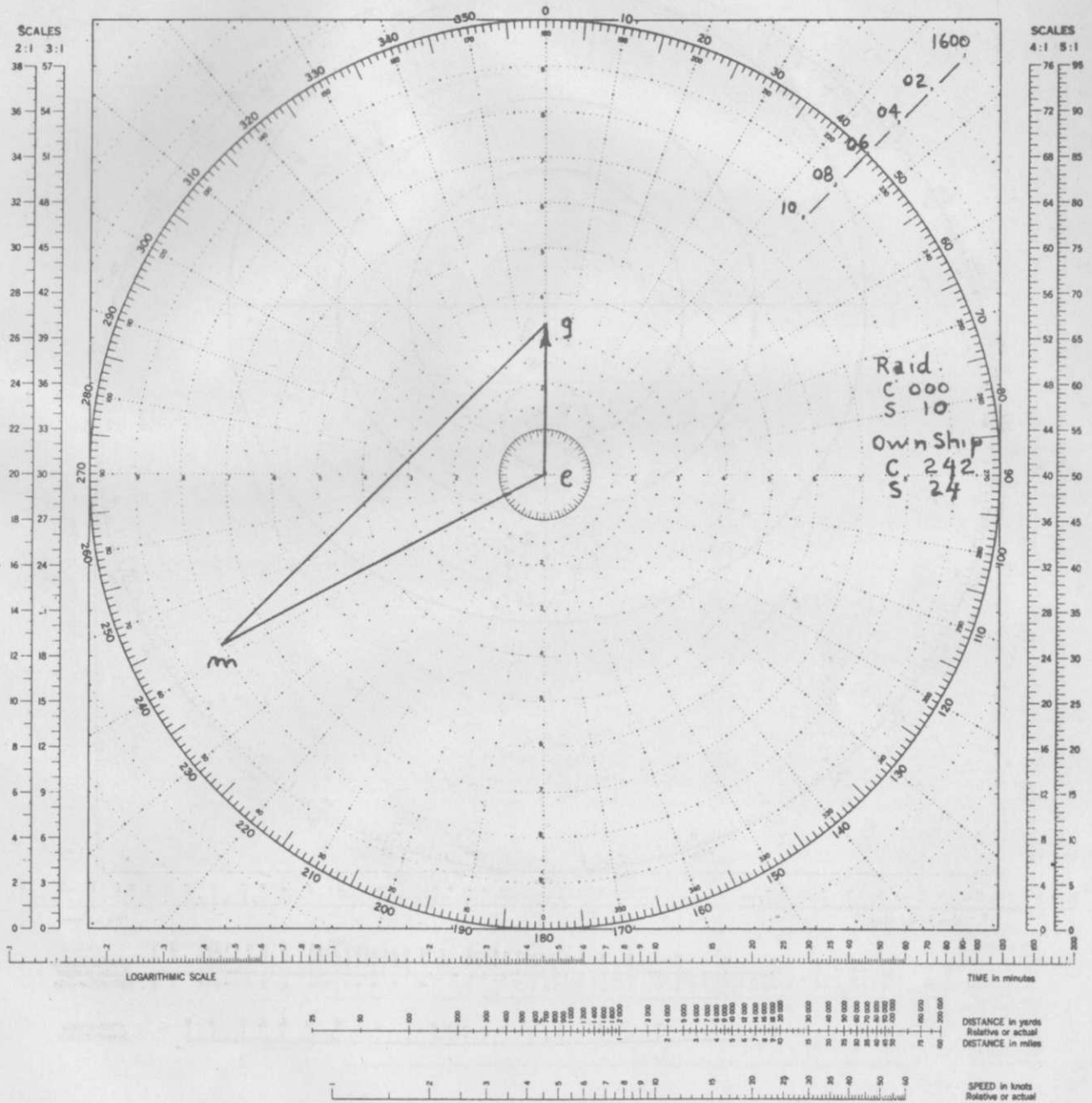


FIGURE 38





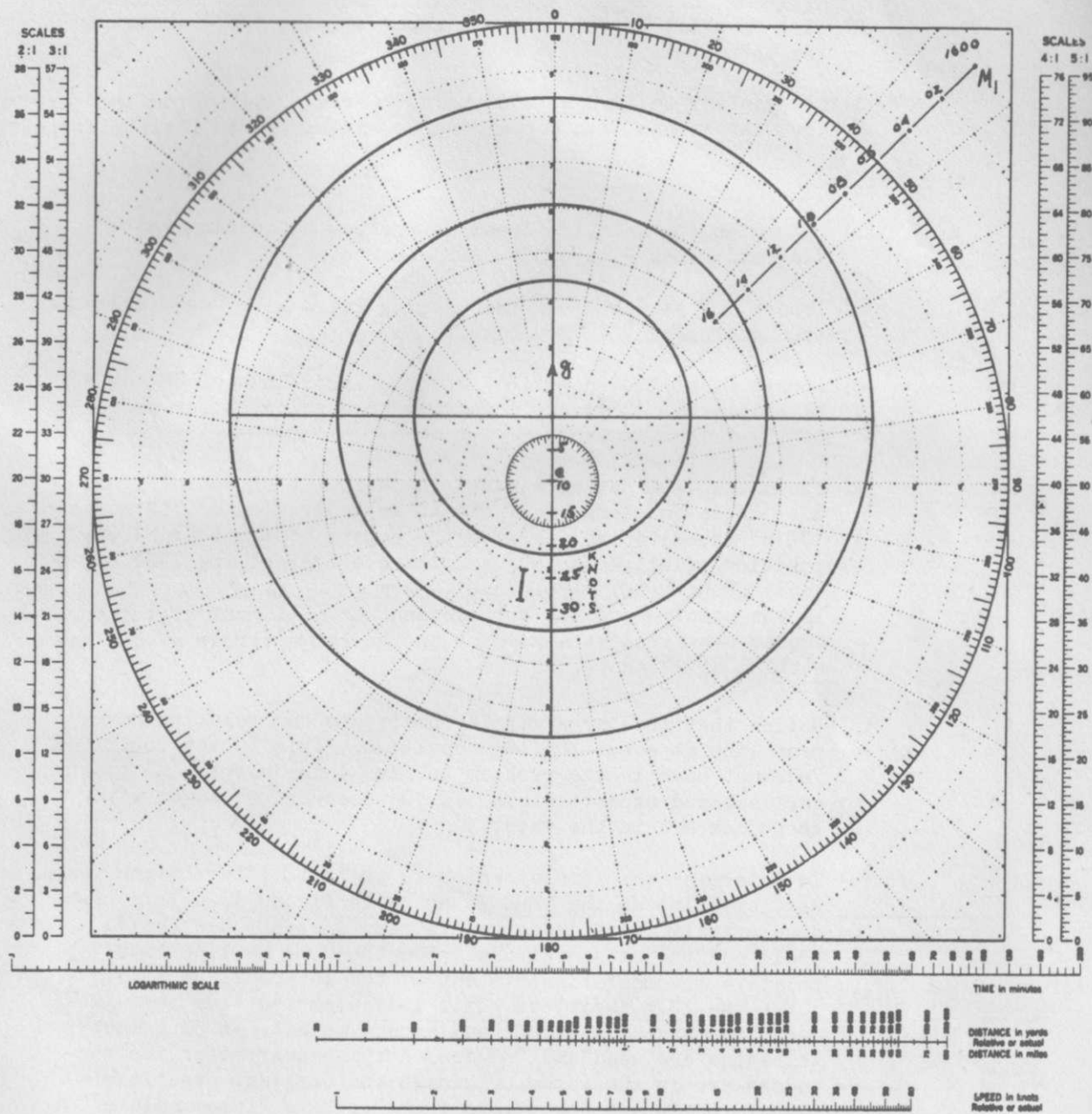


FIGURE 40

Using the Torpedo Effective Range Indicator (TERI) determine the following:

- (1) Earliest time (to nearest minute) that "M" can fire a long range torpedo spread at "G" using torpedo speed of 27 knots.
- (2) Time to shift to intermediate speed setting (33.5 knots) on the torpedoes.
- (3) If we elect to fire at 6000 yards bearing 045(T) from the target, can we use high torpedo speed and expect to hit the target?

(d) Solution.

- (1) Determine the Relative speed of problem by solving vector diagram. (See Figure 38) ANS. 30 knots.
- (2) Locate "G" at center of Maneuvering Board with "eg" indicating true course of "G" (See Figure 39).
- (3) Locate  $M_1$  or 1600 position, and plot positions of "M" at any time interval (2 minute intervals were selected for purposes of this illustration).
- (4) Place the TERI on the maneuvering board as shown in Figure 39. It is so placed that the 10 knot division on "L" scale ("G's" speed) coincides with the center of the board ("G's" position relative to "M") and the diameter of the TERI extends along "G's" course vector. The center of the TERI is the point where the torpedo and "G" will meet if the torpedoes are fired at any point on the large circle with a speed setting of 27 knots.
- (5) Notice that the large circle intersects our relative movement line at about the 1609 position. This is the position "M" must have in the problem to fire torpedoes at "G" the earliest and expect to hit, if "G" does not maneuver after torpedoes are in the water.
- (6) To determine the time at which to shift to intermediate speed setting, line up the TERI as shown in Figure 40. This is done exactly as is described in step 4 except use the "I" scale and the middle circle. Now the  $M_1 - M_2$  line (our relative movement line) is cut by the intermediate circle at about the 1615 position. This indicates the time that "M" can fire torpedoes at "G" and expect to hit, if 33.5 knot torpedoes are used and "G" does not maneuver after the torpedoes are in the water. This is the earliest practicable time to shift speed settings from "low" to "intermediate."
- (7) To determine if we can use high speed setting and expect to hit the target if we fire from 6000 yards bearing 045(T) from "G", line up the TERI as shown in Figure 41. Notice that our elected firing position is inside the small circle; therefore, we can fire using a torpedo speed of 45 knots and expect to hit "G", providing "G", does not maneuver after the torpedoes are water borne.



- (8) We may determine the track angle of our torpedoes from any proposed firing point on the TERI. This may be read in degrees on either side of the bow on the respective range circles. Had we fired high speed torpedoes at time 1619 (as in Figure 41), the approximate track angle would have been 45 degrees. Note we are using as a point of measure, the center of the TERI and not the center of the maneuvering board. In a similar manner any firing position may be determined in advance for a particular track angle. It is suggested that holes be drilled through the TERI as desirable track angles so that these positions may be indicated through the holes by a pencil mark directly on the maneuvering board. This will facilitate determining an approach course.
- (9) If doctrine introduces a safety factor to be subtracted from effective range, the range circles on the TERI will need to be redrawn to conform to these new ranges. The solution set out above will still apply.
- (10) Remember, the TERI is designed for use with our own and not enemy torpedoes. To determine if we are in effective range of the enemy's torpedoes, we would have to make another TERI fitting the characteristics of his torpedoes.

3360. Three Minute Thumb Rules for Determining Course and Speed.

This thumb rule is designed to simplify the steps necessary for determination of a course and speed solution.

The "egm" speed triangle as previously discussed is the basis for the rule and the following are set forth.

- (1) Own ship's course and speed is represented by the "eg" vector.
- (2) Stranger's (or raid as designated) course and speed is represented by the "em" vector.
- (3) Relative speed and Direction of relative speed of raid with respect to our ship is represented by the vector "gm".
- (4) The line of relative movement received and plotted is a relative surface plot and is represented by  $M_1 - M_2$ .
- (5) Items 3 and 4 are parallel and in the same direction with each other.
- (6) The scale for distance must be 1 DIVISION = 1000 yards. (A DIVISION is equal to the space between two rings on a polar plot).
- (7) The scale for speed must be 1 DIVISION = 10 knots.

To compute any speed of travel the distance in yards divided by the time in minutes equals the speed in yards per minute. This speed for our three minute rule purposes must be converted into knots. For clearness this conversion is shown.



1 knot = 1 nautical mile per hour

1 knot = 2000 yards per hour

1 knot = 2000 yards per 60 minutes

1 knot = 100 yards per 3 minutes

From the last statement in this breakdown the conversion can be made.

Yards traveled per minute X .03 = speed in knots.

$$\text{Example: } \frac{4200}{3} \times \frac{3}{100} = 42 \text{ knots}$$

Restating the above we arrive at the heart of the 3 minute thumb rule.

For yards traveled in 3 minutes point off (or drop) two places from the right end of the number of yards traveled. The resultant will be speed in knots.

Properly attach this resultant in knots, which is equal to vector "gm," to vector "eg," and vector "em," or the true course and speed, is solved.

An example can best prove the worth of the last statement and 3 minute thumb rule. As shown in Figure 42 at 00 time raid M is reported at bearing 080° range 8000 yards. Successive reports of bearing 090° range 7800 yards, bearing 101°, range 7700 yards, bearing 111° range 8000 yards, are made at times 01, 02, and 03 respectively. The plotting of these reports gives M's direction of relative speed. Since we have three minutes of plot we may apply our three minute rule. Measure the *length* of the plot from 00 minutes to 03 minutes. Transfer this length of line parallel to M's track and attach it to the end of the "eg" vector. The length of line now becomes the "gm" vector which determines the length of "em" vector and therefore gives us the true course and speed of raid M.

It is apparent from inspection of a maneuvering board that, by using 1 division equals 1000 yards, the maximum range at which a raid may be plotted is 10,000 yards. In order to plot at greater ranges use the following scales:

<u>Scale to be used</u>	<u>Lengths of Line to be taken to equal "gm"</u>
1 Div = 2000 yards	length of 3 minutes of travel X 2
1 Div = 3000 yards	length of 3 minutes of travel X 3
1 Div = 4000 yards	length of 3 minutes of travel X 4

The scale for speed must remain 1 DIV = 10 knots.

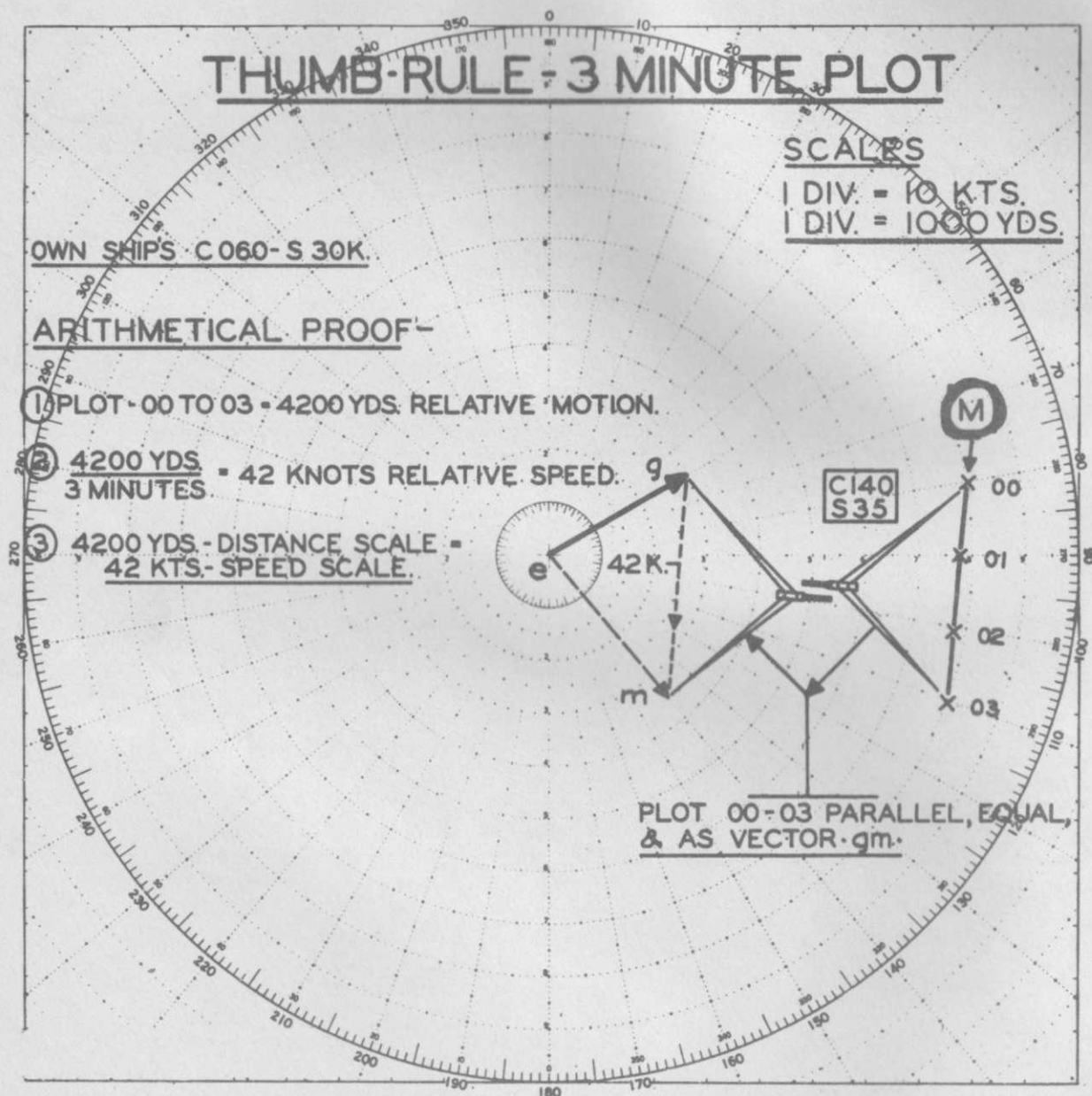


FIGURE 42

## 3370. The Plastic Maneuvering Board.

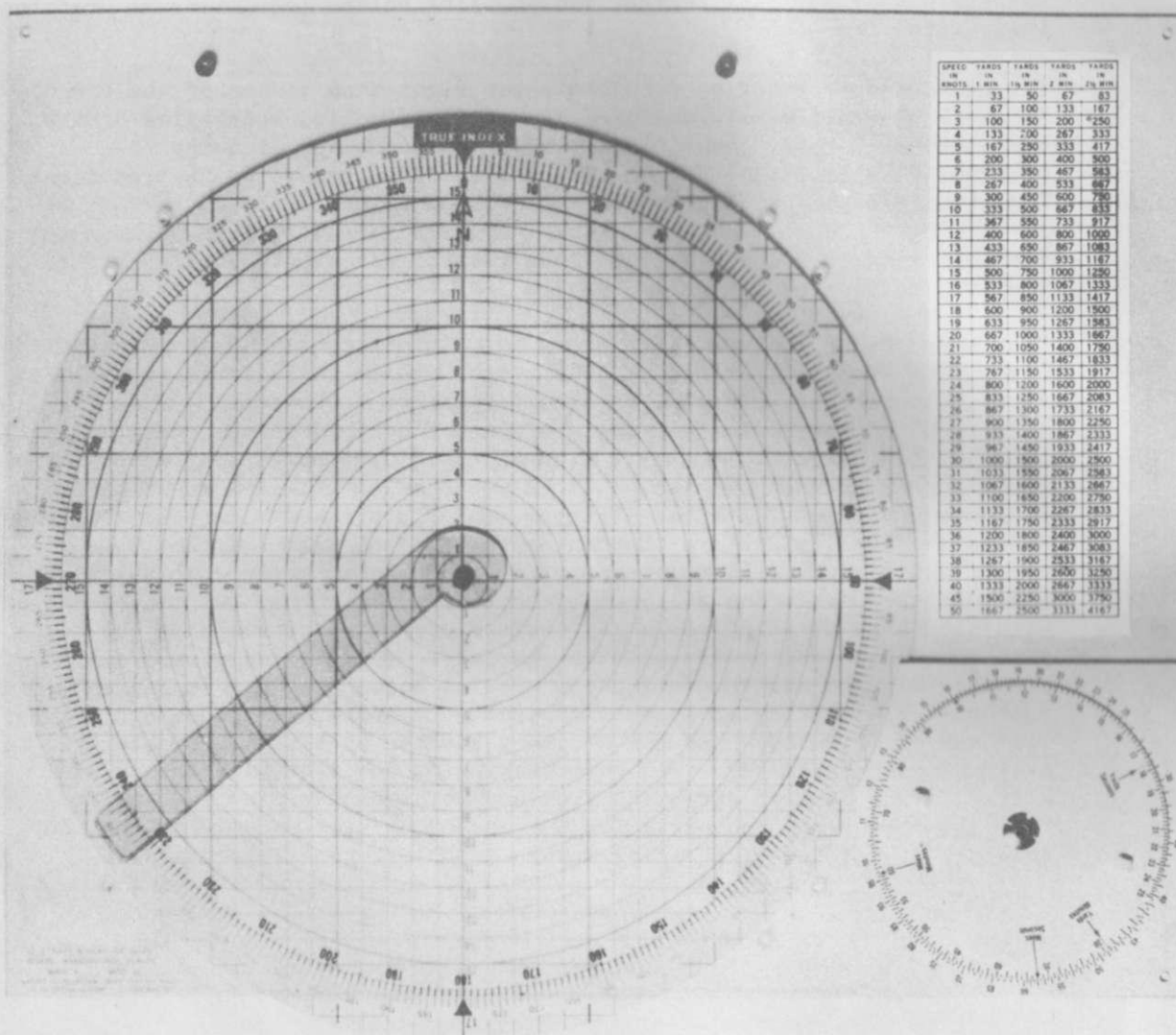
The Plastic Maneuvering Board which is furnished CICs by the Bureau of Ships has been adopted for surface use from the Mk 3 Navigational Plotting Board.

The board is a mechanical device for the solution of vector diagrams without the use of dividers, rulers and parallel rulers (or Universal Drafting Machines).

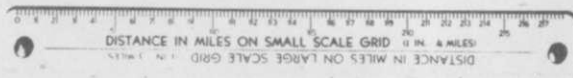
The Mk. 8 computer attached to the lower right hand corner of the board, is a circular slide rule designed to assist in making speed-time-distance computations. This computer eliminates the necessity of using the straight-edge or dividers necessary for computations with the traditional logarithmic scale printed on the maneuvering board.

The following is a description of the Plastic Maneuvering Board printed in the 1943 edition of Dutton's, "Navigation and Nautical Astronomy."

"The board is assembled with a transparent plotting surface over the grid disc. The Plotting surface is of plastic with a mattle finish to make it a suitable writing surface and permitting lines to be erased. The compass rose and the north pointing arrow are inscribed on the under side of the plotting surface. The grid disc which rotates on a pivot under the plotting surface has printed on it, a rectangular grid and a series of concentric circles. A speed-distance scale is printed along the two diametric lines, which are the centerlines of the grid. At the ends of one of the diametric lines are printed "true index" markers which are the mid-points of variation scales. Since the grid disc may be rotated, the grid lines may be oriented in any desired direction by means of the compass rose inscribed on the plotting surface. The speed-distance scale permits the grid and the concentric circles to be used for measuring distance, eliminating the use of dividers. By rotating the grid disc the line may be oriented under the plotting surface so that a grid line is available as a guide for free hand drawing on the plotting surface of a line in any desired direction from any point on the plotting surface. This eliminates the necessity for the use of a ruler as a guide in line drawing, or the use of parallel rulers to obtain parallel motion."



SPEED KNOTS	1 MIN	15 MIN	1 HOUR	2 HOURS	3 HOURS
1	33	50	67	83	100
2	67	100	133	167	200
3	100	150	200	250	300
4	133	200	267	333	400
5	167	250	333	417	500
6	200	300	400	500	600
7	233	350	467	583	700
8	267	400	533	667	800
9	300	450	600	750	900
10	333	500	667	833	1000
11	367	550	733	917	1100
12	400	600	800	1000	1200
13	433	650	867	1083	1300
14	467	700	933	1167	1400
15	500	750	1000	1250	1500
16	533	800	1067	1333	1600
17	567	850	1133	1417	1700
18	600	900	1200	1500	1800
19	633	950	1267	1583	1900
20	667	1000	1333	1667	2000
21	700	1050	1400	1750	2100
22	733	1100	1467	1833	2200
23	767	1150	1533	1917	2300
24	800	1200	1600	2000	2400
25	833	1250	1667	2083	2500
26	867	1300	1733	2167	2600
27	900	1350	1800	2250	2700
28	933	1400	1867	2333	2800
29	967	1450	1933	2417	2900
30	1000	1500	2000	2500	3000
31	1033	1550	2067	2583	3100
32	1067	1600	2133	2667	3200
33	1100	1650	2200	2750	3300
34	1133	1700	2267	2833	3400
35	1167	1750	2333	2917	3500
36	1200	1800	2400	3000	3600
37	1233	1850	2467	3083	3700
38	1267	1900	2533	3167	3800
39	1300	1950	2600	3250	3900
40	1333	2000	2667	3333	4000
41	1367	2050	2733	3417	4100
42	1400	2100	2800	3500	4200
43	1433	2150	2867	3583	4300
44	1467	2200	2933	3667	4400
45	1500	2250	3000	3750	4500
46	1533	2300	3067	3833	4600
47	1567	2350	3133	3917	4700
48	1600	2400	3200	4000	4800
49	1633	2450	3267	4083	4900
50	1667	2500	3333	4167	5000





## 4000. UTILIZATION OF PLOTS.

## 4100. IDENTIFICATION.

During the complicated maneuvers of a night engagement when ships of opposing forces are rapidly changing station relative to each other, and at times even mingling with each other, it becomes impossible for the operators of radar sets to keep track of the varied pips on scopes or to tell friend from foe.

IFF is a primary means of doing this but has not as yet been developed very extensively for surface use. The air search radar with the BL was not designed for the identification of surface units. Further, IFF is subject to battle casualty and material failure. Too, the day may come when the enemy uses IFF deceptively. Methods other than IFF alone are needed to keep contacts identified. Proof of this is the fact that combatant units of our Navy in the confusion of action have unwittingly fired upon their own units.

The use of plots for identification has been evolved as an additional primary means of continuous identification. By keeping track of all units on a plot from the beginning of an engagement when opposing forces are distinctly separated and distinguishable, it is possible to maintain the location of all friendly units relative to hostile units during the tactical maneuvering and melee of battle. Identification can be accomplished on any of the basic types of plots, Summary, Surface, Air or Geographic. A ship prepared with such a display will not fire on its own forces.

## 4200. OTHER USES OF PLOTS.

Under ordinary cruising conditions, a plot of surface vessels in company is required. It may be kept on a Geographic Plot or a Summary Plot, but is more commonly kept on a Surface Plot. By establishing each ship's station on the plot, early detection of radical movement may be made. The actions of a destroyer sheering from the screen to pursue a sonar contact are quickly known to other units, allowing them to take appropriate action. Ships on collision courses are readily apparent and are notified over TBS.

Before broadcasting surface contacts picked up by own ship's radars, to other ships over warning net, we must convert the bearings and ranges from us to bearings and ranges from fleet center. This conversion, as well as the conversion of information reported to us over warning net, is made on the summary plot. In emergencies, as in the case of a close-in surfacing submarine or a sonar contact, the detecting ship will probably report the bearing and range from herself over the warning net. To find the position of this emergency contact from our ship, it must be plotted from the reporting ship. Similarly when own ship picks up a possible target, its position from one of the ships in the screen may be quickly determined and the information sent to that ship so that she may investigate. Plots must be used to prevent own ship firing on own ships or planes. Either a Summary Plot or a Surface Plot can be used to reveal any ship of own force that unknowingly, in the confusion of an action, maneuvers into the line of fire between your own ship and the target. In the event of a night air attack, a Summary Plot will show whether or not a sector is clear of ships for secondary battery fire.

## 4300. TYPES OF PLOTS.

New equipment being developed such as the projection PPI gives promise of providing a method for keeping a Summary, Surface or Air Plot in a manner different and superior to any now used. However, at this time polar plots are kept on several different types of boards. One of the simplest physical setups is a plastic polar plot, on which the plotting is done with china-marking pencils, in colors. This kind of plot varies from 20 inches to 48 inches in diameter, depending upon the problem to be handled and the space available. Another form of Polar Plot found satisfactory in service is a polar plot painted on heavy gauge sheet metal, using small ALNICO (aluminum-nickel-cobalt alloy) magnetic buttons to mark positions. The above plots may be mounted horizontally, vertically, or at any intermediate angle as convenient. There is another form of Polar Plot generally used as a Summary Plot that employs a thick sheet of transparent plastic, about 5 feet in diameter, mounted vertically, on which are etched the necessary bearing lines and range circles. The advantage of this type is that the personnel, by keeping the plot on the back of the plastic sheet, leave the front of the display available for filtering and evaluation. To date this type has been used primarily aboard carriers.

Most Polar Plots are kept on a stationary surface, with own ship's course projector, but some are so constructed that the polar plot can be rotated manually on a fixed base. With this arrangement, either the calibrations on the rotary plot (See Figure 44A) or the calibrations on the fixed base (See Figure 44B) may be considered relative bearings. In the former case the rotary disc must be turned in the same direction and the same number of degrees as is the ship's head. This arrangement has the advantage of carrying a small task force, steaming in circle disposition with base course always the same as fleet axis, through base course changes without any need to reposition the units on the plot. Limiting arcs of train of own batteries, in this case, may be painted on the rotary part of the plot. In the case where calibrations on the fixed base are considered as relative bearings, the rotary disc must be turned in the opposite direction and the same number of degrees as is the ship's head. The advantage of this plot is that a formation steaming on a zig-zag need not be rearranged each time course is changed in the zig-zag plan. Limiting arcs of train of own batteries may be painted on the non-rotating base of the plot. Either of the above methods of keeping the plot may be speeded up by providing drive for the rotary part, through follow-up motors, directly from own ship's gyro.

## 4400. INFORMATION TO BE PLOTTED.

For identification of surface vessels all friendly and enemy vessels must be shown on the plot. TBS calls must be shown alongside all friendly plots, with hull numbers alongside those friendlies that might be reported by such numbers by lookouts. It must also show the designation and composition of all raids, and the position of "fleet center." Where applicable, limiting arcs of train of own batteries should be indicated.

## 4500. SOURCES OF INFORMATION.

The sources from which information may be obtained for the plots are of interest, for the origin of any particular plotted position must be indicated directly on the plot. The paramount source of information for plots is own ship's search radars. Own ship's lookouts will furnish considerable

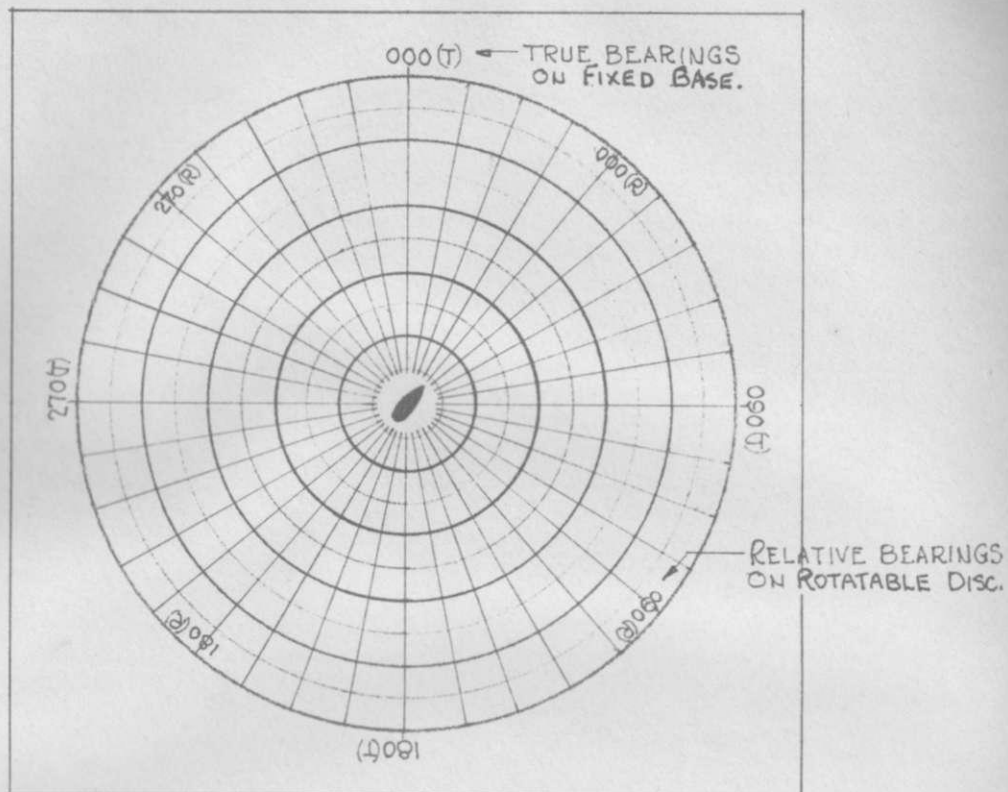


FIG. -44A

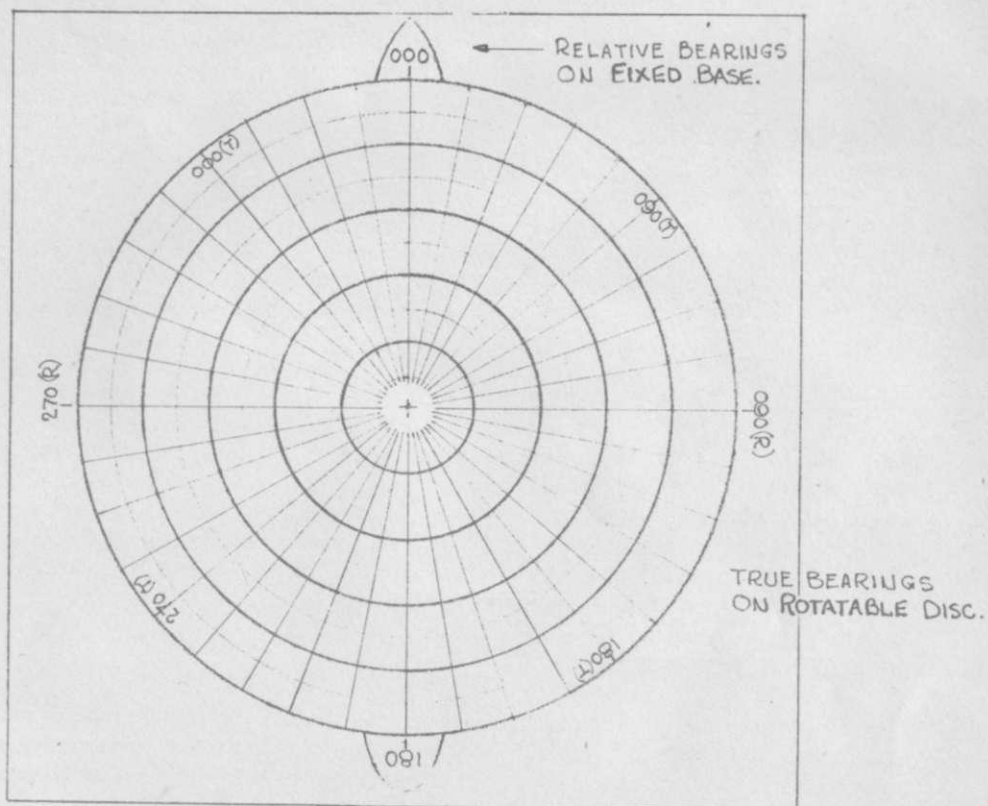


FIG. -44B

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information, and under some conditions an appreciable amount will come in by radio (other ships, shore installations, planes).

4600. KEEPING THE PLOT FOR IDENTIFICATION.

The present position of all friendlies should be indicated by an "o", and the close in scale of the plot must be large enough to present own disposition with sufficient discrimination. The present position of each raid should be indicated by an "X", and enough of the past track should be left on the plot at all times to clearly indicate the direction of relative movement of the raid. The raid designation and composition must also be shown along each raid track. The source of each position report must be clearly indicated either by allotting certain colors to "lookout", "own radar," and "radio," or by writing small sub-scripts next to the position's symbol ( $X_L$  for lookout,  $X_R$  for radio, and  $X$  with no sub-script for own radar; or  $o_L$ ,  $o_R$ , and  $o$  for friendlies). In the case of Summary Plots showing both air and surface targets, the various colors are best reserved to differentiate between air and surface contacts, leaving only sub-scripts to indicate source of reports.



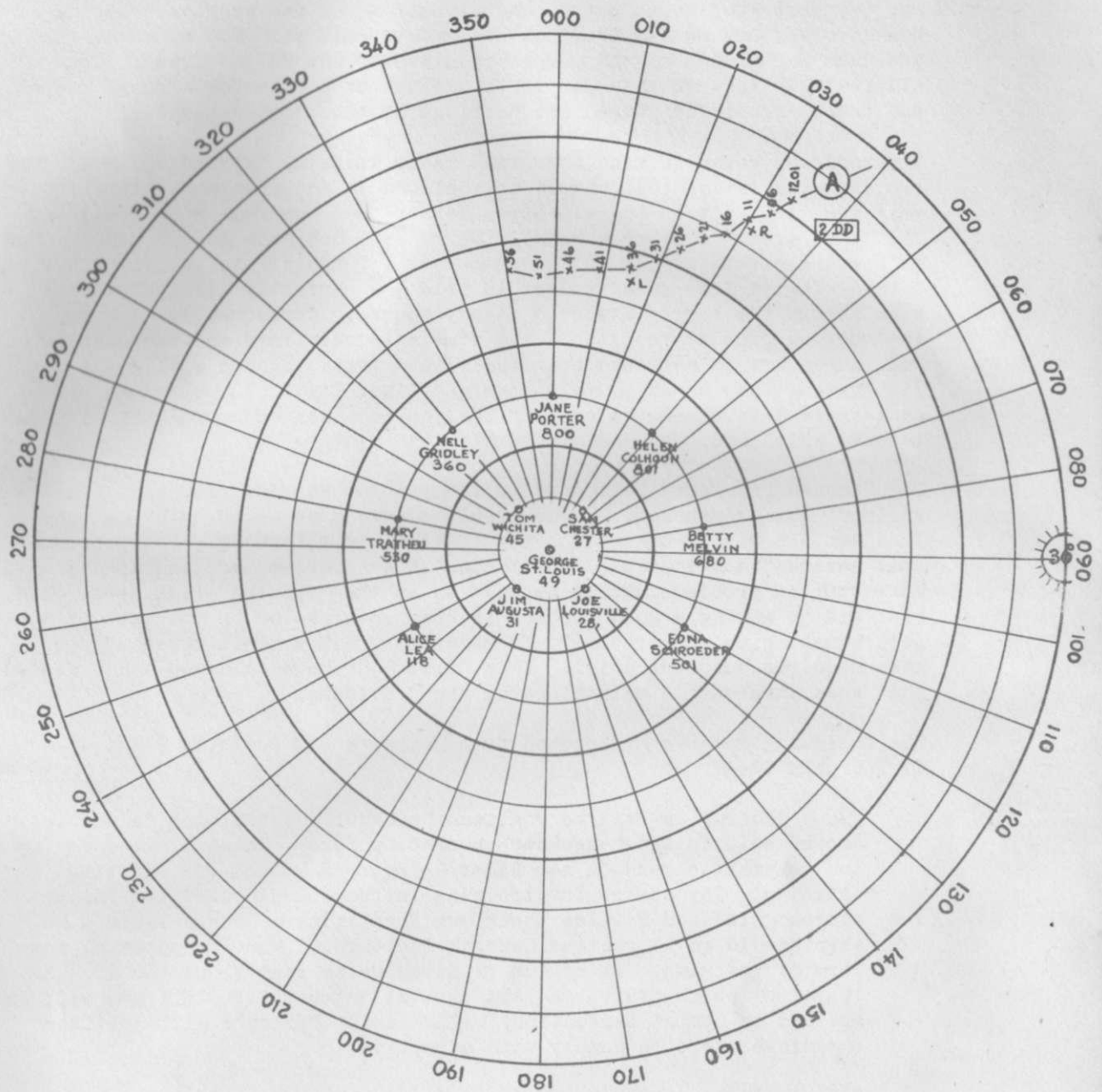


FIG. - 45

## 5000. THE PREPARATION OF CIC PROBLEMS FOR TRAINING.

In preparing CIC problems the first thing to bear in mind is the object of the problem. Each problem should be so designed that some definite object is stressed by working the problem. Once the object is decided on, the next step is to get a general outline of the problem. Decide how involved or how simple it is desired to make it. Now work out the bearings and ranges of the target relative to own ship's track. The simplest way to work this out is to set up the problem on a range keeper and record generated ranges and bearings at the times desired.

It should be borne in mind that real radar tracking carried on in CIC has two characteristics that should be included in the problems. Time intervals may vary. It is the exception rather than the rule when the interval is an even minute or when all the reports are made on the minute. Due to bearing errors mostly and to some extent range errors, a good track of a raid plotted from radar ranges is seldom a perfectly straight line - even though the target steers a steady course. Consequently, a more interesting problem results if the time intervals vary and the bearings and ranges are so selected that the raid's track becomes a slightly wavy line rather than an absolutely straight line. After the bearings and ranges are determined the rest of the job consists of correlating logical reports which would be associated with the plot.

The "Canned Problems" presented in the problem section illustrate the results of this reasoning. These problems were made up to bring out the fundamentals of CIC operations to CIC teams just forming. For personnel that have had considerable experience, these problems are too simple. More complex problems should be made up as the training progresses. The best aid to making a good problem is keen imagination on the part of the person making up the problem. To maintain a CIC crew in constant readiness requires constant drill. This drill must be so planned and executed that keen interest is maintained by the CIC teams.

The following remarks are quoted from DesPac's CIC Bulletin #1-44 of 17 February 1944:

"Many destroyers fail to realize the excellent training facilities aboard ship in the Rangekeepers or Computers. This is evidenced by the constant demand on the Radar Operator's School for plotting training. The desire for training is commendable, but the failure to recognize and utilize their own facilities is inexcusable. No ship should go to routine General Quarters without prosecuting some form of training. Attention is directed to part VI of Pac 10 (USF 10A also) which states in part that all members of CIC teams will be trained to utmost perfection. Commanding Officers will initiate immediate steps to comply with directive.

Very realistic conduct of a torpedo (or any other) duel can be simulated by stationing one officer in 'plot' to conduct the enemy tactics while CIC and Conn maneuver own ship. In such an arrangement it is only necessary to have phones between the surface plotting team and the computer. The JX is a suggested circuit. The complete torpedo control problem can be very realistically simulated by such an arrangement. This drill has the added advantage of being able to accurately determine the outcome of the duel. And too, torpedo director, radar, DRT, and IC casualties can easily be run into the problem. Such training is invaluable and must be used to the fullest

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extent. The results of CIC tracking exercises in the Hawaiian Area leave much to be desired. It showed the perfectly obvious to all concerned that the best equipped CIC in the fleet is no better than its ability to obtain a correct solution. With this in mind, Commanding Officers should constantly check the plotting ability of their CIC teams by means of generated ranges and bearings. Any failure to obtain a reasonably accurate solution should require immediate investigation."

*The above remarks can be made applicable to any ship.*

APPENDIX A

PROBLEMS



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5100. DRILL PROBLEMS.

5110. Finding speed, time or distance when two of these values are given and the third unknown:

$$D = S \times T, \text{ or } S = D/T, \text{ or } T = D/S.$$

D = Distance traveled, expressed in miles or yards.

S = Speed or rate of travel, expressed in knots.

T = Time of travel, expressed in hours or minutes.

Example:

If S = 15 knots, T = 2 hours, then D will equal 30 miles or 60,000 yards.  
And if D = 32 miles and T = 2 hours, then S will equal 16 knots.

5111. Find the missing part below:

	<u>SPEED</u>	<u>TIME</u>	<u>DISTANCE</u>
1.	15 knots	8 hours	?
2.	?	4 hours	17 miles
3.	30 knots	?	20 miles
4.	7 knots	?	26 miles
5.	22 knots	30 minutes	? yards
6.	?	45 minutes	15 miles
7.	22 knots	?	1000 yards
8.	?	3 minutes	1500 yards
9.	19 knots	?	1900 yards
10.	13 knots	6 minutes	? yards

5112.

$$1^{\circ} = 60'$$

$$1' = 60''$$

$^{\circ}$  = degree of arc

' = minute of arc

" = second of arc

- Add:  $125^{\circ} 30' 25''$  to  $23^{\circ} 54' 56''$
- Add:  $35^{\circ} 42' 15''$  to  $330^{\circ} 19' 15''$
- Add:  $22^{\circ} 59' 59''$  to  $68^{\circ} 25' 32''$
- Subtract:  $85^{\circ} 15' 23''$  from  $135^{\circ} 46' 56''$
- Subtract:  $108^{\circ} 34' 14''$  from  $22^{\circ} 32' 10''$
- Subtract:  $122^{\circ} 23' 24''$  from  $15^{\circ} 26' 28''$
- Subtract:  $99^{\circ} 45' 20''$  from  $1^{\circ} 2' 26''$
- Add:  $102^{\circ} 14' 15''$  to  $32^{\circ} 14' 15''$
- Add:  $82^{\circ} 59' 22''$  to  $270^{\circ} 19' 52''$
- Subtract:  $85^{\circ} 11' 21''$  from  $270^{\circ} 18' 19''$

5120. DEAD RECKONING.

5121. Initial point "A", time 1400, make a DR plot of the movements of the

ship if she was maneuvered as follows: 1400 ship on course  $091^{\circ}(T)$ , speed 10 knots; 1430 changes course to  $039^{\circ}$ . She steams for 8 miles on course  $039^{\circ}$  then changes course to  $120^{\circ}(T)$  and steams at 30 knots until 1630.

- Find:
- (1) Distance traveled from 1400 to 1430.
  - (2) Time ship changed course to  $120^{\circ}$ .
  - (3) Total distance traveled.
  - (4) Range and bearing of final position with respect to initial position.

5122. Initial point "A" time 0900, ship on course  $270^{\circ}(T)$ , speed 15 knots. Make a DR plot of the movement of the ship as follows:

0930 change speed to 30 knots.  
 0954 change course to  $120^{\circ}(T)$ .  
 1030 change course to  $060^{\circ}(T)$ .  
 1045 change speed to 10 knots.  
 1100 end of track.

Find from plot the total distance traveled and range and true bearing of 1100 position from 0900 position.

5123. Initial point "A" time 0954, ship on course  $090^{\circ}(T)$ , speed 10 knots. Make a DR plot of the movement of the ship as follows:

0956 change course to  $096^{\circ}(T)$ .  
 0959 change speed to 15 knots  
 1007 change course to  $080^{\circ}(T)$   
 1012 change course to  $075^{\circ}(T)$   
 1018 change speed to 12 knots  
 1027 change course to  $090^{\circ}(T)$   
 1032 change course to  $098^{\circ}(T)$   
 1037 change speed to 10 knots  
 1054 End of problem.

Find from plot the total distance traveled and course and speed made good from initial point "A".

5124. Make a DR plot of a ship starting from point "A" at time 1600 and underway on the following course and speeds:

1600 course  $240^{\circ}$  speed 12 knots.  
 1612 change course to  $270^{\circ}(T)$  speed to 6 knots.  
 1615 change speed to 10 knots.  
 1620 change course to  $060^{\circ}(T)$ .  
 1636 increase speed to 15 knots.  
 1642 change course to  $115^{\circ}(T)$  speed to 10 knots.  
 1650 change course to  $090^{\circ}(T)$ .  
 1700 End of problem at point "B".

Find from plot the total distance traveled, and the bearing and range of "B" and "A".

5125. Make a DR plot of a ship starting from point "A" at time 0600 and underway on the following courses and speeds:

0600 course  $200^{\circ}$ (T) speed 18 knots.  
 0608 change course to  $320^{\circ}$ (T).  
 0618 change course to  $080^{\circ}$ (T) speed to 10 knots.  
 0630 change course to  $150^{\circ}$ (T).  
 0640 change speed to 5 knots; course to  $000^{\circ}$ (T).  
 0655 change course to  $345^{\circ}$ (T).  
 0710 End of problem at point "B".

Find the total distance traveled, and bearing and range of "B" and "A".

5126. Make a DR plot of a ship starting from point "A" at time 1000 and underway on the following courses and speeds:

1000 Course  $350^{\circ}$ (T), speed 20 knots.  
 1007 Change course to  $093^{\circ}$ (T).  
 1011 Change speed to 15 knots.  
 1015 Change course to  $244^{\circ}$ (T), speed to 21 knots.  
 1021 Change course to  $154^{\circ}$ (T).  
 1028 Change course to  $270^{\circ}$ (T), speed to 12 knots.  
 1040 Change course to  $005^{\circ}$ (T).  
 1045 What course will have to be taken at this time to return to point "A", and at 12 knots, how long will it take?

5127. Make a DR plot of a ship starting from point "A" at time 1800 and underway on the following courses and speeds:

2330 Course  $040^{\circ}$ (T), speed 18 knots.  
 2342 Course  $272^{\circ}$ (T), speed 15 knots.  
 2352 Course  $118^{\circ}$ (T), speed 15 knots.  
 2400 Change speed to 12 knots.  
 0010 Course  $185^{\circ}$ (T).  
 0015 Course  $255^{\circ}$ (T), speed 15 knots.  
 0033 Course  $345^{\circ}$ (T), speed 18 knots.  
 0045 End of problem at point "B".

What is the bearing and range of "B" from "A"? At what time after 2350 was the ship closest to point "A"?

5128. Plot the following zigzag plan on a base course of  $040^{\circ}$ (T), speed of ship 18 knots.

Base Course for 4 minutes:

$20^{\circ}$  left of base course for 6 minutes.  
 $10^{\circ}$  left of base course for 5 minutes.  
 $30^{\circ}$  right of base course for 4 minutes.

Base course for 4 minutes:

10° right of base course for 5 minutes.

30° left of base course for 4 minutes.

Base course for 6 minutes:

20° right of base course for 6 minutes.

Find the speed made good.

5129. Plot the following zigzag plan on a base course of 300°(T), speed of ship 15 knots:

10° right of base course for 6 minutes.

Base course for 5 minutes.

25° left of base course for 6 minutes.

15° left of base course for 5 minutes.

Base course for 4 minutes.

15° right of base course for 5 minutes.

10° left of base course for 6 minutes.

25° right of base course for 6 minutes.

Find the speed made good.

#### 5130. SURFACE PLOTTING PROBLEMS.

For use on both DRT and polar coordinate plots. Plot and find courses and speeds of the raids. On summary surface plot, note how changes of course of own ship or of raid affect the plot.

Problem 1.

Own ship's initial course and speed: 015°(T), 15 knots.

<u>TIME</u>	<u>RAID</u>	<u>BEARING</u>	<u>RANGE</u>	<u>TIME</u>	<u>RAID</u>	<u>BEARING</u>	<u>RANGE</u>
00	Able	002	9100	10	Able	140	1720
01	"	005	8160	11	"	160	2600
02	"	007	7220	12	"	172	3620
03	"	012	6360	12 ²	(Own ship changes course to 320°(T)).		
04	"	017	5500	13	Able	172	4700
05	"	024	4660	14	"	172	5800
06	"	033	3960	15	"	172	6860
07	"	042	2880	16	"	172	7940
08	"	058	1920	17	"	173	9100
09	"	096	1400	18	"	172	10240



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## Problem 2.

Own ship's initial course and speed:  $100^{\circ}$ (T), 18 knots.

TIME	RAID	BEARING	RANGE	TIME	RAID	BEARING	RANGE
00	Baker	048	4900	08 ²	(Own ship's speed to 21 kts.)		
01	"	046	4660	09	Baker	039	2780
02	"	045	4400	10	"	036	2500
03	"	044	4180	11	"	034	2280
04	"	043	3920	12	"	028	1980
05	"	040	3700	13	"	024	1740
06	"	040	3500	14	"	016	1500
07	"	040	3320	15	"	008	1280
08	"	040	3120	16	"	355	1160

## Problem 3.

Own ship's initial course and speed:  $220^{\circ}$ (T) 20 knots.

TIME	RAID	BEARING	RANGE	TIME	RAID	BEARING	RANGE
00	Charlie	272	9160	09	Charlie	308	3420
01	"	274	8460	10	"	325	3140
02	"	275	7800	11	"	342	3100
03	"	278	7240	12	"	000	3380
04	"	280	6600	12 ²	(Own ship's course to $200^{\circ}$ (T)).		
04 ²	(Own ship's course to $230^{\circ}$ (T)).			13	Charlie	008	3680
05	Charlie	283	5900	14	"	015	4400
06	"	286	5220	15	"	018	5180
07	"	290	4660	16	"	024	6000
08	"	295	4000	17	"	025	6680

## Problem 4.

Own ship's initial course and speed:  $150^{\circ}$ (T) 18 knots.

TIME	RAID	BEARING	RANGE	TIME	RAID	BEARING	RANGE
00	Dog	282	4040	10	Dog	208	1600
01	"	280	3720	10 ²	(Own ship come to course $180^{\circ}$ (T) 20 knots.)		
02	"	280	3440	11	Dog	186	1440
03	"	278	3160	12	"	165	1460
04	"	275	2840	13	"	148	1640
05	"	272	2560	14	"	135	1900
05 ²	(Own ship slow to 10 kts.)			15	"	124	2360
06	Dog	270	2300	16	"	102	2820
07	"	258	1900	17	"	090	3600
08	"	245	1640	18	"	082	4480
09	"	225	1600	19	"	075	5400

## Problem 5.

Own ship's initial course and speed: 080°(T) 12 knots.

TIME	RAID	BEARING	RANGE	TIME	RAID	BEARING	RANGE
00	Easy	058	19,000	09 ²	Easy	045	11,220
00 ³	"	056	18,400	10 ³	"	042	10,640
01 ³	"	055	17,600	11 ³	"	040	10,000
02 ¹	"	055	17,200	12 ²	"	034	9,160
03	"	051	16,600	13	"	032	8,840
04 ¹	"	052	15,600	13 ²	(Own ship's course to 080°(T)).		
05	"	052	15,000	14	Easy	026	8,520
05 ³	"	050	14,200	15 ²	"	018	8,180
07 ¹	"	048	13,000	16 ¹	"	014	8,000
07 ²	(Own ship's course to 065°(T)).			17	"	010	8,000
08 ¹	Easy	048	12,800				
09	"	045	12,000				

## Problem 6.

(2 targets). Own ship's initial course and speed, 015°(T) 15 knots.

TIME	RAID	BEARING	RANGE	TIME	RAID	BEARING	RANGE
00	Fox	204	3720				
01	"	203	3600				
02	"	204	3500				
03	"	203	3420				
04	"	202	3320				
05	"	202	3200	05 ²	Item	348	3300
06	"	202	3120	06 ²	"	344	2880
07	"	200	3020	07 ²	"	338	2500
08	"	200	3520	08 ²	"	330	2200
09	"	200	4000	09 ²	"	320	1820
10	"	200	4480	10 ²	"	305	1600

Cease tracking

(10¹ Own ship changes course to 320°(T)).

11	Fox	192	4820				
12	"	188	5140				
13	"	182	5200				
14	"	178	5260	14 ²	Item	175	1500
15	"	172	5400				
16	"	166	5560				
17	"	162	5800				
18	"	158	6040	18 ²	"	155	3300
19	"	155	6320				
20	"	150	6580				

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Problem 7.

(2 targets). Own ship's course 060°(T), 12 knots.

TIME	RAID	BEARING	RANGE	TIME	RAID	BEARING	RANGE
00	George	150	8000	00 ²	King	031	7000
01	"	150	8020	01 ²	"	034	6780
02	"	150	8080	02 ²	"	036	6500
03	"	150	8000	03 ²	"	040	6320
04	"	150	8040	04 ²	"	042	6120
05	"	150	7980	05 ²	"	045	5680
06	"	150	8000	06 ²	"	048	5300
07	"	150	8000	07 ¹	"	051	4900

(07² Own ship's course change to 108°(T)).

08	George	150	7800	08 ²	King	056	4240
09	"	148	7360	09 ²	"	056	3700
10	"	150	6940	10 ²	"	054	3220
11	"	152	6520	11 ²	"	055	2700
12	"	150	6200	12 ²	"	056	2220
13	"	150	5660	13 ²	"	055	1650
14	"	152	5240	14 ²	"	055	1300

(14³ Own ship's course change to 060°(T)).

15	George	152	5000	15 ²	King	072	840
16	"	150	5020	16 ²	"	110	600
17	"	150	4980	17 ²	"	156	720
18	"	152	5000	18 ²	"	180	1080
19	"	150	5000	19 ²	"	188	1560

Problem 8.

(3 targets.) Own ship's course and speed 030°(T), 15 knots.

TIME	RAID	BEAR.	RANGE	TIME	RAID	BEAR.	RANGE	TIME	RAID	BEAR.	RANGE
00	Item	315	22,300								
01	"	314	21,700	01 ²	Jig	202	21,400				
02	"	312	20,800	02 ²	"	205	17,000				
03	"	310	20,100	03 ²	"	210	13,000				
04	"	310	19,200	04 ²	"	222	9,100				
05	"	308	18,600	05 ²	"	245	5,800				
06	"	307	18,000	06 ²	"	291	5,000				
07	"	302	17,500	07 ²	"	326	7,500				
08	"	300	17,200	08 ²	"	342	11,200				

Cease tracking

(08² Own ship change course and speed to 180°(T) 18 knots.)

09	Item	300	17,100								
10	"	298	17,200								
11	"	298	17,100					11 ³	King	136	11,000
12	"	298	17,000					12 ³	"	132	10,800

Problem 8. (Cont'd)

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<u>TIME</u>	<u>RAID</u>	<u>BEAR.</u>	<u>RANGE</u>	<u>TIME</u>	<u>RAID</u>	<u>BEAR.</u>	<u>RANGE</u>	<u>TIME</u>	<u>RAID</u>	<u>BEAR.</u>	<u>RANGE</u>
13	Item	300	16,800					13 ³	King	130	11,000
14	"	302	16,600					14 ³	"	125	11,300
15	"	304	16,300					15 ³	"	122	11,300
16	"	305	16,000					16 ³	"	116	11,500
17	"	306	15,900					Cease tracking			
18	"	308	15,500								
19	"	310	15,400								
20	"	312	15,100								

5140. RELATIVE MOVEMENT AND MANEUVERING BOARD PROBLEMS.

5141. Given the following courses and speeds for own ship with the target's relative movement, find the course and speed of the target for each of the following:

- Problem 1. O.S.C. 060°(T), speed 15 knots. Time 1121.  
Target bears 010°(T) 7600 yards. Time 1127.  
Target bears 024°(T) 6500 yards.
- Problem 2. O.S.C. 035°(T), speed 9 knots. Time 0335.  
Target bears 045°(T) 7650 yards. Time 0340.  
Target bears 062°(T) 5100 yards.
- Problem 3. O.S.C. 287°(T), speed 20 knots. Time 1400.  
Target bears 260°(T) 17,600 yards. Time 1404.  
Target bears 270°(T) 15,200 yards.
- Problem 4. O.S.C. 020°(T), speed 17 knots. Time 0910.  
Target bears 040°(T) 19,000 yards. Time 0915.  
Target bears 054°(T) 16,300 yards.
- Problem 5. O.S.C. 025°(T), speed 15 knots. Time 0445.  
Target bears 012°(T) 9100 yards. Time 0448.  
Target bears 022°(T) 6360 yards.
- Problem 6. O.S.C. 330°(T), speed 15 knots. Time 1215².  
Target bears 182° 7700 yards. Time 1218.  
Target bears 182° 10,240 yards.
- Problem 7. O.S.C. 090°(T), speed 18 knots. Time 1120.  
Target bears 038°(T) 4900 yards. Time 1124².  
Target bears 032°(T), 3800 yards.
- Problem 8. O.S.C. 075°(T), 12 knots. Time 1300. Target  
bears 053°(T), 19,000 yards. Time 1304. Target  
bears 047°(T), 15,600 yards.
- Problem 9. O.S.C. 255°(T), speed 20 knots. Time 1021².  
Target bears 323°(T), 8,520 yards. Time 1025.  
Target bears 343°(T), 10,000 yards.
- Problem 10. O.S.C. 170°(T), speed 18 knots. Time 1609.  
Target bears 290°(T), 17,100 yards. Time 1614.  
Target bears 292°(T), 16,600 yards.



5142. Given the course of the guide (GC) and the speed of the guide (GS), and own ship's course (OSC), find the necessary speed for executing each of the following maneuvers and the time required.

- Problem 1. GC = 15 knots. Own ship must move from 12,000 yards on the starboard bow to 6,000 yards on the starboard beam of guide. O.S.C. =  $000^{\circ}(T)$ . Find speed and time.
- Problem 2. GC =  $130^{\circ}(T)$ , GS = 25 knots. Own ship must move from 6,000 yards dead ahead of guide to 5,000 yards on port beam, using a true course at right angles to guide's course. Find speed and time.
- Problem 3. GC =  $130^{\circ}(T)$ , GS = 25 knots. Own ship must move from 5,000 yards on port beam to 3,000 yards dead astern of guide. OSC =  $180^{\circ}(T)$ . Find speed and time.
- Problem 4. GC =  $130^{\circ}(T)$ , GS = 25 knots. Own ship must go from 3,000 yards astern to 5,000 yards on starboard beam of guide. OSC =  $140^{\circ}(T)$ . Find speed and time.
- Problem 5. GC =  $130^{\circ}(T)$ , GS = 25 knots. Own ship must move from 5,000 yards on starboard beam to 6,000 yards dead ahead of guide, using course of  $120^{\circ}(T)$ . Find speed and time. Find the total time that was necessary for the maneuvering ship to circle the guide, on the courses and speeds in problems 2 - 5.
- Problem 6. GC =  $328^{\circ}(T)$ , GS = 18 knots. Own ship must go from 14,000 yards on the port bow to 14,000 yards on the starboard beam. OSC =  $030^{\circ}(T)$ . Find speed and time.
- Problem 7. GC =  $265^{\circ}(T)$ , GS = 16 knots. Own ship must move from a position bearing  $060^{\circ}$  relative from the guide, 9,000 yards, to a position bearing  $120^{\circ}$  relative from the guide, 4,000 yards. OSC =  $140^{\circ}(T)$ . Find speed and time.
- Problem 8. GC =  $180^{\circ}(T)$ , GS = 10 knots. Own ship must move from 7,000 yards  $180^{\circ}(R)$  to 2,000 yards  $330^{\circ}(R)$  from the guide. OSC =  $178^{\circ}(T)$ . Find speed and time.
- Problem 9. GC =  $184^{\circ}(T)$ , GS = 25 knots. Own ship must move from  $030^{\circ}(R)$ , 10,400 yards from the guide, to  $261^{\circ}(T)$ , 12,700 yards, from the guide. OSC =  $250^{\circ}(T)$ . Find the speed and time.
- Problem 10. GC =  $122^{\circ}(T)$ , GS = 20 knots. Own ship must move from guide's starboard bow, 8,200 yards, to a position alongside the guide. OSC =  $090^{\circ}(T)$ . Find the speed and time.

5143. Given the course of the guide (GC), the speed of the guide (GS), and own ship's speed (OSS), find the course or courses for executing the following maneuvers, and the times required.

- Problem 1. GC =  $300^{\circ}(T)$ , GS = 18 knots. Own ship must go from  $270^{\circ}(T)$ , 10 miles, from the guide to 7 miles on the port quarter of the guide at a speed of 20 knots. Find the course and time required.

- Problem 2. GC =  $280^{\circ}$ (T), GS = 25 knots. Own ship is dead ahead of guide, 12,400 yards, and is ordered to go to a position 8,000 yards on the guide's starboard beam, using a speed of 15 knots. Find the two possible courses and the time required for each.
- Problem 3. GC =  $095^{\circ}$ (T), GS = 22 knots. Own ship must go from  $350^{\circ}$ (R) at 15,000 yards to  $315^{\circ}$ (R) at 7,500 yards from the guide, using a speed of 12 knots. Find the two courses possible and the time required for each.
- Problem 4. GC =  $045^{\circ}$ (T), GS = 20 knots. Own ship must move from  $315^{\circ}$ (T), 7,300 yards, to  $220^{\circ}$ (T), 7,000 yards, at a speed of 15 knots. Find the course and the time required.
- Problem 5. GC =  $240^{\circ}$ (T), GS = 12 knots. Own ship must move from five miles on the starboard bow of guide to one mile on the starboard beam at the slowest possible speed. Find the course and the time required.
- Problem 6. GC =  $240^{\circ}$ (T), GS = 12 knots. Own ship must move from five miles on the starboard bow of the guide to one mile on the starboard beam in the shortest possible time, using 10 knots. Find the course and the time required.
- Problem 7. GC =  $160^{\circ}$ (T), GS = 20 knots. Own ship must go from  $000^{\circ}$ (T), 8,000 yards, to  $270^{\circ}$ (T), 4,000 yards from the guide, using a speed of 25 knots. Find the course and the time required.
- Problem 8. GC =  $340^{\circ}$ (T), GS = 18 knots. Own ship must go from  $090^{\circ}$ (R), 8,500, to  $180^{\circ}$ (R), 6,000 yards, from the guide, using a speed of 18 knots. Find the course and the time required.
- Problem 9. GC =  $020^{\circ}$ (T), GS = 16 knots. Own ship must zigzag at a speed of 20 knots, always staying on the port beam of the guide. What courses must it use, and how fast will it be opening or closing the range from the guide?
- Problem 10. GC =  $115^{\circ}$ (T), GS = 22 knots. Own ship must go from dead ahead of guide, 4 miles, to the port beam of the guide, 4 miles, using 18 knots. Find the course that will complete the maneuver in the longest time and the time required.
5144. Given the course of the guide (GC), the speed of the guide (GS), and the time in which the maneuver must be completed, find the courses and speeds necessary to execute the following maneuvers.
- Problem 1. GC =  $210^{\circ}$ (T), GS = 15 knots. Own ship must move from dead ahead of guide, 7,000 yards, to  $060^{\circ}$ (R), 7,000 yards, in ten minutes. Find the course and speed.
- Problem 2. GC =  $315^{\circ}$ (T), GS = 18 knots. Own ship must move from  $285^{\circ}$ (T), 19,000 yards, to  $180^{\circ}$ (T), 14,000 yards, from guide in twenty minutes. Find course and speed.

- Problem 3. GC =  $145^{\circ}$ (T), GS = 29 knots. Own ship must move from 10 miles on the port beam to one mile on the port beam of the guide in one hour. Find course and speed.
- Problem 4. GC =  $110^{\circ}$ (T), GS = 10 knots. Own ship is on guide's port bow at 4,000 yards, and must go alongside of guide in twenty minutes. Find course and speed.
- Problem 5. GC =  $050^{\circ}$ (T), GS = 22 knots. Own ship must go from dead astern, 5,500 yards, to  $270^{\circ}$ (R), 5,000 yards, from guide 35 minutes. Find the course and speed.
- Problem 6. GC =  $005^{\circ}$ (T), GS = 25 knots. Own ship must move from  $040^{\circ}$ (R), five miles, to  $080^{\circ}$ (R), six miles in 12 minutes. Find the course and speed required.
- Problem 7. GC =  $225^{\circ}$ (T), GS = 12 knots. Own ship must move from  $020^{\circ}$ (T), 7,000 yards, to  $160^{\circ}$ (T), 4,000 yards from guide in twenty minutes. Find the course and speed required.
- Problem 8. GC =  $000^{\circ}$ (T), GS = 25 knots. Own ship must go from dead ahead of guide, 12,500 yards, to starboard beam, 8,000 yards, in fifteen minutes. Find the course and speed required.
- Problem 9. GC =  $185^{\circ}$ (T), GS = 16 knots. Own ship must move from  $180^{\circ}$ (T),  $4\frac{1}{2}$  miles, to  $140^{\circ}$ (T), 4 miles, from the guide in ten minutes. Find the required course and speed.
- Problem 10. GC =  $295^{\circ}$ (T), GS = 22 knots. Own ship must move from  $350^{\circ}$ (R), 7 miles, to  $315^{\circ}$ (R),  $3\frac{1}{2}$  miles, in ten minutes. Find the course and speed.

#### 5145. Determining How Close a Contact Will Pass.

- Problem 1. Own ship on  $090^{\circ}$ , 25 knots. Contact tracked on  $120^{\circ}$ , 30 knots. Present radar bearing and range is  $350^{\circ}$ , 18,000 yards. How close will contact pass to your ship? In how many minutes?
- Problem 2. Own ship on  $355^{\circ}$ , 21 knots. Contact track on  $180^{\circ}$ , 18 knots. Present radar bearing and range is  $020^{\circ}$ , 28,000 yards. How close will contact pass to your ship, in how many minutes, and at what bearing?
- Problem 3. Contact on  $291^{\circ}$ , 28 knots. Present range and bearing of contact from you is  $130^{\circ}$  -- 10,000 yards. Own ship on  $290^{\circ}$ , 20 knots. How close will contact pass to you, in how many minutes, at what bearing?
- Problem 4. Own ship on  $148^{\circ}$ , 14 knots. Contact tracked on  $190^{\circ}$ , 8 knots. Present range and bearing is  $190^{\circ}$ , 22,000 yards. Will contact come any closer to your ship?
- Problem 5. Own ship on  $185^{\circ}$ , 21 knots. Friendly ship on  $060^{\circ}$ , 15 knots. Present range and bearing  $200^{\circ}$ ; 8,000. How close will friendly ship pass to your own? What relative bearing will he be closest?



Problem 6. Own ship on  $350^{\circ}$ , 18 knots. Friendly ship on  $325^{\circ}$ , 14 knots. Present position of friendly is  $080^{\circ}$ , 10,000 yards. How close will friendly ship pass to own ship, what relative bearing, and at what time?

Problem 7. Contact tracked on  $180^{\circ}$ , 16 knots. Own ship on  $090^{\circ}$ , 12 knots. Present range and bearing is  $042^{\circ}$ , 20,000 yards. How close will target pass to you and in how many minutes?

#### 5146. Torpedo Attack Problems.

Problem 1. Own ship's initial course =  $040^{\circ}(T)$ , speed = 32 knots. Target bears  $020^{\circ}(T)$ , 19,000 yards, at 2224. Target's course and speed =  $120^{\circ}(T)$ , 18 knots. Execute collision course at 2227. Fire as soon as target is within range of high speed torpedo (46 knots, run of 6,000 yards).

Problem 2. Own ship's speed = 16 knots. Target's course and speed =  $060^{\circ}(T)$ , 10 knots. Target will bear  $210^{\circ}(T)$ , 16,200 yards, at 0645, when own ship will execute approach course. We want to fire on a target angle of  $300^{\circ}(T)$ , with intermediate speed torpedo (33 knots, range of 9200 yards), near limit of torpedo range. Find: Approach course for own ship, time of firing, torpedo course, expected time of hitting.

Problem 3. Own ship's speed = 30 knots. Target's course and speed =  $270^{\circ}(T)$ , 30 knots. Target will bear  $110^{\circ}(T)$ , 20,000 yards, at 0210. Own ship will go on a collision course at 0210, until a course of  $090^{\circ}(T)$  will put own ship bearing  $330^{\circ}(T)$ , 5,000 yards, from target, the firing point. Find: Collision course, time of executing course of  $090^{\circ}(T)$ , time of firing, torpedo course using high speed torpedo (46 knots).

Problem 4. Own ship's speed = 25 knots. Target's course and speed =  $010$ , 20 knots. Target will bear  $140^{\circ}(T)$ , 18,600 yards, at 0415, when own ship will execute approach course. Own ship will fire when target angle is  $310^{\circ}$ , range to target = 5,000 yards, using high speed torpedo (46 knots, range at 6,000 yards). Limits of the tube train:  $260^{\circ}$  and  $280^{\circ}(R)$ . No gyro angle for torpedoes, (i.e. firing course must be nearly at right angles to torpedo course). Own ship must be on firing course 2 minutes before firing. Find: Approach course, firing course, time of executing firing course, time of firing, torpedo course, time of hitting.

#### 5147. Approach, BTC, Retirement Courses and "Cross The T" Course

Start near bottom in the middle of your plotting sheet. Scale 2000 yds/in. DR own task force on C000 S15.

1700	few strangers	098	21500
01	098	21200	The raid has been designated Raid "Easy".
02	099	20900	
03	099	20600	Raid "Easy" consists of 3CA and 4 DD
04	099	20300	
05	100	20000	Should have a good course and speed on target



Figure on the maneuvering board your course to cross the target's T at 12000 yards using a speed of 25kt. Turn to that course at time 1705/ (030)

06	101	19400
07	102 $\frac{1}{2}$	18700

Find an approach course for the DD's in your formation to get to 60° 5000 yards on the target's bow using 30kts. Draw in that course line lightly. (C097)

08	104 $\frac{1}{2}$	18100	FR 144	1000
09	106	17500		
10	108	16800	FR 145	3000
11	110	16300		
12	112	15700	FR 145	5200
13	114	15100		
14	116	14700	FR 145	7200
15	119	14100		
16	122	13700	FR 145 $\frac{1}{2}$	9200
17	125	13200		

At time 17 find the BTC for your friendly DD's to fire 45kt torpedoes. (BTC 064) Find the retirement course they should take to 15000 yards in minimum time using 30kt. (C203) Draw that retirement course in lightly.

18	128	12800	FR 154	11300
19	131	12500	FR	
20	135	12000	FR 166	13800
21	138	12000		
22	142	11800	FR 174	16800

At time 22 all enemy ships are disposed of. The friendly DD's (what's left of them) will rendezvous at a point "X ray" which now bears 296 22000 from the DD and 249 19500 from the heavy units of your task force. What speed must the DD's make to reach point "X ray" simultaneously if the heavy units travel at 25kt? (S 28.2) Time of rendezvous? (1745.6)

#### 5148. Approach, BTC, Retirement Courses.

Start below and to the left of the center of your plotting sheet. Scale 2000 yds/in. DR your own ship, a DD, on C 027 S 20 for 6 or 8 minutes.

00	Screen clear		
01	Few strangers 006 15900		
02	007 $\frac{1}{2}$	15200	The raid has been designated Raid "Able"
03	009	14700	Lookout reports raid consists of 2 CL's
04	010 $\frac{1}{2}$	14100	
05	012	13500	
06	014	13000	

At time 06 you are ordered to make an approach using 30kts to 60° 5000 yds on Raid "Able's" bow. Determine your approach course and DR your ship for 12 minutes on that course. (C 065)

07	013 $\frac{1}{2}$	12400	The lookout reports that the enemy has O. F.
08	012 $\frac{1}{2}$	11900	
09	011 $\frac{1}{2}$	11400	
10	010 $\frac{1}{2}$	10900	Lookout reports an enemy change of course
11	011	10000	Own main battery opens fire
12	011	9000	
13	011	8100	Lookout reports one enemy CL burning
14	011	7200	
15	011 $\frac{1}{2}$	6250	Lookout reports one enemy CL sunk
16	012	5350	You are hit by enemy gunfire

Fire 45 kt torpedoes. Find the BTC. (BTC 046) Find the retirement course to 20000 yards using speed 30. DR own ship on retirement course for 5 min. (C 270)

17	030 $\frac{1}{2}$	5500	Time to expect torpedo hits (19.3)
18	047	6200	
19	060	7400	
20	Screen clear		

Raid "Able"

00-10 C 094 S 18  
10-20 C 123 S 27

5149. Torpedo Approach, Base Torpedo, and Retirement Courses Using The Relative Plot Method.

1. Target course and speed has been determined from the DRT as C060 S20. Ranges and bearings on the target develop as follows:

30	020	9700
31	013	9300
32	006	9000

At time 32 find course to approach to 5000 yds 60° on the target's nearest bow using 30kt. (C053)

33	003	8300
34	359	7700
35	356	7200

From your torpedo effective range device you find you are now in intermediate speed range (torpedo speed 33kt). What BTC would you fire on to secure hits? (BTC 028)

36	351 $\frac{1}{2}$	6800
37	347	6200
38	342	6000
39	336 $\frac{1}{2}$	5500

From the effective range device you are still in intermediate torpedo speed range. What BTC should you use to secure hits?  
(BTC 013-014)

40	328	5250
41	322	5200
42	315	5000
43	308	5000

You are now within high speed torpedo range (45kt). What BTC should be used? (BTC 332-333)

What course to retire in minimum time to 9000 yards using 30kt?  
(C 164-165)

2. Target course and speed from the DRT is C300 S 24.

00	209	18000
01	206	17200
02	202	16500

Find approach course to 5000 yds 50° on target's bow using a speed of 30kt. (C268)

03	201½	15800
04	201	15100
05	200½	14500
06	200	13700

From the torpedo effective range device you have come into low speed torpedo range (torpedo speed). Find the BTC if you were hit by enemy gunfire to get rid of them. (BTC 261)

07	199	13000
08	198	12300
09	197½	11500
10	197	11000
11	196	10200

You are now in intermediate speed range. BTC if torpedoes were fired now? (BTC 240)

12	194½	9400
13	193	8600
14	192	7800
15	190	7200

What BTC would you fire intermediate speed torpedoes? (33kt) (BTC 233)

16	187	6500
17	185	5700
18	180	5000

Fire high speed torpedoes now that you have reached the desired firing point. BTC? (BTC 208)

What course to retire in minimum time to 15000 yards using 30kt? (C076)

3. Target course and speed as determined from the DRT is C140 S18.

20	355	18200
21	000	18000
22	005	17800

What course would you take to approach to 5000 yds 60° on the target's bow using 30kt? (C022)

23	006	16600
24	006	15200
25	007	14000

From the torpedo effective range device you are now in low speed torpedo range (torpedo speed 27kt). What BTC should you fire your torpedoes on? (BTC 036)

26	007	12700
27	008	11400
28	009	10300

You have now come into intermediate speed range (33kt). What BTC to fire torpedoes? (BTC 033)

29	012	9100
30	013	7600

You are still in intermediate speed range, what BTC would you fire on now? (BTC 038) Assuming that you will be in high speed range (45kt) at time 32, what will the BTC be at that time? (BTC 040)

31	016	6200
32	020	5000

Figure a BTC from this 32 position. Does it check with the one obtained by DR-ing your position ahead? What is the retirement course to open the range to 20000 yards in minimum time using 30kt? (C281)

#### 5200. CIC DRILL PROBLEMS.

5201. The object of the following problem is to:

- (1) Exercise personnel in plotting radar contacts.
- (2) Exercise personnel in proper sound powered procedure.
- (3) To give CIC simple problems to solve on a maneuvering board.
- (4) To train CIC personnel to coordinate lookout reports with radar reports.

#### 5210. Drill Problem No. 1.

- (1) The tactical situation: You are approaching Casablanca. Friendly contacts are expected. Visibility ten miles. The following sound powered phone circuits are manned: Evaluator's circuits, Surface search radar circuit, Lookout circuit. Own ship's course 090, speed 30 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure A.

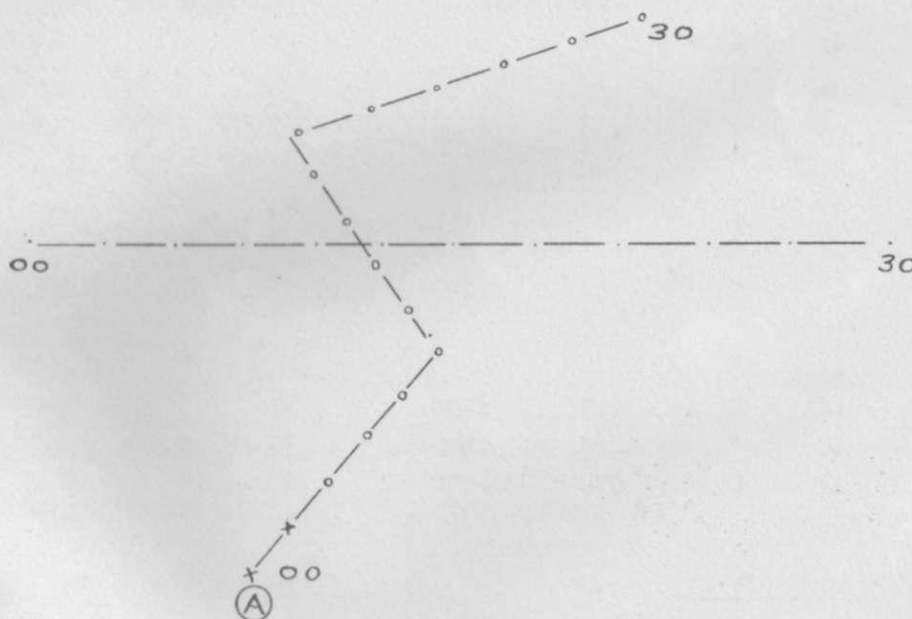


Figure A



PROBLEM NO. 1.

## Evaluator's Circuit:

01 Conn- Combat: Raid "A" bearing 154 range 11.800  
 02² Conn- Combat: Ship reported by lookouts is Raid "A" bearing 154 range 10200  
 04 Conn- Combat: Raid "A" identified by lookouts as USS BROOKLYN is on collision course 042 speed 30  
 12 Conn- Combat: USS BROOKLYN is changing course to port, will pass well astern of us  
 13 Conn- Combat: USS BROOKLYN on course 33⁴ speed 30  
 19 Conn- Combat: USS BROOKLYN is changing course to starboard.  
 21 Conn- Combat: USS BROOKLYN on course 070 speed 30

## Lookout Circuit:

02 Conn- Surface lookout forward: Ship on horizon at relative bearing 062  
 03 Conn- Surface lookout forward: Ship relative bearing 060 is USS BROOKLYN  
 18 Conn- Surface lookout aft: USS BROOKLYN disappearing relative bearing 206

## Surface Search Radar Circuit:

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
00	A	154	11800	15	A	284	4100
01	"	154	11000	16	"	290	5700
02	"	154	10200	17	"	292	7400
03	"	153	9350	18	"	294	9100
04	"	153	8600	19	"	295	10100
05	"	153	7700	20	"	297	10300
06 ¹	"	152	6600	21	"	298	10500
07	"	152	6100	22	"	300	10700
08	"	151	5300	23	"	301	11000
09	"	151	4500	24	"	302	11200
10	"	150	3800	25	"	304	11450
11	"	147	2900	26 ²	"	305	11800
12	"	149	1600	27	"	306	11900
13 ²	"	256	1800	28	"	307	12200
14	"	273	2500	29	"	308	12500
				30	"	309	12800

PROBLEM NO. 2.

## The Tactical Situation:

You are a single ship operating in Chesapeake Bay. It is important to keep a careful track of any other ship picked up by radar. The visibility is now 6 miles, but we are expecting fog to set in. There are two cruisers reported to be making firing runs in this general area. The following sound powered phone circuits are manned: Evaluator's circuit, Surface search radar circuit, Lookout circuit. Own ship's course 065, speed 20 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure B.

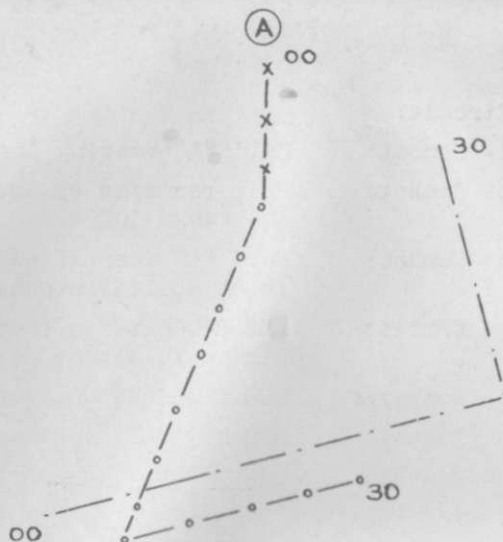


Figure B

Evaluator's Circuit:

01	Conn- Combat:	Raid "A" true bearing 027 range 16500
04	Conn- Combat:	Raid "A" course 180 speed 30
05	Conn- Combat:	Smoke on horizon reported by lookouts is evidently Raid "A"
06	Conn- Combat:	Lookouts have sighted Raid "A"
06 ¹	Conn- Combat:	Raid "A" has changed course to the right to 210 speed still 30
07	Conn- Combat:	Lookouts have identified Raid "A" as the Mobile.
15	Combat- Conn:	Range and bearing on the "Mobile"?
15 ¹	Combat- Conn:	Mobile true bearing 248 range 7500
22	Conn- Combat:	Mobile has changed course to the left to 060 speed still 30
26	Conn- Combat:	Ship sighted by lookouts is the Mobile, true bearing 219, range 11800
30		END OF PROBLEM.

Lookout Circuit:

04	Conn- Surface lookout forward:	Reports smoke on horizon relative bearing 323
05	Conn- Surface lookout forward:	Ship on horizon now at relative bearing 320
06	Conn- Surface lookout forward:	Ship on relative bearing 316 is USS Cruiser Mobile.
18	Conn- Surface lookout aft:	Reports losing USS Cruiser Mobile at relative bearing 168
19	Conn- Surface lookout aft:	Lost sight of cruiser on relative bearing 165
25	Conn- Surface lookout aft:	Reports ship on relative bearing 131 hull down
26	Conn- Surface lookout aft:	Reports ship on relative bearing 137 is USS Cruiser Mobile

PROBLEM NO. 2 (cont).

Surface Search Radar Circuit:

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
00	A	027	16500	16	A	244	9000
01	"	027	15100	17	"	241	10500
02 ²	"	027	13000	18 ²	"	238	12800
03	"	027	12200	19	"	237	13600
04	"	027	10750	20	"	236	14700
05	"	028	9500	21	"	233	14200
06	"	023	8000	22	"	231	13550
07	"	018	6550	23	"	227	12900
08	"	010	5200	24	"	223	12300
09 ¹	"	350	3800	25	"	219	11800
10	"	334	3200	26 ²	"	212	11100
11	"	305	3050	27	"	210	10950
12	"	279	3650	28	"	205	10650
13	"	264	4750	29	"	200	10400
14	"	254	6100	30	"	194	10300
15	"	248	7500				

PROBLEM NO. 3.

### The Tactical Situation:

You Have just left Norfolk. Friendly contacts are expected. The visibility is four miles. The following sound powered phone circuits are manned: Evaluator's circuit, Lookout circuit, Surface search radar circuit. Own ship's course 040 speed 20 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure C.

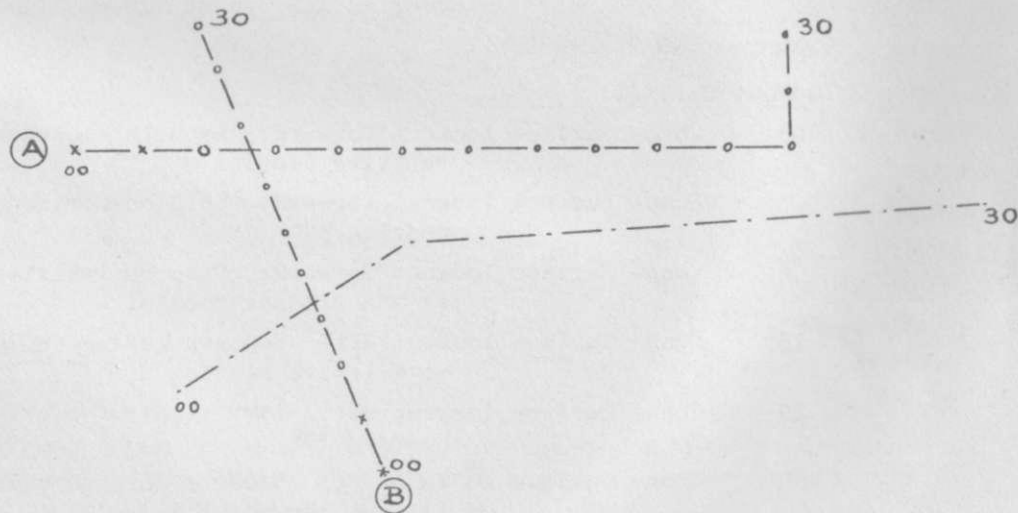


Figure C

PROBLEM NO. 3 (cont).

## Evaluator's Circuit:

00² Conn- Combat: Raid "A" at true bearing 311 range 10500  
 02² Conn- Combat: Ship reported by lookouts is Raid "A"  
 03 Conn- Combat: Raid "B" at true bearing 120 range 4750  
 04² Conn- Combat: Raid "A" identified by lookouts as USS TERROR is on course 340 speed 15. She will pass astern of us.  
 07 Conn- Combat: Raid "B" on collision course 090 30 knots.  
 08² Conn- Combat: Cruiser reported by lookouts is Raid "B". We do not have the sailboat by radar.  
 10² Conn- Combat: Raid "B" identified by lookouts as USS MOBILE is still on collision course. We will collide in four minutes if we don't change our course.  
 11 Combat- Conn: Coming right to 085  
 12 Combat- Conn: Steady on 085  
 14 Conn- Combat: On present course the Mobile should pass clear of us by one half a mile.  
 22 Conn- Combat: Mobile appears to be changing course to port  
 24 Conn- Combat: Mobile is on course 000 speed 30

## Lookout Circuit:

02 Conn- Surface lookouts forward: Ship on relative bearing 075  
 04 Conn- Surface lookouts forward: Ship on relative bearing 084 is USS TERROR  
 07 Conn- Surface lookouts forward: Sailboat 180 R  
 08 Conn- Surface lookouts forward: American cruiser bearing 265  
 10 Conn- Surface lookouts forward: Ship on relative bearing 270 is USS MOBILE  
 15 Conn- Surface lookouts aft: Have lost sight of USS TERROR  
 26 Conn- Surface lookouts aft: Have lost sight of USS MOBILE

## Surface Search Radar Circuit:

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
00	A	311	10500	07 ²	B	157	2550
01	A	312	9850	08 ¹	A	312	4550
02	A	312	9100	08 ²	B	174	2350
02 ²	B	120	4750	09	A	312	4250
03	A	312	8200	09 ²	B	191	2400
03 ²	B	125	4200	10 ¹	A	315	3350
04	A	312	7750	10 ²	B	204	2400
04 ²	B	131	3700	11	A	315	2900
05 ¹	A	312	7050	11	B ²	217	2750
05 ²	B	138	3250	12	A	313	2200
06	A	312	6350	12	B	225	3300
06 ²	B	148	3000	13	A	319	1850
07	A	313	5600	13 ²	B	240	3700



PROBLEM NO. 3 (cont).

## Surface Search Radar Circuit (cont):

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
14	A	325	1600	22	B ²	280	10950
14 ²	B	249	4350	23	A	352	2800
15	A	335	1400	23	B ²	281	11900
15 ²	B	257	5000	24	A	343	3700
16	A	349	1200	24	B ²	282	12700
16 ²	B	263	5700	25	A	340	4800
17	A	002	1150	25	B ²	284	13600
17 ³	B	270	7000	26	A	337	6000
18	A	021	1150	26	B ²	284	14500
18 ²	B	271	7400	27	A	336	7100
19	A	034	1300	27	B ²	285	15400
19 ²	B	274	8200	28	A	334	8250
20	A	046	1400	28	B ²	286	16300
20 ³	B ²	277	9450	29	A	334	9450
21	A	037	1500	29	B ²	286	17300
21	B ²	278	10000	30	A	332	10500
22	A	007	1800	30	B ²	287	18100

PROBLEM NO. 4.

## The Tactical Situation:

You are approaching Bermuda. It is a brilliant night. The visibility is 3 miles. Moon is at 100 true. The following sound powered phone circuits are manned: Evaluator's circuit, Surface search radar circuit, Lookout circuit. Own ship's course 090 speed 30 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure D.

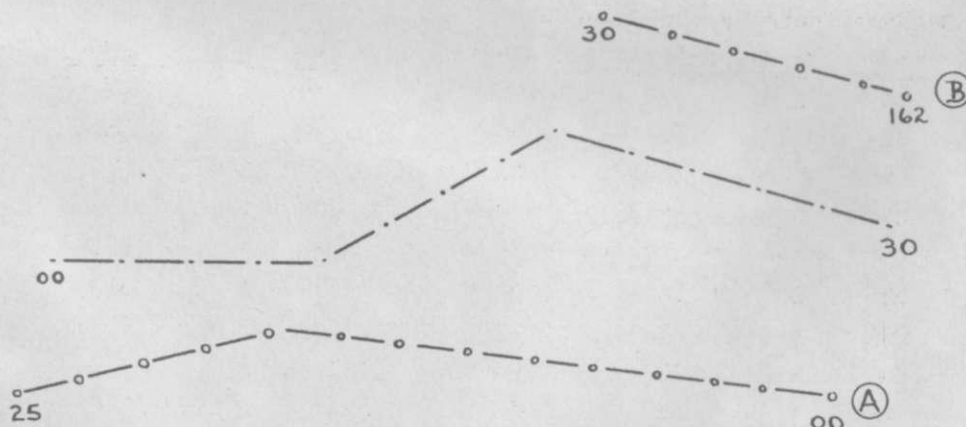


Figure D

PROBLEM NO. 4 (cont).

## Evaluator's Circuit:

01² Conn- Combat: Raid "A" at true bearing 102 range 23200 closing fast

04 Conn- Combat: Raid "A" on course 280 speed 30 should pass one mile off our starboard beam in ten minutes.

06² Conn- Combat: Ship sighted by lookouts is Raid "A"

09 Combat- Conn: Coming left to 060

10 Combat- Conn: Steady on course 060

12 Conn- Combat: Raid "A" identified by lookouts as USS PORTER

17 Conn- Combat: Raid "B" at true bearing 076 range 13600

17² Conn- Combat: USS PORTER is changing course to port

18² Conn- Combat: Raid "B" is on collision course 290 speed 15. The USS PORTER is on course 254 speed 30

19 Combat- Conn: Coming right to 110

20 Combat- Conn: Steady on course 110

22² Conn- Combat: Ship just reported by lookouts is Raid "B"

24² Conn- Combat: Raid "B" identified by lookouts as merchant ship

## Lookout Circuit:

06 Conn- Surface lookouts forward: Ship in path of moon about 6 miles

11 Conn- Surface lookouts forward: Ship now at relative bearing 080 is USS PORTER

22 Conn- Surface lookouts forward: Ship on relative bearing 040 about 3 miles

24² Conn- Surface lookouts forward: Ship on port beam is a merchant ship

## Surface Search Radar Circuit:

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
01	A	102	23200	15	A	226	6200
02	"	103	21000	16	"	232	7800
03	"	103	19200	16 ²	B	078	13100
04	"	104	17200	17	A	236	9700
05	"	105	15000	17 ²	B	078	11800
06	"	106	13500	18	A	239	11700
07	"	108	11400	18 ²	B	077	10900
08	"	111	9500	19	A	239	13600
09	"	116	7200	19 ²	B	076	9000
10	"	121	5800	20	A	240	15800
11	"	137	4600	20 ²	B	073	7800
12	"	161	3900	21 ¹	A	243	17600
13	"	189	3900	21 ²	B	064	6600
14	"	212	4900	22	A	246	19000

PROBLEM NO. 4 (cont).Surface Search Radar Circuit (cont).

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
22 ²	B	054	5800	25	A	252	24300
23	A	249	20800	25 ²	B	004	5100
23 ²	B	037	5000	26 ²	B	349	5600
24	A	251	22400	27 ²	B	348	6400
24 ²	B	022	4800	28 ²	B	332	7200
				29 ²	B	323	8700

PROBLEM NO. 5.

The tactical situation:

You are leaving Charleston. The day is overcast, visibility five miles. Squall forming in the northwest. The following sound powered phone circuits are manned: Evaluator's circuit, Lookout circuit, Surface search radar circuit. Own ship's course 045 speed 30 knots. Suggested plotting scale 2000 yards = 1 inch. This problem will develop as illustrated in Figure E.

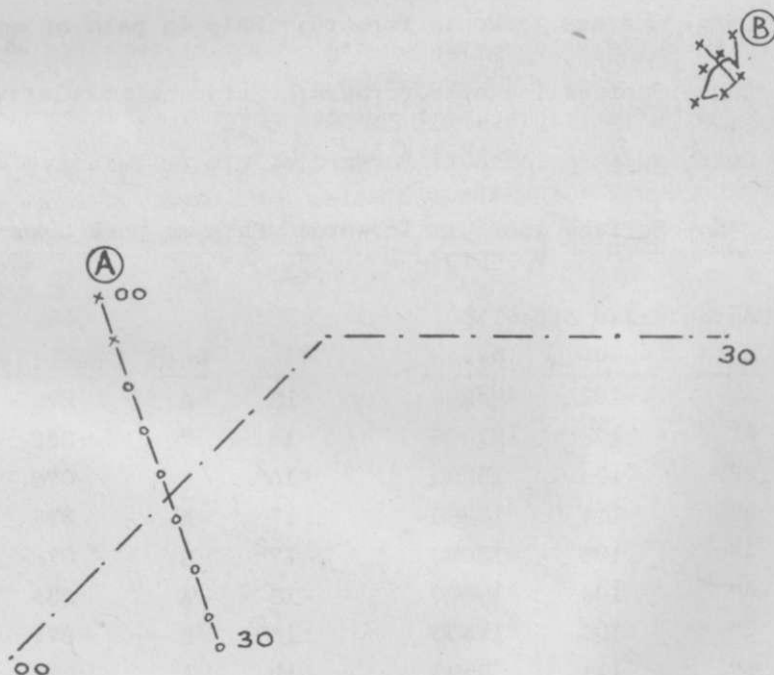


Figure E

PROBLEM NO. 5 (cont).

## Evaluator's Circuit:

00² Conn- Combat: Raid "A" at true bearing 020 range 16550  
 04 Conn- Combat: Raid "A" course 165 speed 30  
 04² Conn- Combat: Ship just reported by lookouts is Raid "A".  
 06² Conn- Combat: Raid "A" identified by lookouts as LCI will  
 pass 1000 yards astern of us  
 09 Conn- Combat: Raid "B" at true bearing 045 range 21900  
 13 Conn- Combat: Raid "B" on collision course 225 speed 10  
 14³ Conn- Combat: Raid "C" bearing 052 range 21650  
 15 Combat- Conn: Coming right 090  
 16 Combat- Conn: Steady on course 090  
 17² Conn- Combat: Ship just reported by lookouts is Raid "B"  
 19 Conn- Combat: Raid "C" shows a very erratic plot and appears  
 to be ionized clouds.  
 20² Conn- Combat: Raid "B" identified by lookouts as tanker

## Lookout Circuit.

04 Conn- Surface lookouts forward: Ship at relative bearing 330  
 about 5 miles  
 06 Conn- Surface lookouts forward: Ship at relative bearing 325 is  
 an LCI  
 17 Conn- Surface lookouts forward: Ship at relative bearing 310  
 about 5 miles  
 18 Conn- Surface lookouts forward: Ship at relative bearing 295 is  
 a tanker

## Surface Search Radar Circuit:

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
00	A	020	16550	13	A	210	2400
01	A	020	15150	13 ²	B	045	15300
02	A	020	13700	14	A	207	3800
03	A	019	12200	14 ¹	B	045	13900
04	A	018	10850	14 ²	C	052	21650
05	A	019	9400	15	A	205	5300
06	A	018	7900	15 ¹	B	046	12700
07	A	017	6600	15 ²	C	055	20450
08	A	016	5050	16	A	204	6700
08 ²	B	046	21900	16 ¹	B	045	11300
09	A	015	3500	16 ²	C	052	18700
09 ²	B	045	20600	17	A	208	7700
10	A	010	2200	17 ¹	B	041	10300
10 ²	B	045	19400	17 ²	C	055	17900
11	A	349	700	18	A	212	8800
11 ²	B	046	17950	18 ¹	B	036	9350
12	A	225	1050	18 ²	C	047	17700
12 ²	B	043	16600	19	A	215	9550



## PROBLEM NO. 5 (cont).

## Surface Search Radar Circuit (cont).

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
19 ¹	B	032	8450	25	A	220	15650
19 ²	C	047	15550	25 ²	B	334	6650
20	A	216	10550	26	A	222	16650
20 ¹	B	023	7600	26 ²	B	323	7100
21	A	217	11500	27	A	221	17500
21 ²	B	015	7050	27 ²	B	314	7750
22	A	219	12500	28	A	224	18800
22 ²	B	008	6600	28 ²	B	309	8500
23	A	219	13550	29	A	223	19750
23 ²	B	354	6400	29 ²	B	302	9300
24	A	220	14600	30	A	224	20800
24 ²	B	345	6400	30 ²	B	297	10300

## PROBLEM NO. 6.

## The Tactical Situation:

You are a single destroyer operating in Solomon Islands area. The visibility is 6 miles. You are about 12 miles West of Shortland Island. The following sound powered phone circuits are manned: Evaluator's circuit, and Surface search radar circuit. Own ship's course 060, speed 30 knots. Suggested plotting scale 2000 yards = 1 inch. This problem will develop as illustrated in Figure F.

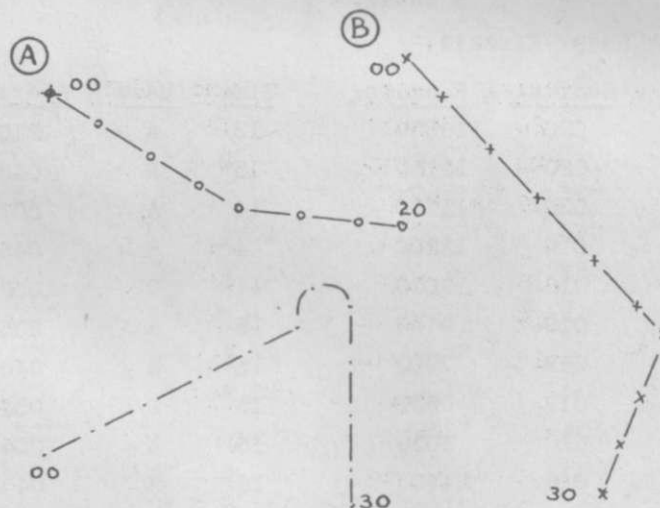


Figure F

## Evaluator's Circuit:

- 06 Conn- Surface lookouts forward: Ship on horizon at relative bearing 300
- 08 Conn- Surface lookouts forward: Ship at relative bearing 300 is USS JOHN PAUL JONES.
- 09 Conn- Control: Director of Raid "B" true bearing range 045 at range 16650
- 12 Conn- Surface: lookouts forward: Ship on horizon at relative bearing 000

PROBLEM NO. 6. (cont).

Evaluator's Circuit: (cont).

13 Conn- Surface lookouts forward: Jap destroyer at relative bearing  
000 has opened fire on the JOHN PAUL JONES

14 Control- Conn: Commence firing target "B"

15 Combat- Conn: Coming left to 000

16 Combat- Conn: Steady on 000

16² Combat- Conn: Coming to 090

17 Combat- Conn: Steady on 090

18 Combat- Conn: Coming to 173

19 Combat- Conn: Steady on 173

26 Conn- Surface lookouts forward: Two direct hits on Jap destroyer

30 Conn- Surface lookouts forward: Jap destroyer sinking fast

Surface Search Radar Circuit:

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
00	A	359	18500	13 ²	B	068	11700
01	"	359	17400	14	A	355	4700
02	A	358	16400	14 ²	B	073	11300
02 ²	Land from 070 to true bearing 130			15	A	356	3900
approximate range 24,000							
03	A	358	15350	15 ²	B	079	10750
03 ²	B	037	20700	16	A	353	3150
04	A	359	13300	16 ²	B	086	10400
04 ²	B	039	19600	17	A	019	1900
05	A	359	13200	17 ²	B	095	11100
05 ²	B	040	18600	18	A	045	1100
06	A	356	12400	18 ²	B	103	11200
06 ²	B	043	17600	19	A	040	1500
07	A	356	11300	19 ²	B	103	11150
07 ²	B	045	16650	20	A	043	2400
08	A	357	10250	20 ²	B	103	10600
08 ²	B	049	15700	21	"	105	10000
09	A	356	9200	22	"	105	9300
09 ²	B	051	14800	23	"	105	8900
10	A	355	8200	24	"	106	8400
10 ²	B	053	13900	25	"	107	7800
11	A	355	7150	26	"	107	7300
11 ²	B	059	13100	27	"	109	6800
12	A	353	6250	28	"	100	6450
12 ²	B	062	12400	29	"	090	6500
				30	"	080	6400

PROBLEM NO. 7.

## The Tactical Situation:

In this problem your own ship is the guide. You have in company, a DE who is not radar equipped. Your captain desires to maneuver the DE to various stations. Your captain will call on you for courses and speeds that he will use to signal to the DE in order that that ship may take the various stations. The following sound powered phone circuits are manned: Evaluator's circuit, and Surface search radar circuit. Own ship's course 090, speed 15 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure G.

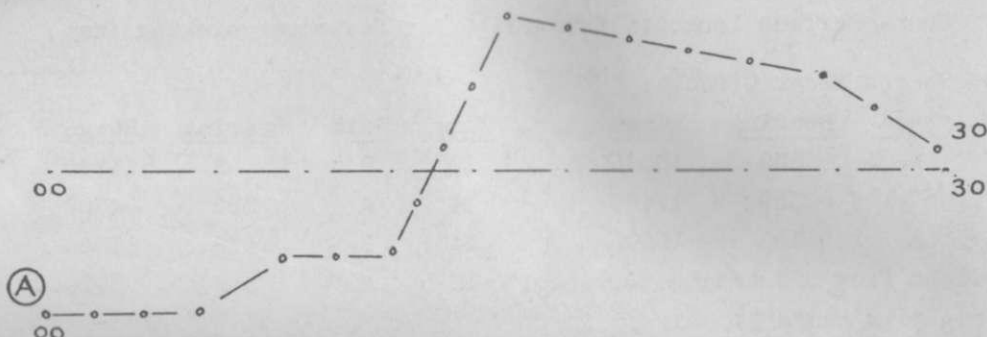


Figure G

## Evaluator's Circuit:

- 00 Combat- Conn: What is the necessary course and speed for the DE to take station one mile on my starboard quarter, using 5 minutes to complete the maneuver?
- 04 * Conn- Combat: Course for DE is 062, speed  $7\frac{1}{2}$  knots.
- 05 Combat- Conn: What is the necessary course and speed for the DE to take station one mile on our port quarter, using 4 minutes to complete maneuver?
- 11 * Conn- Combat: Course for DE is 035, speed 26 knots.
- 16 Combat- Conn: What is the necessary course and speed for DE to take station two miles on my port quarter, completing maneuver 6 minutes from now?
- 16 * Conn- Combat: Course for DE is 038, speed  $10\frac{1}{2}$  knots.
- 17 Combat- Conn: When DE gets on station two miles on my port quarter; what will be the necessary course for her to take station one mile on my port beam, using maximum speed,  $32\frac{1}{2}$  knots?
- 20 * Conn- Combat: Course for DE is 098

* These are the reports that Conn should expect from Combat.

PROBLEM NO. 7. (cont).

## Evaluator's Circuit: (cont).

21 Combat- Conn: When DE arrives on station, what course should she steer to come alongside and deliver mail, using a speed of 21 knots?

23 * Conn- Combat: Course for DE to come alongside, 135

30 END OF PROBLEM

* These are the reports that Conn should expect from Combat.

## Surface Search Radar Circuit:

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
00	A	180	2000	15	A	297	1500
01	"	180	2100	16	"	315	2000
02	"	181	2000	17	"	315	2400
03	"	180	2100	18	"	316	2750
04	"	180	2000	19	"	315	3200
05	"	189	1850	20	"	315	3600
06	"	199	1850	21	"	316	4000
07	"	208	1850	22	"	320	3600
08	"	218	1800	23	"	326	3050
09	"	225	2000	24	"	333	2600
10	"	226	2000	25	"	345	2400
11	"	225	2000	26	"	000	2000
12	"	225	2000	27	"	000	1500
13	"	244	1550	28	"	000	1000
14	"	271	1400	29	"	000	500
				30	"	Within minimum range	

PROBLEM NO. 8.

## The Tactical Situation:

You are on patrol in Caroline Islands area; time, midnight; visibility 300 yards. The sound powered phone circuits to be manned are: Evaluator's circuit and Surface search radar circuit. Own ship's course 090, speed 30. Suggested plotting scale, 2000 yards = 1 inch. This problem will develop as illustrated in Figure H.

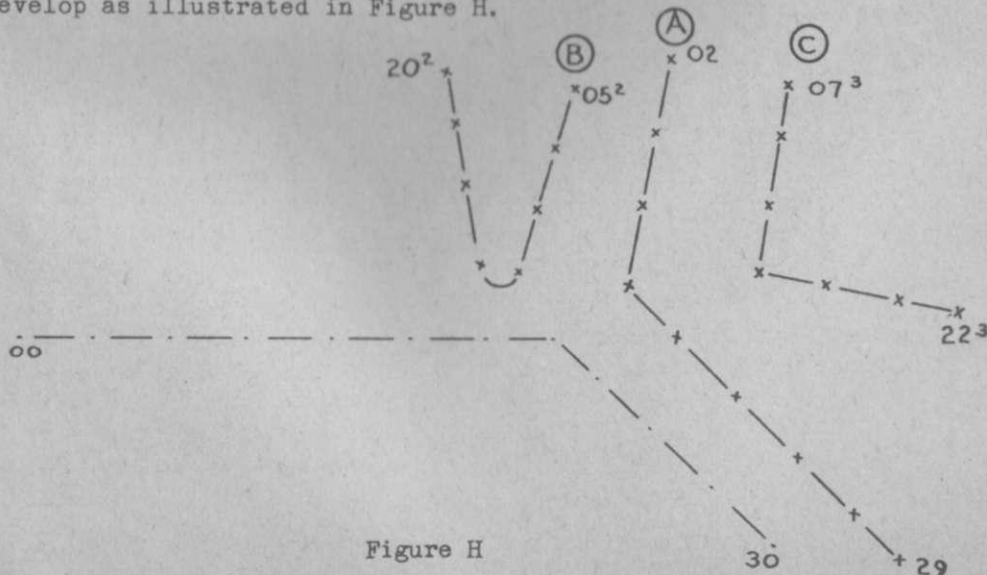


Figure H



## PROBLEM NO. 8. (cont).

## Evaluator's Circuit:

08 Conn- Control: Director on Raid "A" at true bearing 971 range 16,000.  
 10 Conn- Control: Ready to open fire Raid "A".  
 11 Control- Conn: Commence firing.  
 11 $\frac{1}{2}$  Conn- Surface lookouts forward: Explosions on ship at relative bearing 340.  
 13 Conn- Surface lookouts forward: Explosions on ship at relative bearing 000.  
 20 Combat- Conn: Coming right to 145.  
 21 Combat- Conn: Steady on 145.  
 24 Conn- Surface lookouts forward: Explosions on ship at relative bearing 350.

## Surface Search Radar Circuit:

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
02	A	064	25200	14 ³	C	094	12400
03	"	065	23700	15	A	098	9000
04	"	066	22100	15 ²	B	039	6050
05	"	067	20650	15 ³	C	095	12450
05 ²	B	063	18350	16	A	105	8600
06	A	068	19050	16 ²	B	024	6200
06 ²	B	063	16850	16 ³	C	095	12300
07	A	069	17600	17	A	110	8400
07 ²	B	065	15400	17 ²	B	010	6900
07 ³	C	077	19000	17 ³	C	096	12300
08	A	072	16200	18	A	116	8200
08 ²	B	066	13800	18 ²	B	000	7700
08 ³	C	078	17600	18 ³	C	097	12300
09	A	073	14600	19	A	123	8200
09 ²	B	064	12400	19 ²	B	351	8750
09 ³	C	082	16200	19 ³	C	098	12300
10	A	075	13400	20	A	130	8400
10 ²	B	071	10800	20 ²	B	345	9900
10 ³	C	085	14850	20 ³	C	099	12300
11	A	078	11750	21	A	136	8600
11 ²	B	073	9200	21 ³	C	100	12300
11 ³	C	088	13550	22 ¹	A	136	8600
12	A	083	10300	22 ³	C	096	12550
12 ²	B	076	7800	23 ¹	A	136	8600
12 ³	C	092	12300	24	A	136	8700
13	A	087	9800	25	A	136	8600
13 ²	B	067	8900	26	A	136	8600
13 ³	C	093	12300	27	A	136	8600
14	A	092	9400	28	A	136	8600
14 ²	B	054	6300	29	A	136	8700

PROBLEM NO. 9.

The Tactical Situation:

You are searching for a submarine reported to be in this region. It is night, no moon, visibility about 3 miles. The sound powered phone circuits to be manned are the Command circuit and Surface search radar circuits. Own ship's course 090, speed 15. Suggested plotting scales: 1000 yards = 1 inch, 200 yards = 1 inch. This problem will develop as illustrated in Figure I.

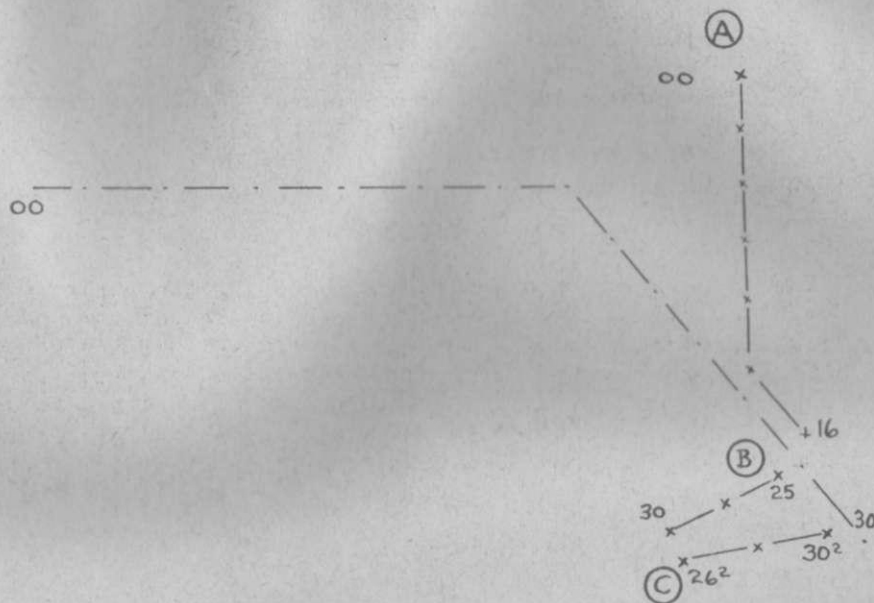


Figure I

Command Circuit:

- 06 Bridge- Surface lookouts forward: Surfaced submarine dead ahead  
3 1/2 miles
- 07 Bridge- Surface lookouts forward: Submarine is submerging
- 08 Combat- Conn: Coming right to 144.
- 09 Sound contact left cut on 113, right cut on 127, range 2100.
- 10 Sound contact left cut on 112, right cut on 129, range 1750.
- 11 Sound contact left cut on 118, right cut on 132, range 1500.
- 12 Sound contact left cut on 121, right cut on 137, range 1200.
- 13 Sound contact left cut on 126, right cut on 146, range 900.
- 14 Sound contact left cut on 123, right cut on 143, range 650.
- 15 Sound contact left cut on 120, right cut on 141, range 500.
- 16 Sound contact left cut on 112, right cut on 138, range 250.
- 18 Releasing depth charges.

## PROBLEM NO. 9 (cont.)

## Surface Search Radar Circuit (21JS):

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
04	A (Sm pip)	082	4350	26 ²	C	245	2200
05	A	086	3750	27	B	312	3600
06	"	092	3300	27 ²	C	258	2200
07	"	098	2800	28	B	312	4000
08	"	107	2400	28 ²	C	270	2250
24	New contact	316	2300	29	B	310	4500
25	B (Sm pip)	315	2600	29 ²	C	282	2400
25 ²	New contact	233	2250	30	B	310	4900
26	B	314	3100	30 ²	C	292	2700

## PROBLEM NO. 10.

## The Tactical Situation:

You are one of three destroyers escorting a carrier to New York from Norfolk. Due to engine breakdown you get behind and are now trying to find the carrier and resume station from the carrier at relative bearing 300° at 1400. The following sound powered phone circuits are manned: Captain's battle circuit, Surface search radar circuit, and Evaluator's circuit. Ship's course 090, speed 15 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure J.

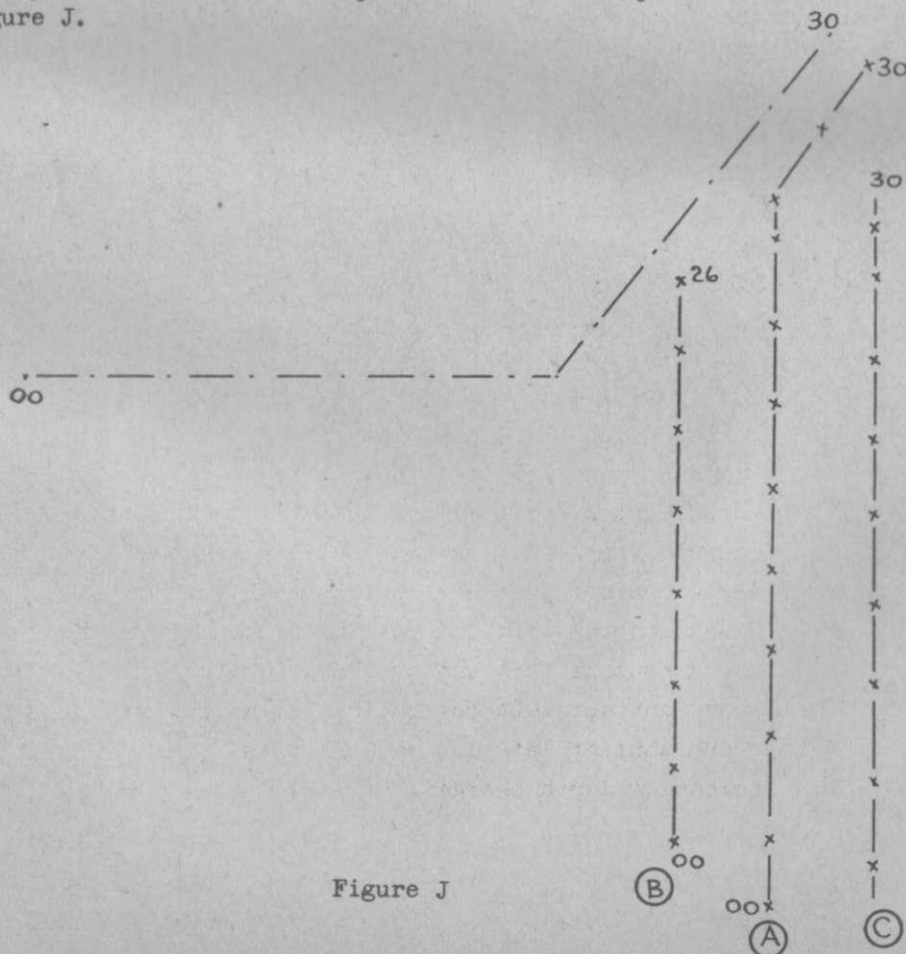


Figure J

## PROBLEM NO. 10. (cont.)

## Evaluator's Circuit:

04 Combat- Conn: Do you think Raid "A" is the carrier?  
 04² Conn- Combat: Affirmative  
 05 Combat- Conn: What course should I steer at 15 knots to take required station and how long will it take?  
 06 Conn- Combat: Suggest course 073. That would put us on station in 19 minutes.  
 12 Combat- Conn: What course should I steer now, at 15 knots, to take station and how long will it take?  
 13 Conn- Combat: Course 062 would put us on station in 13 minutes.  
 16 Combat- Conn: What course should I steer now to take station at 15 knots, and how long will it take?  
 16² Conn- Combat: Course 045 will put us on station in 11 minutes.  
 17 Combat- Conn: Coming left to 045, speed 15 knots.  
 18 Combat- Conn: Steady on course 045.  
 26 Conn- Surface lookouts forward: Destroyer 300 yards broad on starboard bow.

## Surface Search Radar Circuit (21JS):

Time	Raid	Bearing	Range	Time	Raid	Bearing	Range
00	A	123	15900	09 ²	B	119	9300
00 ²	B	122	14800	09 ³	C	114	10900
01	A	122	15300	10	A	118	9650
01 ²	B	122	14200	10 ²	B	118	8600
02	A	122	14700	10 ³	C	113	10300
02 ²	B	121	13600	11	A	118	9000
03	A	122	14050	11 ²	B	118	7850
03 ²	B	121	13000	11 ³	C	112	9800
04	A	122	13400	12	A	117	8500
04 ²	B	120	12400	12 ²	B	116	7400
04 ³	C	117	13850	12 ³	C	111	9000
05	A	121	12800	13	A	116	7800
05 ²	B	120	11800	13 ²	B	113	6700
05 ³	C	117	13350	13 ³	C	110	8400
06	A	121	12200	14	A	115	7100
06 ²	B	120	11200	14 ²	B	113	6050
06 ³	C	116	12850	14 ³	C	108	7800
07	A	120	11500	15	A	114	6500
07 ²	B	120	10500	15 ²	B	111	5400
07 ³	C	118	12100	15 ³	C	105	7200
08	A	120	10900	16	A	112	5850
08 ²	B	120	9900	16 ²	B	109	4800
08 ³	C	115	11500	16 ³	C	103	6600
09	A	119	10250	17	A	110	5200



PROBLEM NO. 10. (cont).Surface Search Radar Circuit (21JS) (cont).

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
17 ²	B	105	4200	23 ³	C	099	3700
17 ³	C	101	6000	24	A	117	2550
18	A	108	4650	24 ²	B	100	1400
18 ²	B	100	3600	24 ³	C	097	3300
18 ³	C	099	5450	25	A	120	2250
19	A	109	4300	25 ²	B	102	1200
19 ²	B	102	3250	25 ³	C	096	3000
19 ³	C	098	5100	26	A	124	1900
20	A	110	3950	26 ²	Lost surface "B"		
20 ²	B	100	2900	26 ³	C	096	2600
20 ³	C	097	4750	27	A	129	1600
21	A	112	3600	27 ²	C	094	2250
21 ²	B	101	2500	28	A	135	1300
21 ³	C	098	4400	28 ²	C	092	1900
22	A	112	3250	29	A	149	1050
22 ²	B	099	2150	29 ²	C	092	1500
22 ³	C	097	4050	30	A	165	900
23	A	115	2900	30 ²	B	067	900
23 ²	B	100	1800	30 ³	C	090	1200

PROBLEM NO. 11.The Tactical Situation:

You are a single ship operating in Chesapeake Bay, about to conduct a firing practice. There is a tug towing a target about two miles off your starboard bow. CIC must be prepared to give the captain the necessary courses and speeds for the tug to take various stations. A close search must be kept for any surface contacts which might foul the range. The sound powered phone circuits to be manned are the Evaluator's circuit, Lookout circuit and Surface search radar circuit. Own ship's course 090, speed 30. Suggested plotting scale: 1000 yards = 1 inch. This problem will develop as illustrated in Figure K.

## PROBLEM NO. 11 (cont).

## The Tactical Situation (cont).

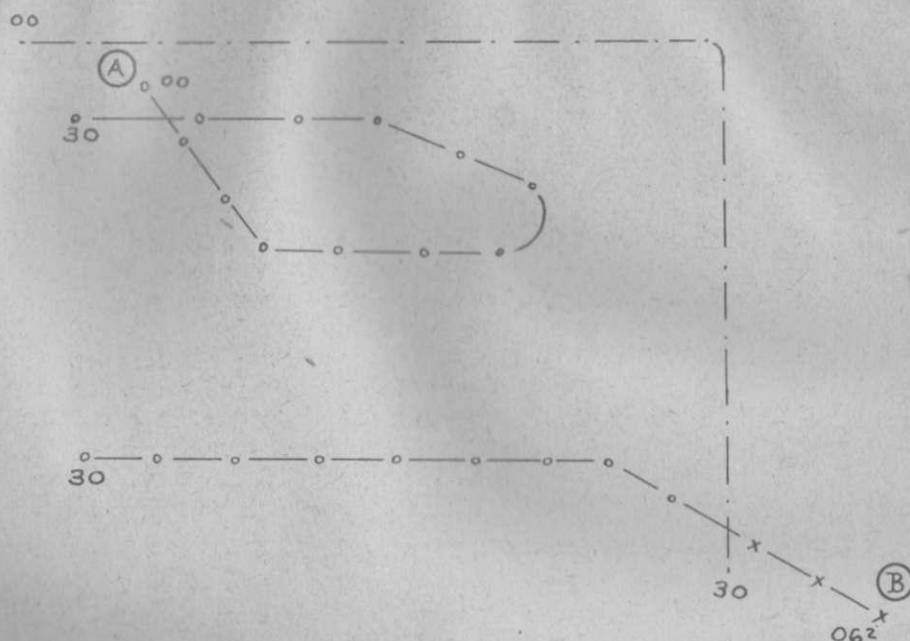


Figure K

## Evaluator's Circuit:

00	Combat- Conn:	What course should tug steer to take station 4 miles on our starboard beam at a speed of 30 knots, and how long will the maneuver take?
02	Conn- Combat:	Tug should steer 145, if she does she would be on station in 6 minutes
03	Conn- Combat:	Tug is on course 145, speed 30, she will be on station in 5 minutes
07	Conn- Combat:	Raid "B" true bearing 151 range 17500
10	Conn- Combat:	Raid "B" course 315, speed 20.
11	Combat- Conn:	Is the tug on station? (Answer affirmative)
14	Conn- Combat:	Lookouts have sighted Raid "B".
14 ¹	Combat- Conn:	Coming right to course 180.
14 ²	Conn- Combat:	Lookouts have identified Raid "B" as the Augusta.
15	Combat- Conn:	Steady on course 180.
15 ²	Combat- Conn:	What course should tug steer to take station 4 miles on the starboard beam of the Augusta?
16	Conn- Combat:	The Augusta has changed course to 270, speed 20.
17	Conn- Combat:	Tug is on correct course 290, speed 30. She will be on new station in 3 minutes.

PROBLEM NO. 11 (cont.)

## Evaluators's Circuit (cont).

- 21 Conn- Combat: Tug is now on station 4 miles on the starboard beam of the Augusta.
- 28 Combat- Conn: Range and bearing on the Augusta.
- 29 Conn- Combat: The Augusta at true bearing 273 range 13600.
- 30 End of Problem.

## Lookout Circuit:

- 00 Conn- Surface lookouts forward: Tug and target at relative bearing 025,  $1\frac{1}{2}$  miles.
- 13 Conn- Surface lookouts aft: Ship on horizon at relative bearing 090.
- 14 Conn- Surface lookouts aft: Ship on horizon at relative bearing 090 is the Augusta.
- 22 Conn- Surface lookouts aft: Have lost sight of tug and target at relative bearing  $110^{\circ}$ .
- 27 Conn- Surface lookouts forward: Have lost sight of Augusta at relative bearing  $085^{\circ}$ .

## Surface Search Radar Circuit (21JS):

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
00	A	110	3800	15 ³	B	202	13400
01	A	123	3800	16	A	218	6610
02	A	136	4050	16 ²	B	206	12800
03	A	148	4400	17	A	231	6390
04	A	156	5000	17 ³	B	212	12000
05	A	164	5675	18	A	247	6520
06	A	170	6400	18 ²	B	216	11500
06 ²	B	151	17500	19	A	260	7050
07	A	174	7175	19 ²	B	222	11300
07 ²	B	154	16400	20	A	270	7900
08	A	178	8000	20 ²	B	229	11000
08 ²	B	158	15300	21	A	279	8700
09	A	178	8000.	21 ²	B	235	10900
09 ²	B	163	14400	22	A	284	9570
10	A	180	8000	22 ²	B	242	10900
10 ²	B	169	13700	23	A	289	10500
11	A	180	8000	23 ²	B	247	11100
11 ²	B	175	12900	24	A	292	11440
12	A	180	8000	24 ²	B	253	11300
12 ²	B	182	12900	25	A	295	12490
13	A	180	7800	25 ²	B	259	11800
13 ²	B	190	13000	26	A	297	13600
14	A	189	7150	26 ²	B	264	12200
14 ²	B	196	13400	27	A	299	14600
15	A	205	7390	27 ²	B	266	12900

PROBLEM NO. 11 (cont).

## Surface Search Radar Circuit (21JS) (cont).

<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>	<u>Time</u>	<u>Raid</u>	<u>Bearing</u>	<u>Range</u>
28	A	302	15700	29 ²	B	278	14300
28 ²	B	273	13600	30	A	305	17900
29	A	304	16800				

PROBLEM NO. 12.

## The Tactical Situation:

We are convoy USF 10 making arrival at Gibraltar. In addition to ships present, an American destroyer, the USS FLUSSER has joined company with us. She has been assigned station 5000 yards of relative bearing 315° from us. The following sound powered phone circuits are manned: Evaluator's circuit, Surface search radar circuit, and TBS radio circuit. The TBS calls are: Rider = OTC; Spurs = Flusser. Own ship's course 090, speed 15 knots. Suggested plotting scale 1000 yards = 1 inch. This problem will develop as illustrated in Figure L.

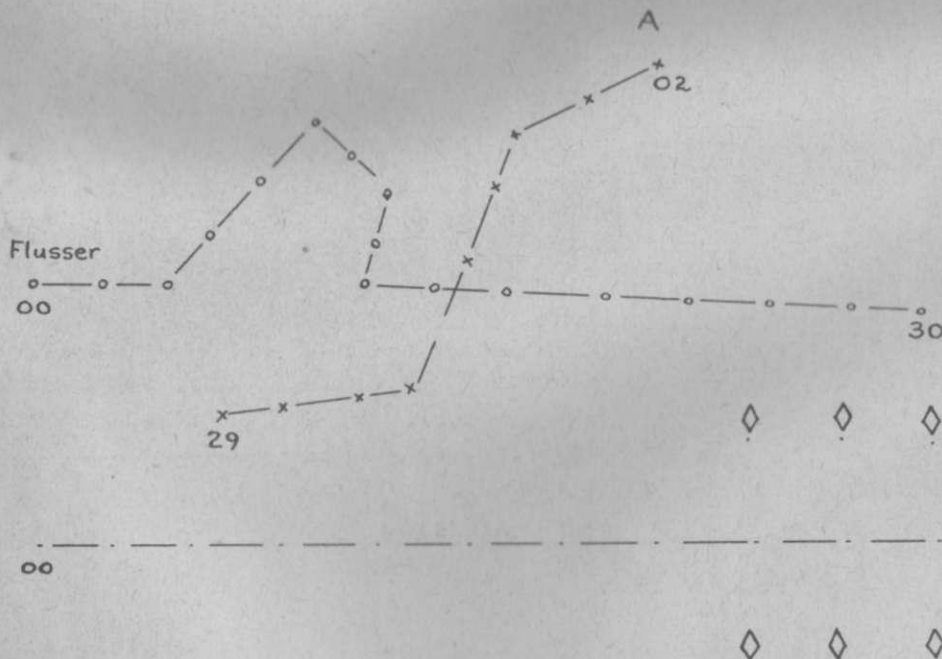


Figure L



PROBLEM NO. 12 (cont).

## Evaluator's Circuit:

01 Bridge- Surface lookout forward: Destroyer at relative bearing 315 is USS FLUSSER. Bridge Aye Aye

05 Bridge- Surface lookout forward: FLUSSER seems to be changing course away from us. Target angle 180. Bridge Aye Aye

16 Bridge- Surface lookout forward: FLUSSER appears to be stopped near Spanish gunboat. Bridge Aye Aye

18 Bridge- Surface lookout forward: Buoy relative bearing 345 Bridge Aye Aye.

19 Bridge- Surface lookout forward: Buoy relative bearing 015 Bridge Aye Aye.

21 Bridge- Surface lookout aft: FLUSSER and BRUNO underway. BLUSSER target angle 080. Bridge Aye Aye.

22 Bridge- Surface lookout aft: Bruno target angle 300

24 Bridge- Surface lookout forward: FLUSSER passing abeam to port, target angle 090

## TBS Radio Circuit:

<u>Time</u>	<u>Message</u>
00	"Hello, Spurs, this is Rider. How do you hear me? Over
00 ²	This is Spurs. I hear you loud and clear. Reporting for duty. Over.
01	This is Rider. Roger
02	Hello, Spurs, this is Rider. Take station 315 Relative, 5000 yards from fleet center. Over
02 ²	This is Spurs. Roger
04	Hello, Spurs, this is Rider. Veer out and investigate stranger bearing 041, 8 miles from me. Acknowledge. Over
04 ¹	This is Spurs. Wilco. Out
10	Hello, Rider, this is Spurs. Vessel is Spanish gunboat. Over
10 ¹	This is Rider. Roger
14	Hello, Rider, this is Spurs. Vessel identified as Spanish gunboat, Bruno, on neutrality patrol
14 ¹	This is Rider. Roger
15	Spurs, this is Rider. My compliments to Bruno and request her to stop or steer clear of me. Over
15 ¹	This is Spurs. Roger. Bruno is stopping. Out

## PROBELM NO. 12 (cont.)

## Surface Search Radar Circuit (21JS):

Time	Raid	Bearing	Range
00	Friend	046	5100
01	"	041	4750
02	"	037	4400
02 ²	New target	046	17500
03	Fluss	036	4400
03 ²	A	043	16100
04	Fluss	036	4400
04 ²	A	041	15100
05	Fluss	032	5100
05 ²	A	039	14800
06	Fluss	028	5900
06 ²	A	036	13300
07	Fluss	025	6600
07 ²	A	035	12300
08	Fluss	023	7400
08 ²	A	034	11400
09	Fluss	024	8000
09 ²	A	033	10500
10	Fluss	024	8700
10 ²	A	031	9600
11	Fluss	025	8500
11 ²	A	030	8700
12	Fluss	025	8100
12 ²	A	028	7800
13	Fluss	024	7300
13 ²	A	025	7000
14	Fluss	019	6450
14 ²	A	021	6050
15	Fluss	015	5700
15 ²	A	016	5350
16	Fluss	010	5050
16 ²	A	012	4800
17	Fluss	004	5000
17 ¹	New target	078	4600
17 ²	A	004	4600
18	Fluss	358	5000
18 ¹	Buoy	076	4200
18 ²	A	359	4700

Time	Raid	Bearing	Range
19	Small target	107	3600
19 ²	"	"	078 4800
20	"	"	103 4600
20 ²	PPI shows two columns of small targets ahead bearing 070 to 110		
21	Fluss	351	4900
21 ²	A	337	4650
22	Fluss	357	4700
22 ²	A	326	4650
23	Buoy	078	4600
23 ²	A	316	4900
24	Fluss	009	4450
24 ²	Buoy	105	3850
25	Fluss	016	4400
25 ²	A	298	6000
26	Fluss	024	4400
26 ¹	Buoy	078	4600
26 ²	A	292	6800
27	Fluss	028	4500
27 ¹	Buoy	104	4100
27 ²	A	298	7700
28	Fluss	034	4150
28 ²	A	285	8600
29	Fluss	040	4800
29 ²	A	283	9500
30	Fluss	045	5000
30 ²	PPI shows many small targets close in. Ranges and bearings will be given at $\frac{1}{2}$ minute intervals.		
31	Buoy	291	2700
31 ²	"	250	3000
32	"	304	1800
32 ²	"	242	2000
33	"	333	1100
33 ²	"	217	1250
34	"	026	1100
34 ²	"	164	1100

PROBLEM NO. 13.

TEAM PRACTICE

Conditions: Start the DR plot below and to the left of center of your plotting sheet. Scale 2000 yds/in. Your destroyer "Garnet" is part of a small destroyer task group steaming in column 1000 yards apart. You expect to intercept two transports coming down from the North. A strong enemy task group is in the area and you do not wish to let your presence be known. "Emerald" is the leading DD (and guide) followed by your ship "Garnet," 1000 yds astern, "Ruby" follows you 1000 yds astern. Your task group is on CO27 speed 20. You do not know how long you will be on this course. Your present DR position, at 0100, is  $L10^{\circ} 17'N$ ?  $Lol67^{\circ} 20'W$ .

- 0100 Screen clear of strangers "Emerald" Bearing 027 Range 1000, "Ruby" Bearing 208 Range 1000
- 01 Few small strangers; probably two, Bearing 006 Range 15900
- 02 Strangers Bearing  $007\frac{1}{2}$  Range 15200 The raid has been design "Raid Fox"
- 03 Strangers Bearing 009 Range 14700 Evaluation using the intelligence dope shows Raid "Fox" is the two expected enemy transports.
- 04 Bearing  $010\frac{1}{2}$  Range 14100 Should have a CO94 S18 on Raid "Fox" by now.
- 05 Bearing 012 Range 13500 TBS xmission "Do not execute Dog, standby to make William run on Raid Fox" Figure the approach course you would turn to at time 0106 using speed 30 to reach a position  $60^{\circ}$  5000 yds on Raid Fox's nearest bow. DRT plotters check the solution on the DRT.
- 06 Bearing 014 Range 13000 TBS xmission "Standby to execute Corpen 065 speed 30 knots--standby execute" Plotters note that in a corpen movement the axis will change
- 07 Bearing  $013\frac{1}{2}$  Range 12400
- 08 Bearing  $012\frac{1}{2}$  Range 11900 At this time the bridge requests the time you will reach the position to fire torpedoes.
- 09 Bearing  $011\frac{1}{2}$  Range 11400
- 10 Bearing  $010\frac{1}{2}$  Range 10900 Raid Fox appears to be changing course. Prepare to figure a new approach course to reach the firing point.
- 11 Bearing 011 Range 10000
- 12 Bearing 011 Range 9000 TBS xmission "Execute Dog only if our presence is detected--the present course change in all probability is part of their zig-zag plan"
- 13 Bearing 011 Range 8100 The bridge requests advice on the necessity of change of approach course to a favorable firing point.
- 14 Bearing 011 Range 7200 You should by now have an approximate course and speed on Raid Fox of C123 S27. You should have decided that your present approach course will place you in a favorable firing position.



PROBLEM NO. 13 (cont.)

## TEAM PRACTICE (cont.)

- 15 Bearing 011 $\frac{1}{2}$  Range 6250 Figure a base torpedo course to fire a 45kt spread at time 16 at Raid Fox.
- 16 Bearing 012 Range 5350 Torpedoes away on BTC 046. Find the course to open the range in minimum time to 20000 yards using speed 30. Turn to course 270 speed 30.
- 17 Bearing 030 $\frac{1}{2}$  Range 5500
- 18 Bearing 047 Range 6200 At what time would you expect torpedo hits?
- 19 Bearing 060 Range 7400 Shortly after time 19 the lookout reports two explosions indicating torpedo hits on the transports.
- 20 TBS xmission "Secure problem, rotate positions for the next problem."

PROBLEM NO. 14.

## Team Practice

Conditions: Start your DRT plot near the bottom in the middle of your plotting sheet. Scale 2000 yds/in. Your cruiser "King" is part of a task force cruising on course 000 speed 15 in battle disposition 3S1. Enemy contact to the East is imminent. Plotters note particularly your disposition.

Opal	1000		Ace	0000
dd's Pearl	2000	cruisers	King	1180
Garnet	3000		Queen	2180
Ruby	4000		Jack	3180
Emerald	5000			

Circle spacing is 1000 yards. Fleet course and axis is 000. Your present DR position at 1700 is L2⁰03'N, L0179⁰17'E/

- 1700 Few strangers Bearing 098 Range 21500
- 01 Strangers Bearing 098 Range 21200 The raid has been desig  
Raid "Easy"
- 02 Bearing 099 Range 20900 Raid Easy looks like 3 large and 4  
small ships
- 03 Bearing 099 Range 20600 Ace's report over the TBS estimates  
the composition of Raid "Easy" as 3 cruisers and several DD's.
- 04 Bearing 099 Range 20300 Plotters convert this range and  
bearing to fleet center for an amplifying report to OTC.
- 05 Bearing 100 Range 20000 By this time you should have a good  
course and speed on the raid. Figure a course to cross the  
target's T at 12000 yds using speed 25. TBS xmission "Standby  
to execute Corpen 030 speed 25 at time 1705--standby execute."
- 06 Bearing 101 Range 19400 TBS xmission "Destroyers make William.  
run on Raid Easy at time 1707"



PROBLEM NO. 14 (cont.)

## TEAM PRACTICE (cont.)

- 07 Bearing 102 $\frac{1}{2}$  Range 18700 Find an approach course for your DD's in formation to reach 60° 5000 yds on the target's nearest bow using 30 kts. Draw in that course line lightly to check your solution against the plots that will follow. (097)
- 08 Bearing 104 $\frac{1}{2}$  Range 18100 FR Bearing 144 Range 1000 The lookout reports our DD's making their torpedo run off to starboard about  $\frac{1}{2}$  mile.
- 09 Bearing 106 Range 17500 Your FDO reports a plane down Bearing 020 Range 20 miles.
- 10 Bearing 108 Range 16800 FR Bearing 145 Range 3000
- 11 Bearing 110 Range 16300 Estimate the time your DD's will reach the firing position on the target's bow.
- 12 Bearing 112 Range 15700 FR Bearing 145 Range 5200
- 13 Bearing 114 Range 15100 Lookout reports the enemy cruisers have opened fire.
- 14 Bearing 116 Range 14700 FR Bearing 145 Range 7200
- 15 Bearing 119 Range 14100 Own DD "Emerald" is hit. Own cruisers open fire the lookout reports.
- 16 Bearing 122 Range 13700 FR Bearing 145 $\frac{1}{2}$  Range 9200 At time 17 your DD's will reach the firing point. Find the BTC for their 45 knot spread torpedoes. Draw in the BTC lightly. Surface plotters check the results of the assistant evaluator on the DRT.
- 17 Bearing 125 Range 13200 Find the retirement course the destroyers should take to reach 15000 yards in minimum time using a speed of 30 kts. Draw that line in lightly to see how it checks with the plots that will follow.
- 18 Bearing 128 Range 12800 TBS xmission from destroyers "Torpedoes away on BTC 064 retiring on course 203."
- 19 Bearing 131 Range 12500 Figure the time that the torpedoes that the destroyers fired at time 17 should hit.
- 20 Bearing 135 Range 12000 FR Bearing 166 Range 13800 Lookout reports that "Jack" is hit in the stern and on fire. "Emerald" is dead in the water sinking rapidly.
- 21 Bearing 138 Range 12000 The lookout reports shell hits on the leading enemy cruiser--that a small fire was started.
- 22 Bearing 142 Range 11800 FR Bearing 174 Range 16800 The enemy now breaks off the engagement and retires to the South. The remainder of your force will rendezvous at point "Zebra" which now bears 296 range 22000 from the destroyers and 249 range 19500 from the heavier units of your task force. What speed must the destroyers have to reach point "Zebra" simultaneously with the heavier units if the heavy units make 25 knots? (S 28.2) Time of rendezvous? (1745 $\frac{1}{2}$ )

PROBLEM NO. 15.

## Surface Plotting Exercise

Start below and to the right of the center of your sheet. Scale 2000 yds/in. Your task group is on 0280 S20. You do not know how long you

PROBLEM NO. 15 (cont.)

## Surface Plotting Exercise (cont.)

will be on that course. Your present DR position at 0426 is  $L26^{\circ}14'S$   $Lol46^{\circ}29'W$ . Your task group consists of your ship, a CL, steaming with another CL and 3 destroyers. Your mission is screening landing operations to the south of you. Contact with surface forces is expected.

- 0526 Few strangers Bearing 356 Range 18900 Looks like 6 or 8 ships
- 27 Strangers Bearing 357 Range 17700 Raid desig Raid "Dog"
- 28 Raid "Dog" Bearing 358 Range 16700 The lookout reports that raid "Dog" appears to be 2 large ships probably cruisers and 6 small ships probably destroyers.
- 29 Bearing 359 Range 15700
- 30 Bearing 000 Range 14600 The cruisers open fire on raid "Dog"
- 31 Bearing 001 Range 13500
- 32 Bearing 000 Range 13000 One enemy cruiser hit.
- 33 Bearing 359 Range 12300
- 34 Bearing 358 Range 11750 Sound contact; Left cut on, Bearing 207 Range 3600
- 35 Bearing 357 Range 11100 The Sound contact is desig raid "Easy," Right cut on Bearing 199 Range 3400 Raid "Dog" appears to be splitting.
- 36 Bearing 356 Range 11100 Bearing 357 Range 10300 appears to be 4 DD's closing Nearer raid is designated "D-1"
- 37 Bearing 357 Range 11100 appears to be 2 CA and 2 DD's desig "D-2" Dog-1 Bearing 358 Range 9500 Right cut on Bearing 177 Range 3000
- 37² D-1 Bearing 359 Range 9000 One enemy DD is hit
- 38 Left cut on Bearing 162 Range 3000
- 38¹ D-1 Bearing 359 Range 8700 (Raid D-1 designated primary Target)
- 38² D-2 Bearing 356 Range 11100  
Another small target Bearing 359 Range 9300 is designated D-3 and reported by lookouts as one DD burning.
- 39 D-3 Bearing 002 Range 9500
- 39¹ D-1 Bearing 395 Range 7500
- 39² D-2 Bearing 000 Range 12000 Lookout reports that the burning DD (D-3) has exploded and sunk.
- 40 D-1 Bearing 359 Range 6300  
D-2 Bearing 004 Range 13000
- 41 D-1 Bearing 000 Range 5100 Lookout reports one DD burning badly  
D-2 Bearing 007 Range 14000
- 42 D-1 Bearing 355 Range 5000 Two DD's sunk Change cus to 190 S 30  
D-2 Bearing 009 Range 15000
- 43 D-1 Bearing 354 Range 6600  
D-2 Bearing 010 Range 17000  
Another contact Bearing 356 Range 7000 The lookout reports that this is a single DD burning dead in the water --desig D-4
- 44 D-1 Bearing 356 Range 8600
- 45 D-2 Bearing 010 Range 20000 Lookout reports the CA's are retiring at high speed. All other raids have disappeared from the screen.