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O.U. 5274.

Remarks on Handling Ships.

1934.

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O.U. 5274.

REMARKS ON HANDLING SHIPS

O.U. 5274 (1) Addendum No. 1 to O.U. 5274 has been bound inside the back cover of this book.

All corrections up to and including P. 204/41 have been incorporated in this reprint.

1934.

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REMARKS ON HANDLING SHIPS.

1934.

The accompanying book, "Remarks on Handling Ships," having been approved by My Lords Commissioners of the Admiralty, is promulgated for information and guidance.

The book represents the opinions of experienced officers of His Majesty's Fleet and is in no sense a manual.

O.U. 5274—Remarks on Handling Ships, 1921—is hereby superseded and is to be destroyed.

By Command of their Lordships,

O. Murray

ADMIRALTY, S.W.1.
April, 1934.

CONTENTS.

CHAPTER I.

BEHAVIOUR OF A SHIP WHEN TURNING.

General.—Definitions.—Turning trials.—Loss of speed when turning.—Conditions influencing turning.—Heel when under rudder.

When the rudder of a ship is put over she begins at once to leave her straight course and to travel along a path which is at first one of increasing curvature. After she has turned through 90° the path will become approximately a circle.

Diagram 1 illustrates a typical path described by a ship in turning through 360° when steaming ahead.

The point about which a ship pivots when turning, varies with dissimilar conditions and at different parts of a turn. When moving ahead, the point will be usually from one-sixth to one-third of the ship's length from the stem. Some ships, however, pivot about a point close to the stem, and it is possible for the pivoting point to be ahead of the ship. A speed boat is a case in point. For recording purposes in seagoing trials, the position of the compass platform is usually selected.

In Diagram 1, " A " is the position of the compass platform at the moment when the rudder is put over. " B," " C," " D," &c., are the positions of the compass platform when the ship has turned through 45°, 90°, 135°, &c., respectively. At " J," where the ship has turned through 360°, it will be observed that she is inside her original track. In rare cases this point has been known to fall outside the original track.

Definitions.

The following terms are used with reference to the paths described by ships when turning :—

The **Advance** of a ship for a given turn is the distance that the ship moves in the direction of her original line of advance from the point where the rudder is put over. " AR " is the advance for a turn of 135°.

The **Transfer** of a ship for a given turn is the distance that the ship moves transversely from her original line of advance. " SC " is the transfer for a turn of 90°.

The **Tactical Diameter** is the amount that the ship has moved transversely from her original line of advance when she has turned through 180°. " PE " is the tactical diameter or transfer for 180°.

The **Final Diameter** is the diameter after the ship's path has become circular.

The **Distance to New Course** is the distance measured along the original line of advance, from the position of the compass platform when the rudder is put over, to the point of intersection between the old and new courses. " AS " is the distance to new course or advance for a turn of 90°. For turns of over 150°, the distance to new course becomes excessive and is, therefore, not used.

The **Intermediate Course and Distance.**—The intermediate distance is the length of the line joining the position of the compass platform when the rudder is put over, and the position when the ship has turned to her new course. The intermediate course is the angle which this line makes with the original line of advance. " AD " is the intermediate distance and " SAD " the intermediate course for a turn of 135°.

The **Length of the Arc** is the distance along the path described by a ship during a turn, measured from the position of the compass platform when the rudder is put over, to the position when steadied on the new course. " BCDE " is the length of the arc for a turn of 180°.

The practical application of these definitions may be studied in the Admiralty Manual of Navigation, Volume 1.

Turning Trials.

Fleet work and navigation in pilotage waters require that a ship's turning powers shall be known, particularly the path traversed in the first 180°.

Turning trials are normally carried out in calm weather and a smooth sea, in order that definite data may be obtained. In strong winds and a rough sea, there is an infinite variety of circumstances which influence the space and time required for turning.

Detailed instructions for carrying out turning trials may be found in Form S. 347—Report of Turning Trials.

Unless stated to the contrary, the following remarks assume that the ships considered are turning under the action of their rudders alone, and that up to the amount when the rudder is put over, the ships are proceeding at uniform speed on a steady course.

Paths for Typical Ships.—Diagrams 2, 3, 4, 5 and 6 illustrate the paths experimentally determined for ships of various classes. The curves represent mean results obtained under favourable conditions. The individual results of a number of trials carried out under similar conditions, sometimes vary considerably, so that any one trial cannot be accepted as a final indication of a ship's behaviour on all occasions; nor will the behaviour of two ships of the same class be exactly the same.

Loss of Speed when Turning (Table 1).—Whilst a ship is turning the first 180°, her motion is not uniform. It is, therefore, important to determine the times occupied in turning through various angles. In the first stages of a turn, the reduction in speed is not great, but as the rate of turning increases, so does the reduction in speed along the ship's path.

The actual rate of loss of speed is greatest between 20° and 90°, but the speed continues to fall until the ship has turned through about 180°.

Speed of Engines when Turning.—When a twin or multiple screw ship turns under rudder, it is noticeable that the outer screws increase speed, whilst the inner ones decrease speed. It is the practice at sea to reduce steam to the outer, and increase steam to the inner engines, thus maintaining the revolutions as nearly as possible to those ordered.

In a new ship, however, when dockyard or contractors' turning trials are carried out, the revolutions have not been adjusted in this manner, as the majority of such trials are carried out at full power and maximum rudder as a test of material. Consequently, there may have been a difference between the results obtained by this method, and those obtained under normal seagoing conditions. Hence the need for further trials by ship's officers Instructions for Dockyard and Contractor's Trials have now been revised, and are given on Form D. 500 (revised May, 1936.) The revolutions are kept constant as in trials by ship's officers, except at full power, when no adjustment is made.

Determination of the Actual Speed at any Point in the Turn.—The actual speed at any point in the turn may be determined by drawing a graph. The mean speed for every 30° is calculated and plotted at the mid point of that portion of the turn. The points thus obtained are joined by a curve, and the speed at any instant may be obtained. Fig. 1.

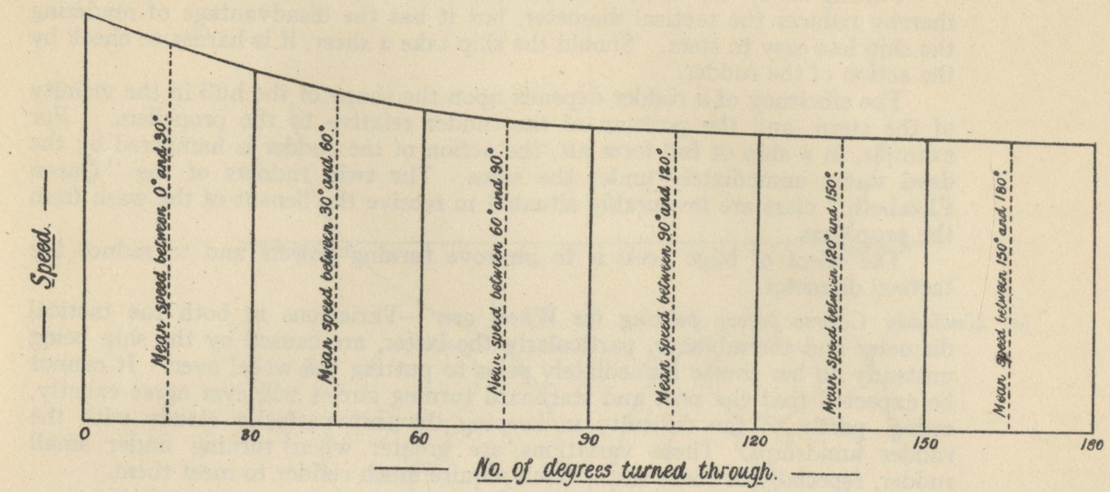
Table 1 illustrates the results obtained from certain ships.

Table 2 illustrates the times taken to turn for typical modern ships, when using various rudder angles and speeds.

When a ship is steadied on her new course after a turn, an appreciable interval will elapse before she regains her normal speed. To allow for this when plotting, a value known as the "Time Correction" must be applied to the "Times taken to turn."*

* *See* Chapter III, page 8, *ibid*, and Admiralty Manual of Navigation, Volume 1.

Fig. 1.



Conditions Influencing Turning.—The turning effect of the rudder reaches its maximum value at about 40°. Most warships have a full rudder angle of about 35°. In addition to the rudder angle used, the factors which chiefly influence the path of a ship when turning under the action of the rudder, are as follows:—*

(*a*) *Draught of Water and Trim of Ship.*—A reduction in the draught of a ship, usually results in an increase in the tactical diameter. In most cases a trim by the stern is accompanied by an increase in the tactical diameter, and a trim by the bow, by a decrease.

(*b*) *List.*—The following example illustrates the effect of a list. When moving ahead, each bow presents an inclined plane, say, 150 feet long, to a pressure from right ahead. In this length, given an average beam of 60 feet at the waterline, a list of 1° will make a difference of 150 square feet between the immersed areas of the two bows. The pressure on this additional area on one bow, set at an angle of 5° to 15° from the fore and aft line will turn the ship towards the less immersed bow. Thus, a list to port will decrease the tactical diameter of a ship when she is turning to starboard, and *vice versa*.

A moderate wind will cause a ship to heel slightly to leeward and is a contributory reason for the tendency to carry weather helm.†

(*c*) *Speed.*—The path of most heavy ships when turning under the influence of a given rudder angle is but slightly affected by the speed, although at high speeds the advance increases. Destroyers, however, increase their turning circle considerably with the speed. The rate of turning will vary with the speed.

(*d*) *Effect of Design.*—Battlecruisers, cruisers and destroyers possess a relatively large tactical diameter due to their great length in proportion to their draught, fine form and high speed; but fine form has the advantage of making a ship steadier under rudder. Battleships, however, possess smaller tactical diameters due to their beam, draught and momentum, but they are less steady under rudder, particularly at low speeds, and require considerable effort to check a swing.

* *See* Table 3 for examples of the effect of changes in the rudder angle on the tactical diameter.

† The effect of the wind and sea on the turning powers of a ship is dealt with fully in Chapter IV.

Cutting away the deadwood enhances the turning powers of a ship and thereby reduces the tactical diameter, but it has the disadvantage of rendering the ship less easy to steer. Should the ship take a sheer, it is harder to check by the action of the rudder.

The efficiency of a rudder depends upon the shape of the hull in the vicinity of the stern, and the position of the rudder relative to the propellers. For example, in a ship of full form aft, the action of the rudder is hampered by the dead water immediately under the stern. The twin rudders of the "Queen Elizabeth" class are favourably situated to receive the benefit of the wash from the propellers.

The effect of bilge keels is to improve turning powers and to reduce the tactical diameter.

(*e*) *Unsteady Course before putting the Wheel over.*—Variations in both the tactical diameter and the advance, particularly the latter, are caused by the ship being unsteady on her course immediately prior to putting the wheel over. It cannot be expected that the port and starboard turning circles will ever agree exactly, owing partly to the difficulty in keeping the ship perfectly steady with the rudder amidships. These variations are greater when turning under small rudder, especially in those ships which require much rudder to meet them.

Heel when under Rudder.—On the rudder being put over, the effect of the rudder pressure is to cause the ship to heel inwards, but as she gains angular velocity, the centrifugal forces predominate and the ship will heel outwards. This outward heel is noticeable in modern ships turning at high speed. If the rudder is righted abruptly, the centrifugal forces which are still acting, will at first increase the angle of heel, until the angular velocity is reduced. This phenomenon is remarkable in picket boats and other small craft.

A noteworthy exception to the outward heel, may be observed in the case of a speed boat under rudder. Here the centrifugal forces are expended in the "side slip" as the craft turns. The only remaining factor is the rudder pressure, which causes the speed boat to heel inwards.

CHAPTER II.

PROPELLERS *

General.—The single screw ship.—The twin or multiple screw ship.—Steaming with one engine stopped.—Steering by main engines.

The only single screw ships remaining in service are, sloops of the war programme and certain auxiliaries.

All capital ships (except "Rodney" and "Nelson"), post-war cruisers and aircraft carriers (except "Hermes") are driven by four propellers.

"Rodney," "Nelson," "Hermes," the majority of "D" and "C" class cruisers remaining in service, and all flotilla leaders, destroyers and submarines, are fitted with twin propellers.

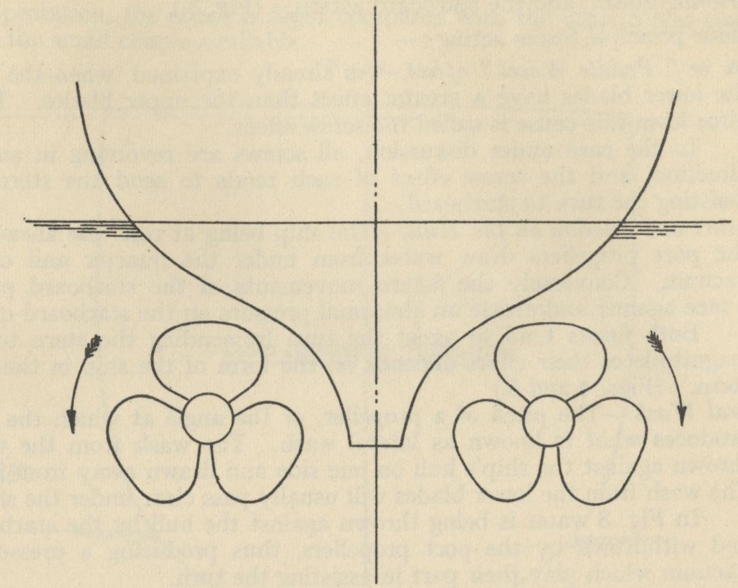
Most single-screw ships are fitted with a right-handed propeller, *i.e.*, when going ahead it revolves in a clockwise direction, viewed from its after side.

Twin- and multiple-screw ships are usually fitted with out-turning propellers, *i.e.*, the starboard screws are right-handed, and the port screws left-handed. (Fig. 2.)

The action of screw propellers is affected by the motion of the water at the after end of the ship relative to the surrounding water. This motion is known as the **Wake.** The wake has three principal components, namely: **Frictional Wake,** which is the belt of water dragged along with the ship; **Wake due to "Stream Line" Action,** caused by the shape of the hull; and **Transverse Waves** generated by the ship's motion ahead.

* General remarks on propellers are contained in Seamanship Manual, Volume 1.

Fig. 2.



The Single-Screw Ship.

Moving Ahead from Rest.—The first movements of the propeller of a right-handed single-screw ship starting to go ahead from rest with the rudder amidships, will tend to throw the ship's stern to starboard. This is due to the upper blades being fairly near the surface of the water and experiencing less resistance than the lower blades which are well immersed.

After the ship has gathered way, the frictional wake creates a disturbance against the upper blades which neutralises the previously greater resistance experienced by the lower blades, and the tendency of the ship's stern to move to starboard disappears. Finally, at high speed the effect of the frictional wake predominates and the ship's stern will, if anything, incline to port.

Moving Astern from Rest.—On the propeller being put astern from rest, the ship's stern will swing to port, for the same reason as when going ahead from rest. As sternway is gathered, there is no frictional wake to assist the upper blades in balancing the effect of the lower blades; the ship's stern will, therefore, continue to swing to port.

Reversing the Propeller whilst Moving Ahead.—The "kick" of the stern to port will be delayed until the ship's way has been deadened sufficiently for the predominant effect of the frictional wake to be frustrated.

Putting the Engines Ahead whilst Moving Astern.—The tendency of the stern to move to starboard will be delayed until the momentum of the swing to port has been overcome.

The Twin- or Multiple-Screw Ship.

When a twin- or multiple-screw ship proceeds from rest, or is moving with all screws going either ahead or astern, the various tendencies to turn in either direction caused by one set of screws, are neutralised by those of the other. If, however, one set of screws is reversed, the fact that all propellers are now revolving in the same direction, produces unbalanced forces which tend to turn the ship.

These forces will be considered for a ship with out-turning screws, starting from rest, with the port screws going ahead, and the starboard astern. (Fig. 3.)

There are four principal forces acting :—

(*a*) *Screw or " Paddle Wheel " effect.*—As already explained, when the ship is at rest, the lower blades have a greater effect than the upper blades. The nett lateral force from this cause is called the screw effect.

In the case under discussion, all screws are revolving in an anti-clockwise direction, and the screw effect of each tends to send the stern to port, thus assisting the turn to starboard.

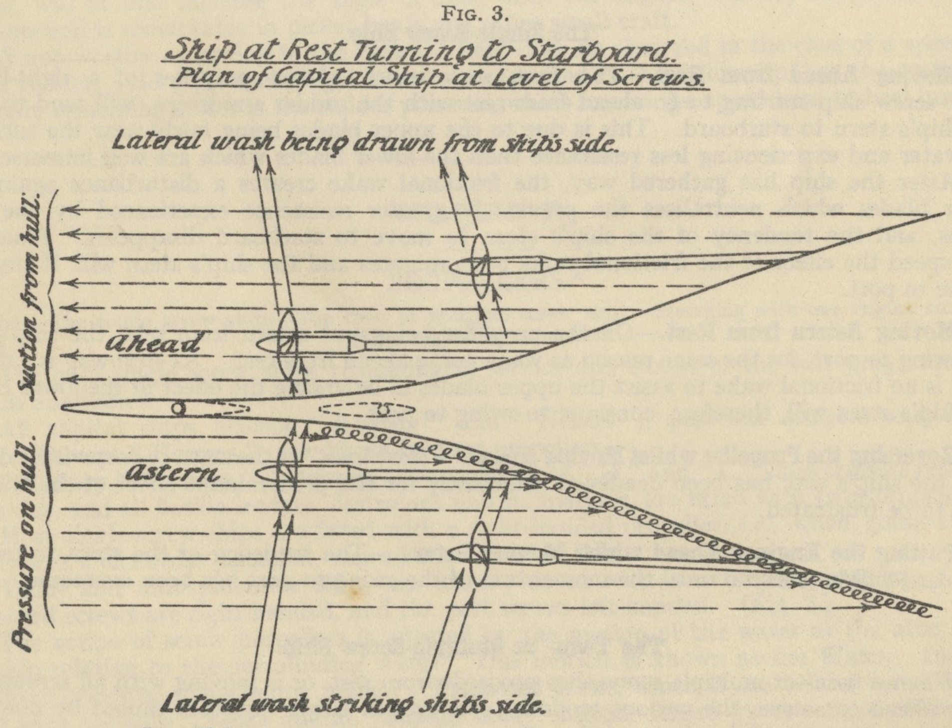
(*b*) *Pressure and Suction on the Hull.*—The ship being at rest, the ahead revolutions of the port propellers draw water from under the quarter and create a partial vacuum. Conversely the astern movements of the starboard propellers throw a race against and create an abnormal pressure on the starboard quarter.

Both forces tend to assist the turn by sending the stern to port, but the magnitude of their effort depends on the form of the ship in the vicinity of the stern. (Figs. 4 and 5.)

(*c*) *Lateral Wash.*—The pitch of a propeller, or the angle at which the blades are set, produces what is known as lateral wash. The wash from the upper blades is thrown against the ship's hull on one side and drawn away from it on the other. The wash from the lower blades will usually pass clear under the ship's bottom.

In Fig. 3 water is being thrown against the hull by the starboard propellers and withdrawn by the port propellers, thus producing a pressure and partial vacuum which play their part in assisting the turn.

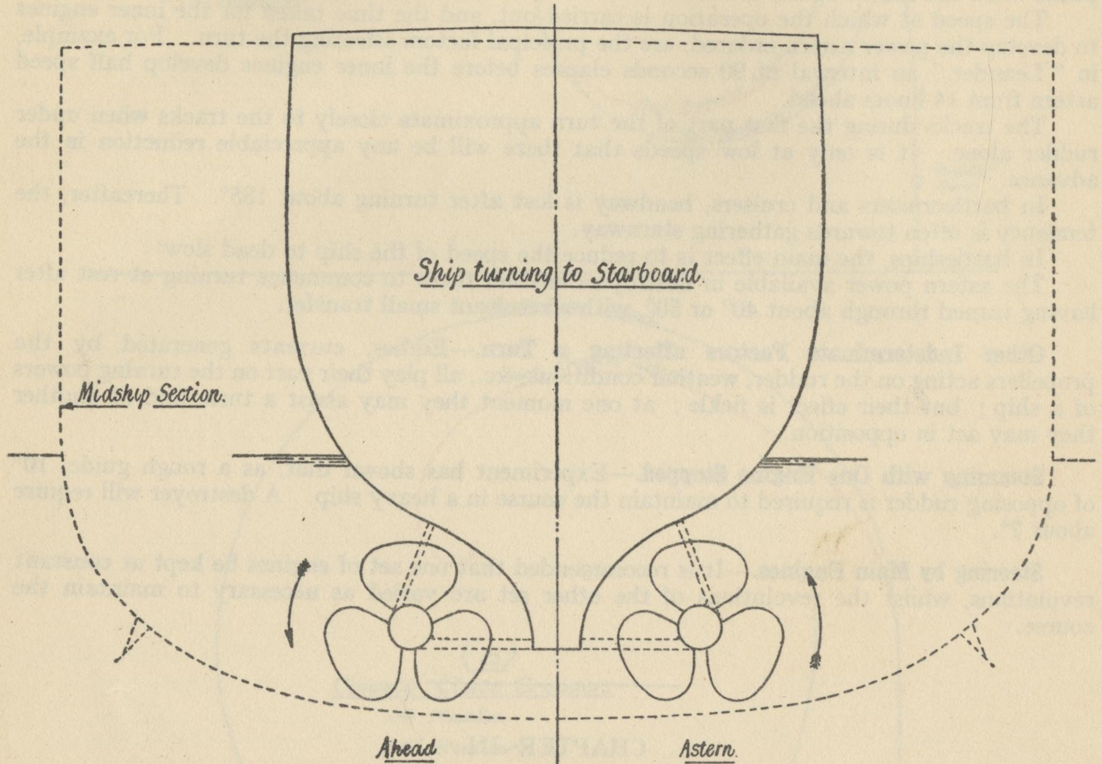
FIG. 3.



It will be apparent from a perusal of Figs. 4 and 5 that the effect of lateral wash must depend entirely on the shape of the ship's stern and the amount of deadwood against which it acts. In the case of a destroyer, the effect is nil.

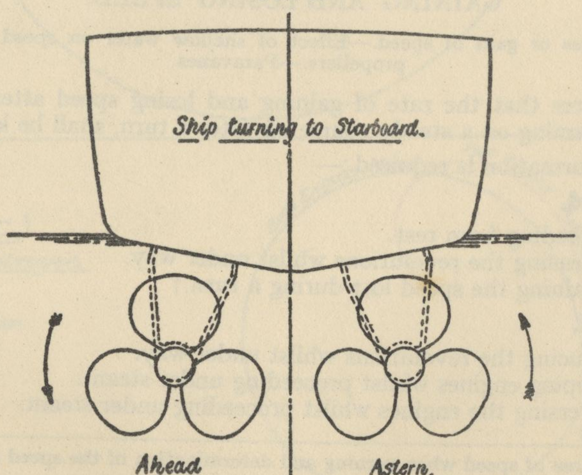
(*d*) *Thrust.*—The astern revolutions of the starboard propellers exert a pull aft on the starboard thrust blocks, whilst the port propellers push forward. Contrary to expectation, the effect is slight compared with the other forces concerned, owing to the small couple available.

FIG. 4.



Section through " A " Class Cruiser at Inner Screws.

FIG. 5.



Section through " D " Class Destroyer at Screws.

Reversing the Inner Propellers when Turning.

Fig. 6 illustrates (*a*) in black, the paths described by three types of ship when turning under full rudder with all engines moving ahead at 14 knots, and (*b*) in red, the resultant paths when the inner engines are ordered astern at the moment of putting the rudder over.

The speed at which the operation is carried out, and the time taken for the inner engines to develop the power astern ordered, are the principal factors affecting the turn. For example, in "Leander," an interval of 90 seconds elapses before the inner engines develop half speed astern from 14 knots ahead.

The tracks during the first part of the turn approximate closely to the tracks when under rudder alone. It is only at low speeds that there will be any appreciable reduction in the advance.

In battlecruisers and cruisers, headway is lost after turning about 135°. Thereafter, the tendency is often towards gathering sternway.

In battleships, the main effect is to reduce the speed of the ship to dead slow.

The astern power available in destroyers enables them to commence turning at rest after having turned through about 40° or 50°, with a resultant small transfer.

Other Indeterminate Factors affecting a Turn.—Eddies, currents generated by the propellers acting on the rudder, weather conditions, &c., all play their part on the turning powers of a ship; but their effect is fickle; at one moment they may assist a turn, and at another they may act in opposition.

Steaming with One Engine Stopped.—Experiment has shown that, as a rough guide, 10° of opposing rudder is required to maintain the course in a heavy ship. A destroyer will require about 7°.

Steering by Main Engines.—It is recommended that one set of engines be kept at constant revolutions, whilst the revolutions of the other set are varied as necessary to maintain the course.

CHAPTER III.

GAINING AND LOSING SPEED.*

Determination of the loss or gain of speed.—Effect of shallow water on speed.—Foul bottom.—Size of propellers.—Paravanes.

Fleet work requires that the rate of gaining and losing speed after changing the engine revolutions whilst steaming on a steady course, or after a turn, shall be known.

The following information is required :—

Gaining Speed.

(*a*) Proceeding from rest.
(*b*) Increasing the revolutions whilst under way.
(*c*) Regaining the speed lost during a turn.†

Losing Speed.

(*d*) Reducing the revolutions whilst under way.
(*e*) Stopping engines whilst proceeding under steam.
(*f*) Reversing the engines whilst proceeding under steam.

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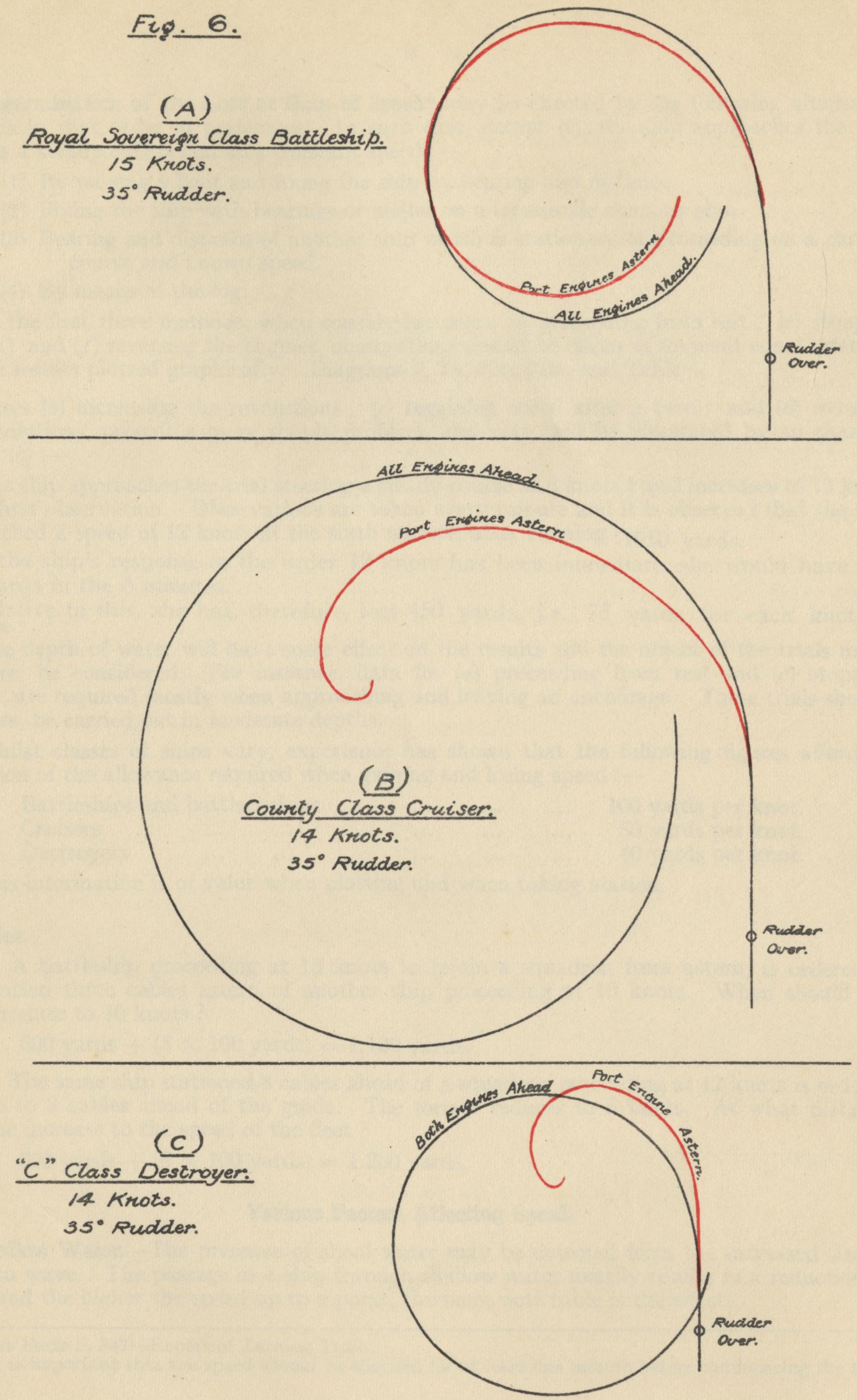
* *See* Chapter I.—Loss of speed when turning and determination of the speed during a turn.
† *See* Footnote, Chapter I, page 2.

Fig. 6.



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Determination of the Loss or Gain of Speed* may be effected by the following alternative methods in that order of preference. In each case, except (*c*), the ship approaches the trial steering a steady course and at a constant speed :—

(1) By passing a boat and fixing the ship by bearing and distance.

(2) Fixing the ship with bearings or angles on a large scale chart or plan.

(3) Bearing and distance of another ship which is stationary or proceeding on a parallel course and known speed.

(4) By means of the log.

In the first three methods, when considering cases (*a*) proceeding from rest ; (*e*) stopping engines ; and (*f*) reversing the engines, observations should be taken at frequent equal intervals and the results plotted graphically. Diagrams 7, 7A, 8 and 8A, and Table 4.

Cases (*b*) increasing the revolutions ; (*c*) regaining speed after a turn ; and (*d*) reducing the revolutions, present a more simple problem, and may best be illustrated by an example of case (*b*) :—

The ship approaches the trial steering a steady course at 6 knots,† and increases to 12 knots at the first observation. Observations are taken every minute and it is observed that the ship has reached a speed of 12 knots at the sixth minute, after running 1950 yards.

If the ship's response to the order 12 knots has been immediate, she would have run 2,400 yards in the 6 minutes.

Relative to this, she has, therefore, lost 450 yards, i.e., 75 yards for each knot of increase.

The depth of water will have some effect on the results and the object of the trials must, therefore, be considered. For instance, data for (*a*) proceeding from rest and (*e*) stopping engines, are required mostly when approaching and leaving an anchorage. These trials should, therefore, be carried out in moderate depths.

Whilst classes of ships vary, experience has shown that the following figures afford an indication of the allowance required when gaining and losing speed :—

Battleships and battlecruisers	100 yards per knot.
Cruisers	50 yards per knot.
Destroyers	40 yards per knot.

This information is of value when plotting and when taking station.

Examples.

(*a*) A battleship proceeding at 15 knots to rejoin a squadron from astern, is ordered to take station three cables astern of another ship proceeding at 10 knots. When should the former reduce to 10 knots ?

600 yards + (5 × 100 yards) = 1,100 yards.

(*b*) The same ship stationed 8 cables ahead of a squadron proceeding at 12 knots is ordered to close to 3 cables ahead of the guide. The former reduces to 6 knots. At what distance must she increase to the speed of the fleet ?

600 yards + (6 × 100 yards) = 1,200 yards.

Various Factors Affecting Speed.

Shallow Water.—The presence of shoal water may be detected from the increased size of the stern wave. The passage of a ship through shallow water usually results in a reduction of speed, and the higher the speed up to a point, the more noticeable is the effect.

* *See* Form S. 347—Report of Turning Trials.

† It is important that the speed should be checked for at least one minute before commencing the trial.

Briefly, the reason for this is due to changes in wave formation. The waves normally generated by a large moderate speed ship, produce a crest at the bow and stern, and a trough amidships. When passing through shallow water, the waves become larger and longer. As the size increases, so does the resistance against the ship, thus reducing her speed. By the increase in length, the ship loses the support of the crest at the stern. This causes her stern to settle and is the reason why the quarterdecks of heavy ships have been flooded when passing at high speed over 9 or 10 fathom * patches.

An exception to the above rule is found in certain high speed moderate draught ships, such as destroyers where there may be a reduction in resistance due to the change in wave formation, and as a result, on certain shallow water speed trial courses there is an appreciable increase in speed. The phenomenon is, however, so complex that recourse must be made to experimental data to estimate the quantitive effect in any specific case.

Foul Bottom.—Extended periods lying in tropical harbours will cause a rapid growth of weed and shell on the ship's bottom. Frequent high speed steaming and visits to fresh water rivers will reduce the growth. On first proceeding to sea after a prolonged period in harbour during which the bottom has grown very foul, the loss of speed will be slightly greater than after a few hour's steaming, when a portion of the growth will have been discarded.

Whilst it is not possible to lay down any definite rules regarding the increase in revolutions necessary to maintain speed with a foul bottom, experience within the Mediterranean indicates that the following allowances are recommended :—

Type of Ship.	Out of dock—	
	6 months.	12 months.
Battleship	1¼ knots	2½ knots.
Cruiser	1¼ knots	2½ knots.
Destroyer	1¾ knots	3½ knots.

Frequent observations are the only certain means of determining the allowance for individual ships on various stations.

Size of Propellers.—Ships fitted with small propellers take appreciably longer to gather way from rest than ships of the same type fitted with large propellers. Similarly, when stopping they carry their way more owing to the smaller drag of the propellers. For instance, when ships of the " Royal Sovereign " and " Queen Elizabeth " classes anchor in company with the latter as guide, if " Royal Sovereign " should be 100 yards outside station when the signal to stop engines is hauled down, she will carry her way into station by the time the signal to anchor is made.

Paravanes.—Table 5.

* Attention is called to the need for increased safety margins as regards depth of water when proceeding at high speed.

(ii) When under way at any considerable speed, there is, in deep water, no appreciable change of trim, but there is a bodily sinkage of the vessel as a whole. It is not strictly an increase of draught, since it is caused, not by a deeper immersion of the hull, but by the lowering of the mean water level immediately surrounding it, (compared with that of the adjacent sea), due to the water displaced by the ship's passage being unable to return in time completely to fill the trough so caused. Typical figures for this sinkage are "Hood"—3 ft., "Leander"—2 ft., destroyer—1 ft.

(iii) In shallow water the return of the water is further retarded. The crest at the bow continues to support the ship forward, but, due to the drag on the returning water, the trough becomes deeper and moves further astern. A considerable change of trim results, the ship now being borne on the downward slope from crest to trough, instead of from crest to crest across the trough. As a typical example, "Hood" drawing 33 ft. aft, has, when at rest in 14 fathoms, 51 ft. between her keel and the sea bottom. Crossing the same depth at a speed of 28 knots, this distance is reduced aft to 31 ft., a settling of the stern of 20 ft. In lesser depths the effect will be more pronounced and correspondingly more dangerous.

CHAPTER IV.

HANDLING A SHIP.*

General.—Steam available.—Wind and weather helm.—Wind drift.—Checking a sheer.—Effect of shallow water on steering.—Turning under rudder in narrow waters.—Control of the ship when engines are stopped and working astern.—Steering a ship with sternway.—Turning at rest.—Turning short.—Use of an anchor when turning.—Approaching an anchorage.—Allowance of cable for depth when mooring.—Anchoring and mooring in a tideway.—Clearing hawse by means of the engines.—Securing between two buoys.—Securing to a single buoy.—Leaving a buoy.—Berthing at a wall or jetty.—Leaving a wall or jetty.—Berthing stern to a mole or jetty.—" What is the ship doing ? "—Passage through canals and restricted waters.—Use of tugs.—Pilots.·· USE OF AIRCRAFT.

Knowledge gained by experience is essential for the proper handling of ships. The problems encountered in one class of ship will not be the same in others. Thus, an officer skilled in handling one type of ship will find something to learn in the handling of another, whether she be larger or smaller.

In a light-draught ship the principal consideration will often be the rate at which she will drift owing to the wind, whilst in a heavy ship it may be her inertia or her sluggishness in answering her rudder.

Unless the ship is of an entirely new class, information as to her behaviour will be available in the navigational data book and should be studied as a preliminary to the practical handling of the ship.

On assuming command, an officer should take any opportunity of trying out the capabilities of his ship by such manœuvres as dropping and picking up a lifebuoy, using engines and rudder in various ways, and with the wind in different relative directions.

Steam Available.—Astern power in many types of ship is a weak point. When manœuvring in harbour, steaming in fog (especially in frequented and pilotage waters), &c., it is advisable to have extra boilers connected.

Wind and Weather Helm.—Most ships seek to turn into the wind when they have head way or stern way. The pivoting point is well forward when the ship is going ahead, and further aft when going astern. Thus the area of upper works exposed to the wind is greater abaft the pivoting point when going ahead, and *vice versa*.† Extreme cases may be quoted, of " Nelson " and " Rodney," who, owing to their high superstructure aft, carry large weather helm when going ahead ; and a destroyer, whose stern flies into the wind when going astern, owing to her high forecastle.

With no way on, ships lie with the wind approximately abeam.

The lower the speed, the greater will be the amount of weather helm carried.

When carrying weather helm on passage it may be an advantage to run the weather engines faster than the lee engines. This will reduce the amount of weather helm and greater speed should be obtained for the same fuel consumption.

Owing to a ship's sluggishness in answering her rudder when turning away from a beam wind, a greater advance than the normal must be allowed.

When engines are stopped, and occasionally when proceeding at slow speed, many ships will turn into the wind against full rudder. This is a constant source of embarrassment when coming to anchor, but control can usually be regained by going slow ahead with one or both sets of engines for a few seconds, without increasing the way of the ship appreciably.

Wind Drift.—The wind exercises its greatest effect on a ship lying stopped. The effect decreases as the ship moves ahead and gathers way. For example, a ship under way with the wind on her beam stops engines. When her way is lost, she will lie broached to and

* *See* Seamanship Manual, Volume 2.
† *See* Chapter I, page 3, *ibid* Heel caused by the wind.

drifting slowly to leeward. The water under her lee commences to move with her, gains in momentum and finally ship and water settle down to say, 2 knots. On proceeding ahead again, the ship enters water with little or no drift. The rate of drifting then falls off rapidly to say, $\frac{3}{4}$-knot at slow speed and $\frac{1}{4}$-knot at half-speed.

Checking a Sheer.—Even when uninfluenced by wind, the rudder alone will not check a heavy sheer in many ships when engines are stopped. It is necessary to go ahead with the engines on the side towards which the bow is swinging. The other engines may be put astern if it is desired to prevent the ship from gathering more headway, but water pressure will be taken off the rudder and, unless the ship is practically stopped, it is doubtful if they will assist in checking the sheer. If sea room permits, probably the quicker and more sure method is to go maximum revolutions ahead with the one set of engines and slow ahead with the other. (Figs. 7 and 8.)

Effect of Shallow Water on Steering.—It has been shown briefly in Chapter III how speed is affected by shallow water. Similarly complex conditions exist with regard to steering. The flow of water round the ship is no longer truly three-dimensional and the pressures and velocities of the water are disturbed from the normal. Underneath the ship the water gap between the hull and the sea bottom is restricted, and the difficulty of maintaining a steady streamline flow at this part is increased by the frictional drag of the hull, thus rendering the ship directionally unstable. Further, the action of the rudder is minimised by the increased slip of the propellers, which results in a considerable drawing of water to the propellers and a slowing down of the flow aft in the surrounding water. This was demonstrated in some experiments carried out with a merchant ship in shallow water, when some wooden chocks thrown into the water near the rudder stock, kept company with the ship for over 30 seconds. When the experiments were repeated in the open sea, the chocks were swept away at once. This condition is aggravated in ships designed so that the rudder does not readily receive benefit from the wash of the propellers ; moreover, a following current will set up eddies around and further reduce the efficiency of the rudder.

As a result of the foregoing conditions, a ship will take longer to obey her rudder when altering course in shallow water, and correspondingly longer to check a yaw or sheer.

Experiment has shown that unsteady steering begins to show itself when the draught exceeds 0·7 times the depth of water, and any attempt to proceed at high speeds will also produce it.

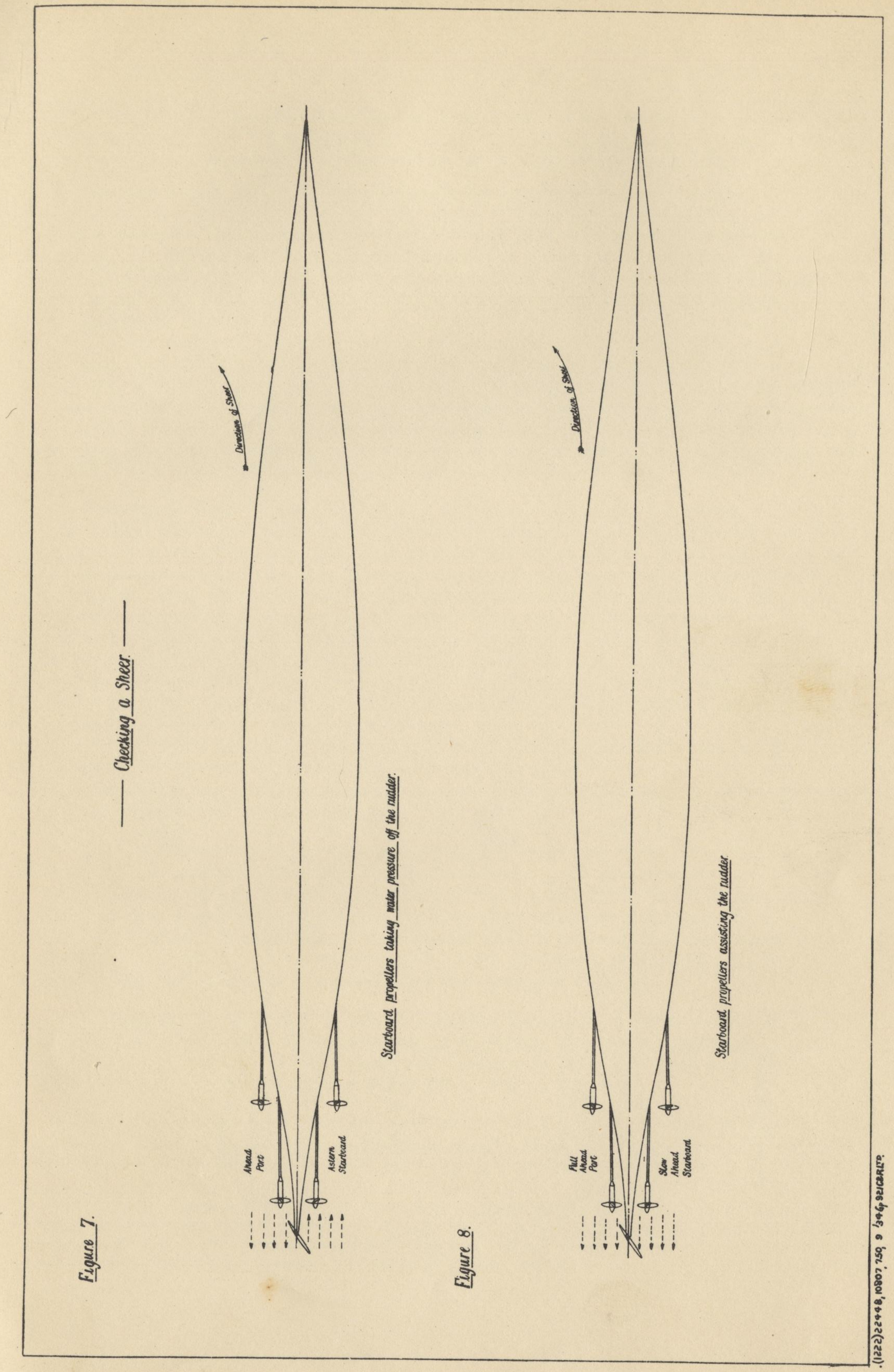
This embarrassing state of affairs is enhanced when the water is restricted as well as shallow. The increased difficulties experienced, and the measures recommended to overcome them, are described later under **"Passage through Canals and Restricted Waters."**

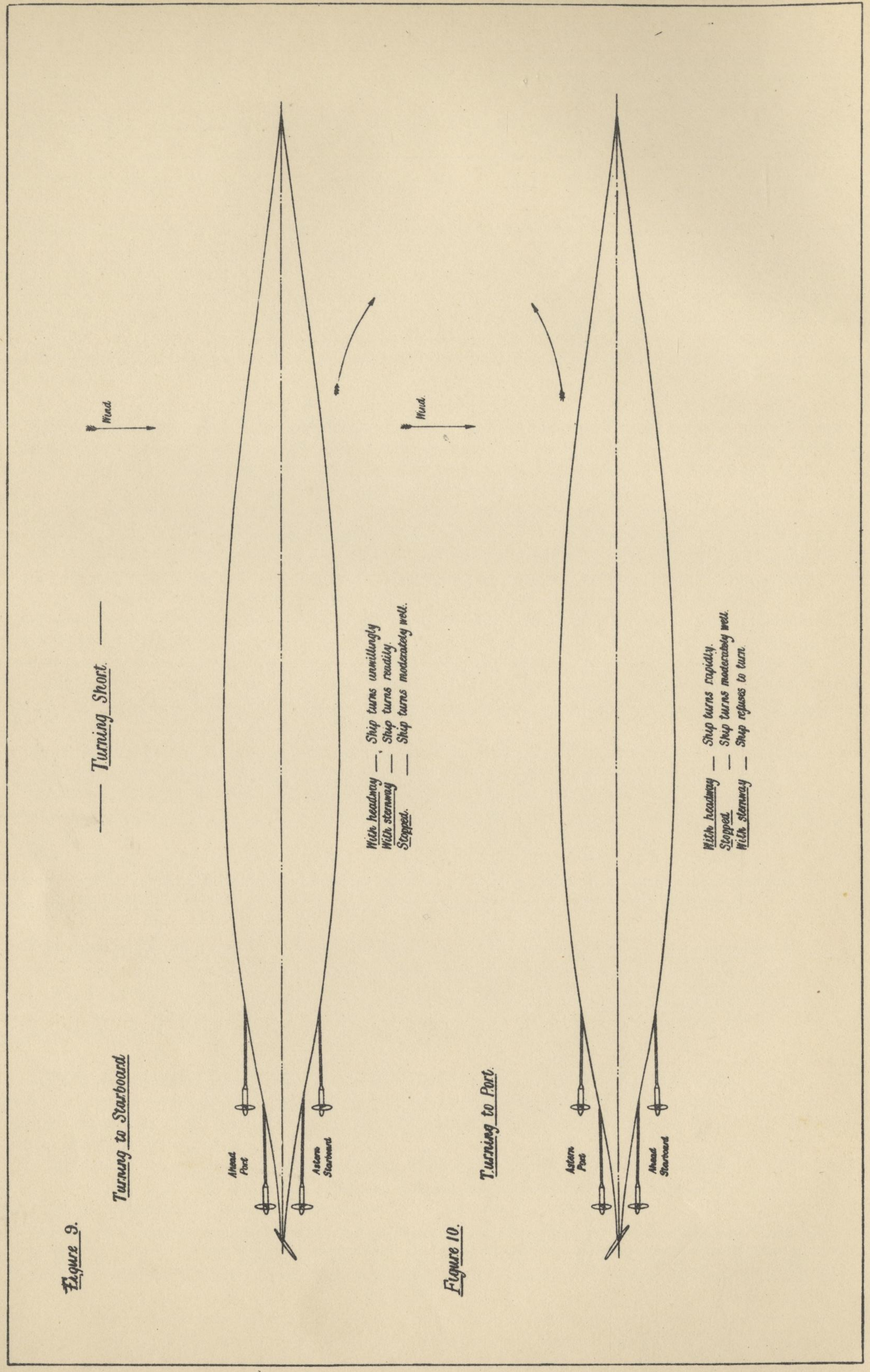
Turning under Rudder in Narrow Waters.—In a confined harbour where there are large turns in a narrow channel, and especially when a strong beam wind will hinder turning, it is often an advantage to give the ship small rudder in the later stages of the approach to a bend. This will give the ship a bias or "desire" to turn in the right direction so that there will be no doubt or delay in starting to turn when the rudder is finally put over.

Control of the Ship when Engines are Stopped and Working Astern.—No ship with headway and with engines stopped will steer so well as when the propellers are revolving ahead. Battleships in particular steer badly with engines stopped, but dead slow ahead is usually sufficient to keep them under control.

A ship with headway and with engines working astern may be kept fairly steady whilst her way is being lost. If, however, for any reason a sudden sheer develops, the rudder will be powerless to check it.

For these reasons, when berthing a heavy ship, her way should be deadened whilst there is still ample sea room. The engines can then be used ahead or as necessary for the final stages of berthing. Should the berth be approached with too much way, thus leaving no alternative





but to put the engines astern, the ship may take a sheer and be out of control at a critical period of the manœuvre. This risk must, however, be accepted when cross currents prevail in the approach, as sufficient way must be maintained to pass through them safely.

Steering a Ship with Sternway.—Usually the rudder has much less effect than when going ahead, and in a heavy ship, reliance can rarely be placed on the rudder to steer her. Resort should, therefore, be made to moderate sternway only, so that, should the ship steer wildly, her way can be checked before a critical situation develops. Even when there is ample sea room, and when handling destroyers and ships which are known to steer well astern, it must be remembered that a heavy strain is brought on the steering gear, and there may be difficulty in righting the rudder.

In calm weather, a right-handed single-screw ship is best manœuvred astern by pointing the stern to starboard of the desired direction, gathering plenty of sternway, and then stopping engines. The rudder will then steer the ship. With sufficient sternway the rudder will sometimes overcome screw effect; steering is then possible with the engines going slow astern.

Wind is an important element when making a stern board, as the tendency of the stern to fly into the wind is difficult to overcome. In a single-screw ship, however, the wind can sometimes be employed to advantage to compensate for screw effect.

Turning at Rest (or turning without gathering way ahead or astern).—In cruisers and larger ships where maximum boiler power is seldom available, this manœuvre is best carried out by going maximum revolutions astern with one set of engines, consistent with maintaining steam pressure, whilst the revolutions of the ahead engines are adjusted as necessary to effect a balance. This balance can be found by experiment and in some ships orders exist that, whenever the telegraphs are at " Half ahead " one and " Half astern " the other, the engines are to be so manœuvred. Alternatively, some standing orders direct that " Half astern " means maximum revolutions without loss of steam pressure, whilst the revolution telegraph shall be obeyed by the ahead engines only. Other officers prefer to order " Full astern " on one set of engines, and to maintain the balance with the ahead engines by ordering the telegraph to " Full," " Half " or " Slow," as necessary.

In destroyers and ships where ample boiler power is normally available, it is usually neither necessary nor desirable to use more than half-speed.

Full rudder is generally used with balanced rudders, but occasionally some ships are found to turn better under moderate rudder.

Shallow Water will reduce the rate of turning, with the result that ships will sometimes refuse to turn without gathering way ahead or astern. In abnormally shallow water, and in confined spaces such as a basin, ships will on occasions turn better when the engines are worked either at slow speed, or stopped periodically to allow eddies of water to subside.

The operation of turning at rest is slower than when turning under rudder with engines ahead. For example, a " Queen Elizabeth " class battleship proceeding from rest at 12 knots and turning 180°, will gain five minutes on one turning at rest.

Turning Short.—Turning at rest is executed frequently in fleet work, but it is seldom necessary at other times. Whenever sea room permits it is more expeditious to gather slight way ahead and astern. If there is any wind blowing from the side away from the turn, a slight stern board may well expedite the manœuvre. Figs. 9 and 10.

Use of an Anchor when Turning.—An anchor underfoot is of value in assisting a turn in a confined space, especially in a single-screw ship.* When weighing, if it is desired to cant the ship towards the direction in which it is required to turn, a sheer should be given with the

* In certain narrow rivers, where there are recognised turning berths, it may be necessary to proceed astern down the river until the turning berth is reached. If there is a beam wind and the stream is strong, it is a good plan to let go an anchor at short stay and " drag " it down the river. This will help to steady the ship and prevent her bow from being swung off by the wind.

engines in the opposite direction, when about one shackle more than the depth of water is still out. This tautens the cable so that the act of breaking out the anchor hauls the ship sharply back again. An attempt to assist her in the required direction with the engines, before the anchor breaks ground, will fail.

Approaching an Anchorage.—Table 6 indicates the practice in certain classes of ships regarding the distance at which speed is reduced and engines stopped on approaching an anchorage. The ideal to be aimed at when coming to single anchor, is to bring the ship up at the moment when the required amount of cable has been veered. When anchoring in deep water, it is customary to veer cable during the approach. Speed should, therefore, be reduced in time for the necessary cable to be veered and prepared in readiness for letting go on anchoring.

Allowance of Cable for Depth when Mooring.—Contrary to expectation allowance for depth of water when mooring may be neglected, except in places where there is an abnormal depth or rise and fall of tide. For example, ships normally moor in about 10 fathoms with the anchors approximately 150 fathoms apart. A moment's reflection will bring conviction that the allowance of cable for a depth of 10 fathoms, is of no account, *i.e.*, 8 feet.

An allowance is, however, necessary for working cables in order to insert the swivel. This will vary according to the method used and the position of the slips relative to the hawse pipes.

It is inadvisable to aim at too taut a moor in deep water, owing to the possibility of straining the cable gear.

Anchoring and Mooring in a Tideway.—It is best to stem the stream or current. Whilst consideration must be given to the effect of wind, a high contrary wind is necessary to overcome the effect of a moderate stream. When it is inconvenient to stem a slight current, it may be sufficient to lay the cable out across it. The bight of cable will act as a brake and prevent undue strain whilst the ship is swinging and getting her cable.

When coming to anchor in a single ship stemming a strong current, it is often more satisfactory to lay out the cable with sternway. There will then be no doubt as to when the ship has got her cable and no risk of the cable getting under the bottom if the direction of the current has been wrongly estimated. If, on the other hand, the cable is laid out against the current, steam must be kept on the engines and the ship watched carefully until it is certain that she is riding correctly.

Anchoring head to stream with a beam wind, it is often advisable to let go the lee anchor and lay out the cable as the ship comes astern. The bow will fly towards the wind to a position athwart wind and stream. The cable will then grow clear, broad on the bow.

Violent yawing in a strong river current can be checked by letting go both anchors spanned across the stream. (Fig. 11.)

When anchoring with the stream, a heavy strain is brought on the cable when the ship has swung half way round. It may be possible to avoid this by commencing to turn immediately the anchor is let go ; the engines are then manœuvred and cable veered in small amounts before the strain becomes excessive. Unless, however, the ship is manœuvred with delicate judgment, there is risk of the cable running out to a clench and parting before the ship is finally swung. Should, therefore, circumstances permit, it is more seamanlike to turn the ship round before anchoring or mooring. A heavy ship is recommended to avoid attempting to moor with a flood stream of more than half a knot under her. Nevertheless, circumstances may arise when the crowded state of the anchorage, combined with the strength of the stream precludes attempting to turn before anchoring. Under such conditions, it is safer to anchor, turn the ship, and then moor after the ship has swung.

When mooring against a strong current, it is sometimes preferable to execute a dropping moor, thus reducing the risk of dragging the upstream anchor.

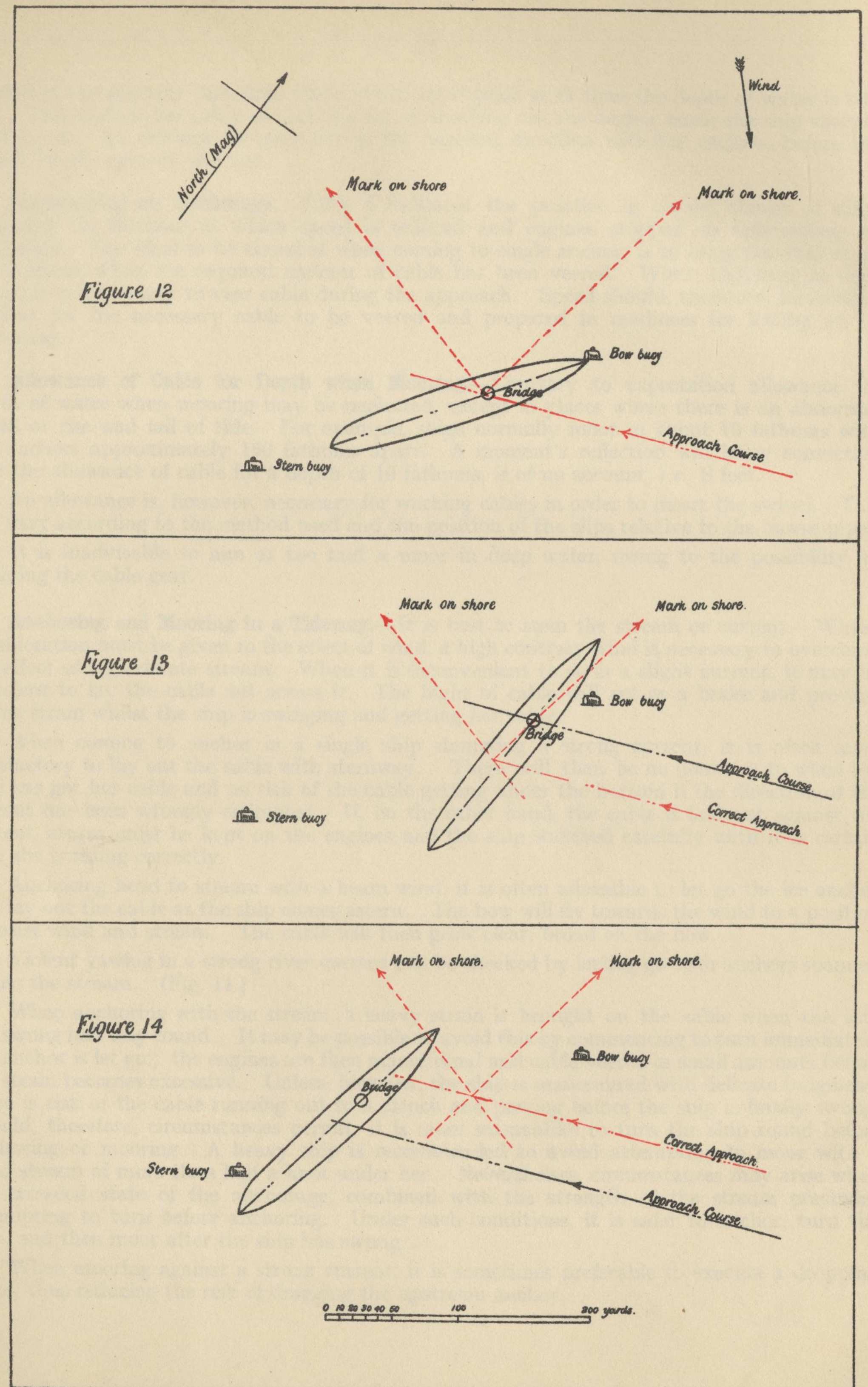


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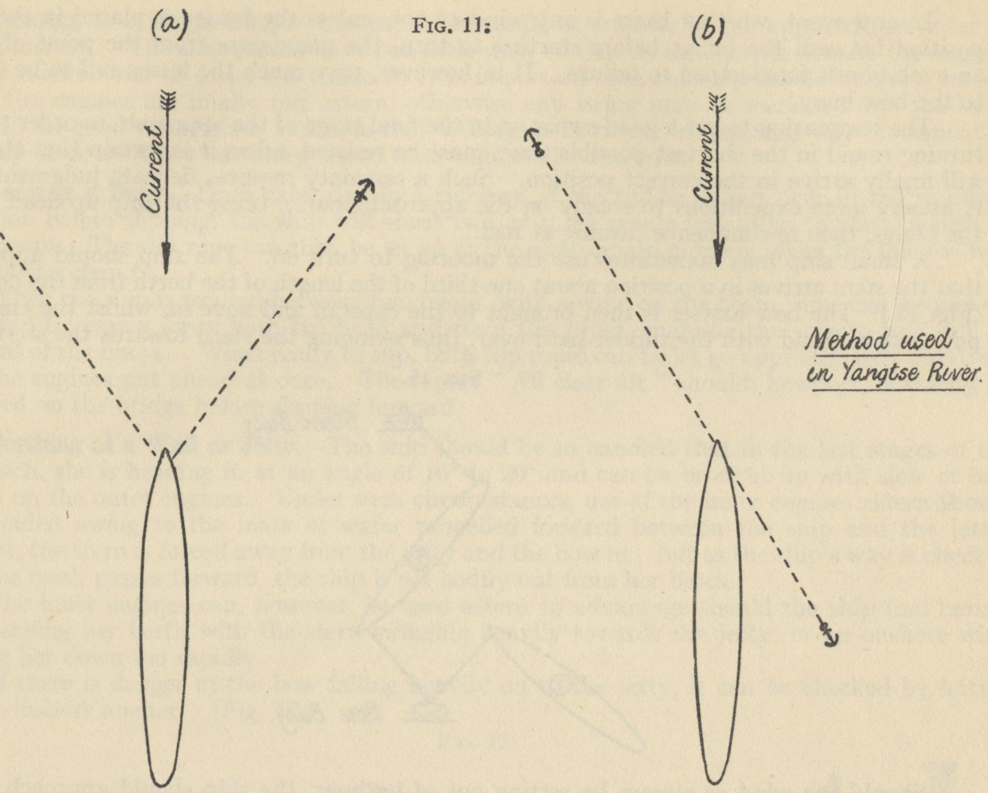
Fig. 11:



Clearing Hawse by means of the Engines.—The cables may grow down either side of the stem and give the impression that they are clear, whereas there are actually turns below the forefoot.

If there is doubt as to whether the hawse is clear, the engines should be put astern to tauten the cables ; any turns will then probably clear, unless the moor is abnormally slack and the cables are frapped round each other. It may be found necessary to turn the ship cautiously in the direction of open hawse in order to bring a strain on both cables.

Securing between Two Buoys.—At some ports, such as Malta Grand Harbour, it is frequently necessary to turn round, with no room to do so under rudder. The pivoting point of the ship should be placed in the position it will occupy when secured, and the ship then turned at rest. In ships which are subject to the influence of the wind, allowance for drift whilst turning must be made in selecting the position of the pivoting point. In Fig. 12, the ship has arrived with her bridge in the correct position between the buoys, assisted by compass bearings or transits of various marks on shore, so that when the ship has been turned, the stem is in the ideal position for assisting the cable officer.

Fig. 13 illustrates the case of a ship which has arrived with her bridge 40 yards too near to the bow buoy. It will be seen that the natural inclination to make a stern board on finding the ship too close to the bow buoy, will make matters worse, observing that the ship will find herself finally to leeward of her berth. The only remedy is to move ahead, bring the ship's turning point, *i.e.*, the bridge, abreast the bow buoy, complete the turn, and then make a stern board.

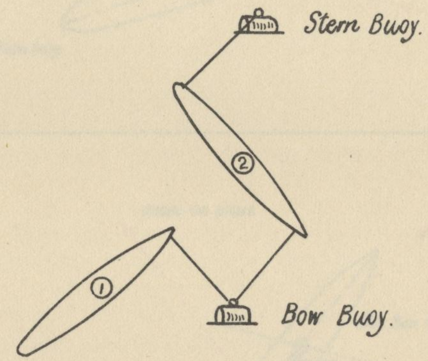
In Fig. 14 the situation is reversed, *i.e.*, the bridge is 80 yards too close to the stern buoy, except that with a wind from the north-west, it is safe to move ahead, relying on the wind to bring the ship down bodily to her correct alignment between the buoys.

In any event, whether there is any wind or not, unless the bridge is placed in the correct position between the buoys before starting to turn, the manœuvre from the point of view of an evolution is foredoomed to failure. It is, however, very much the lesser evil to be too close to the bow buoy.

The temptation to get a good swing on in the final stage of the approach, in order to ensure turning round in the shortest possible time, must be resisted unless it is certain that the bridge will finally arrive in the correct position. Such a certainty requires delicate judgment, and it is usually more expeditious to steady on the approach course, bring the ship up dead between the buoys, then re-commence turning at rest.

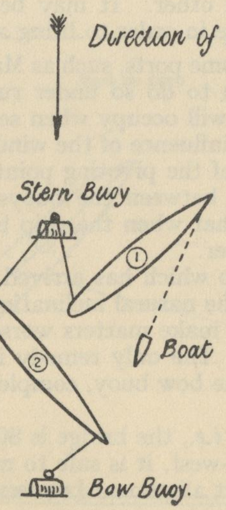
A small ship may sometimes use the mooring to turn on. The ship should approach so that the stem arrives in a position about one-third of the length of the berth from the bow buoy. (Fig. 15.) The bow hawser is then brought to the capstan and hove in, whilst the engines are put to slow ahead with the rudder hard over, thus swinging the stern towards the stern buoy.

FIG. 15.



Should the wind or stream be setting out of harbour, the ship should approach so as to bring the stern close to the stern buoy and the wind or stream on the bow. (Fig. 16.) The stern hawser is then secured and hove in whilst the wind or stream carry the bow down towards the bow buoy. The progress of the boat carrying the bow hawser will be facilitated by pulling to leeward.

FIG. 16.



Securing to a Single Buoy.—Use should be made of transits in the approach, in order to detect any set. The ship should have but little way, so that as the buoy is neared, the engines can be manœuvred to assist the rudder. It is important that the ship should be quite steady when the engines are finally put astern, otherwise any swing may be increased and the buoy missed. If good transits are available they will again be of use in detecting any movement of the ship after the buoy has disappeared from sight under the bow.

Leaving a Buoy.—On a calm day in a tideway, if the rudder is put over in the required direction before slipping, the ship will sheer two or three points according to the strength of the stream. The slip rope can then be let go at the appropriate moment when the buoy is well clear of the stem.*

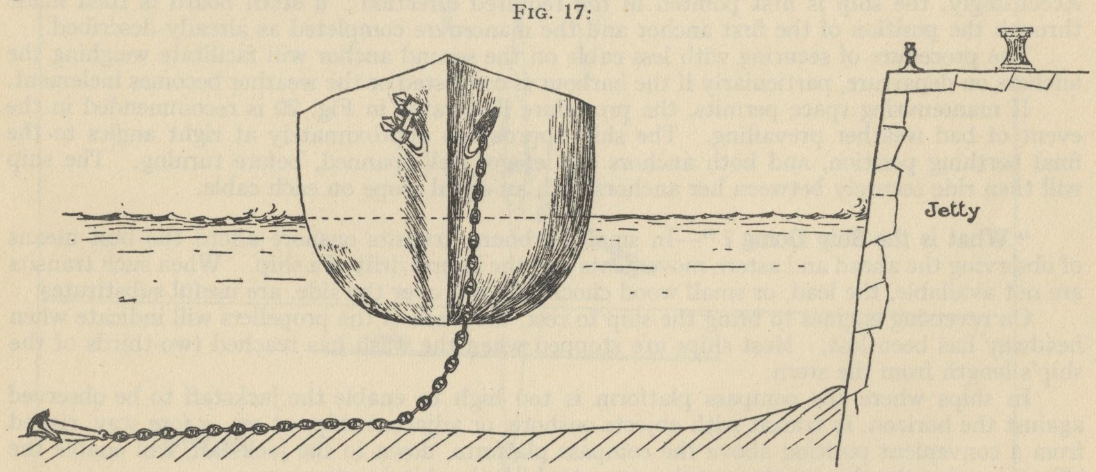
When the ship is secured between two buoys, with a wind on the beam, time can frequently be saved by easing away both the head and stern slip ropes, enabling the ship to ride well to leeward of the buoys. When ready to slip, both slip ropes can be let go approximately together, and the engines put ahead at once. The report " All clear aft " should, however, normally be received on the bridge before slipping forward.

Berthing at a Wall or Jetty.—The ship should be so handled that in the last stages of the approach, she is heading in at an angle of 10° to 20° and can be brought up with slow or half astern on the outer engines. Under such circumstances, use of the inner engines astern should be avoided owing to the mass of water propelled forward between the ship and the jetty. At first, the stern is forced away from the jetty and the bow in ; but as the ship's way is checked and the wash passes forward, the ship is set bodily out from her berth.†

The inner engines can, however, be used astern to advantage should the ship find herself approaching her berth with the stern swinging heavily towards the jetty, or an onshore wind setting her down too rapidly.

If there is danger of the bow falling heavily on to the jetty, it can be checked by letting go the inshore anchor. (Fig. 17.)

FIG. 17.



Under certain conditions of conflicting wind and stream, it may be advisable to bring the ship up dead, short of her berth and then go ahead into it, using rudder and engines as necessary.

In a single-screw right-handed ship, it is preferable to berth port side alongside. The ship can then approach at a steep angle, which is often an advantage at a crowded wharf. If, however, it is necessary to berth starboard side alongside with an offshore wind, the ship

* A small ship will sometimes find it advantageous when leaving a river buoy on the ebb, to reeve a slip rope from aft and allow the ship to swing on it.

† *See* page 19—EFFECT ON STEERING WHEN PASSING THROUGH CANALS AND RESTRICTED WATERS The sheer experienced when approaching a canal bank may also be felt when closing a solid wall or jetty.

should approach as close as possible at slow speed. Immediately prior to reversing the engines, the bow should be canted out, assisted if necessary by a " kick " ahead ; the screw effect when going astern, will then balance the outward cant.

Leaving a Wall or Jetty.—Leaving a jetty unaided by tugs, it is preferable to leave stern first, except when there is a strong offshore wind, when all hawsers can be cast off and the ship will drift clear. Before moving the inner propellers, they should be manœuvred well clear of the jetty by going slow ahead on a spring with the outer engines. If it is necessary to leave bow first, the ship should be manœuvred astern on a spring, after placing a catamaran aft to keep the inner propellers clear of the jetty.

When a current is setting along the jetty from forward, the bow hawsers should be cast off first. The bow will sheer away from the jetty, the remaining hawsers can then be cast off and the current will carry the ship clear.

Similarly, when the current is setting from aft, the ship will clear without difficulty by reversing the process.

Berthing Stern to a Mole or Jetty*.—This is a frequent practice in small congested harbours, and the method adopted will depend on the weather conditions and the space available for manœuvring.

In Fig. 18, the ship approaches the position of the first anchor on a convenient course and anchors with slight headway to permit spanning the anchors. The ship is then turned at rest (or on the anchor in a single-screw ship) until the stern is pointed in the required direction. Sternway is then gathered and the second anchor let go when two or three shackles have been veered on the first anchor. Cables should be veered judiciously in order to ensure a taut moor, otherwise there may be risk of parting the stern hawsers when attempting to heave in slack cable after securing aft.

Fig. 19 illustrates circumstances where there is no room to turn after anchoring. Accordingly, the ship is first pointed in the required direction ; a stern board is then made through the position of the first anchor and the manœuvre completed as already described.

The procedure of securing with less cable on the second anchor will facilitate weighing the anchors on departure, particularly if the harbour is congested or the weather becomes inclement.

If manœuvring space permits, the procedure illustrated in Fig. 20 is recommended in the event of bad weather prevailing. The ship approaches approximately at right angles to the final berthing position, and both anchors are let go, well spanned, before turning. The ship will then ride securely between her anchors with an equal scope on each cable.

" What is the Ship Doing ? "—In small harbours, transits onshore afford the best means of observing the ahead and astern movements and the lateral drift of a ship. When such transits are not available, the lead, or small wood chocks thrown over the side, are useful substitutes.

On reversing engines to bring the ship to rest, the wash of the propellers will indicate when headway has been lost. Most ships are stopped when the wash has reached two-thirds of the ship's length from the stern.

In ships where the compass platform is too high to enable the jackstaff to be observed against the horizon, in transit with objects onshore, or adjacent ships at sea, a fore stay, rigged from a convenient position above the compass platform, down to the jackstaff, will enable the officer conning the ship to observe the rate at which the ship is swinging.

Passage through Canals and Restricted Waters†.—Ships moving through canals or restricted waterways, produce a cushioning or banking-up effect on the water which is proportionate to the ship's displacement and speed. Hence the local orders imposing a speed limit at dock

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* In some well-sheltered harbours one anchor only is used to hold the ship, with a second underfoot to prevent yawing.

† *See* O.U. 5390/27, Passage of H.M. Ships through the Panama Canal, and Hydrographic publication H.D. 300, Information on Suez Canal.

Figure 18.

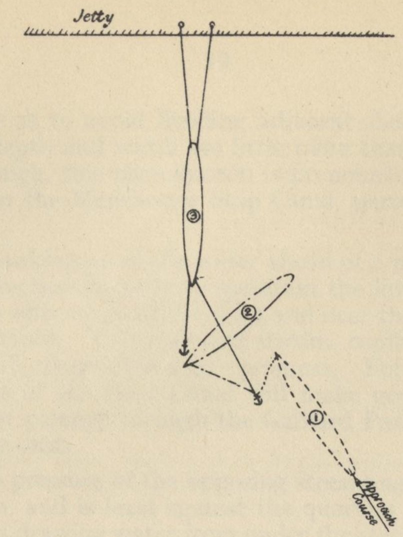


Figure 19.

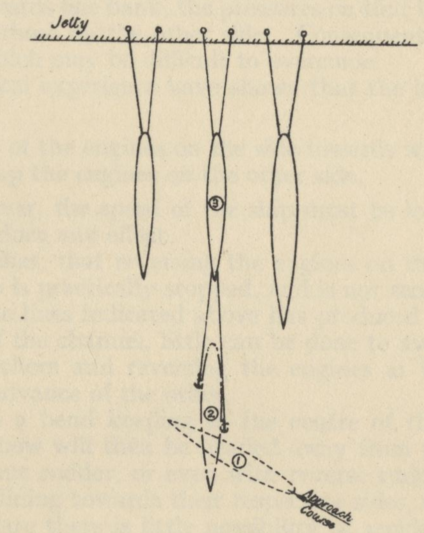
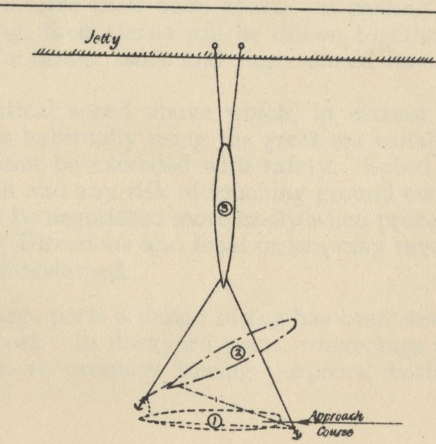


Figure 20.



approaches and harbours, so as to avoid flooding adjacent shores and damaging craft in the vicinity. In canals, where depth and width are little more than the draught and beam of the largest ships which pass through, this phenomenon is pronounced. It is on record that a ship proceeding at undue speed in the Manchester Ship Canal, parted the hawsers of a ship three miles away.

Effect on Speed.—The banking up of the water ahead of a moving ship generates a current or stream in the opposite direction in order to maintain the level of water in the canal; it is greatest in the centre (*i.e.*, on either side of the ship) and near the surface, and least at the sides and near the bottom of the canal. This opposing stream, combined with the effect of shallow water described in Chapter III, retards the ship's progress. For example, a heavy ship passing through the narrow portions of the Suez Canal will make good approximately 5¼ knots at revolutions for 7 knots, whilst passage through the Gaillard Pass of the Panama Canal reduces a ship's speed by some 40 per cent.

Effect on Steering.—The pressure of the opposing stream against the bows decreases when past the ship's greatest beam, and is least against the quarters; the reduction is accentuated by the action of the propellers drawing water from under the stern. So long as the ship remains in the centre of the canal, these pressures are divided equally either side of the ship. Should the ship, however, move towards one bank, the pressures on that bow and quarter will be greater and less respectively, than those on the other side. Consequently, the ship will tend to sheer back towards the centre, which may be difficult to overcome.

Experiment and practical experience have shown that the best method of breaking a bad sheer is to:—

Increase the speed of the engines on the side towards which the ship is sheering.
Reduce or even stop the engines on the other side.

To be successful, however, the speed of the ship must be low in order that there shall be ample reserve power to produce any effect.

Experiment shows further, that reversing the engines on the side away from the sheer is less effective unless the ship is practically stopped, and is not recommended.

If prompt action on the lines indicated above has produced no effect by the time the bow has sheered to the centre of the channel, little can be done to avoid striking the opposite bank beyond letting go both anchors and reversing the engines at full power. The mid-channel anchor should be let go in advance of the other.

Ships should approach a bend keeping in the centre of the canal, but inclining to the outside of the bend. The bow will then be headed away from the nearer bank and the bend sometimes negotiated without rudder, or even with reverse rudder. Further, when two ships are passing, rather than inclining towards their respective sides, they should steer to pass close to each other. With due care there is little possibility of accident, for, on meeting, the water pressure between them will force their bows apart; in passing they will tend to parallel each other, and when separating, their sterns will be drawn together. Thus, these influences will counteract the effect of the nearer bank and ships should have no difficulty in regaining the centre of the channel.

Every ship has a critical speed above which, in certain depths, her steering becomes increasingly erratic. Ships habitually using the great sea canals have a speed known as their "canal speed," which cannot be exceeded with safety. Speed must also be limited in order to avoid damage from wash and any risk of touching ground owing to increased draught.

Bends may sometimes be negotiated more easily when proceeding with the stream.

A study of the Sailing Directions and local orders may reveal local phenomena regarding which it is desirable to be forewarned.

Use of Tugs.—In all large ports a design of tug has been developed which best meets with the requirements of that port. In dockyard ports, where tugs are required for moving ships without steam in addition to ordinary towing purposes, both paddle and screw tugs are maintained.

Screw tugs are more suitable for towing ahead and, by reason of the immersion of the propeller, can exert more power in rough weather. **Paddle tugs** are neither intended nor suitable for long tows at sea. On the other hand they are better adapted for towing alongside ; the turning moment exerted by their paddles is greater, and they are capable of developing more power astern. Their shape, however, precludes them from being used alongside submarines and certain other types of warship. They are better suited for pushing against a ship, since they can more easily maintain their position.

Ships should avoid gathering headway or sternway when a tug's hawser is growing at a large angle to the ship's fore and aft line, such as when hauling off a wharf. In such a situation there is risk of the tug being drawn in against the ship's side, or of parting the tow. Further, the movements of the ship may render it impracticable for the hawser to be slipped in the tug. For this reason, the ends of towing hawsers are required to be brought to slips in-board unless the tug is secured alongside.

Ships with steam at command, should not employ **tugs alongside** if it can be avoided, since this involves risk of fouling the propellers, and damage to the ship or tug owing to swell. The ship's own engines can usually provide all the astern power and turning moment required, and the manœuvre can be expedited if tugs are not so employed. Moreover a tug in such a position can be of little assistance in preventing a ship from drifting broadside, but she may render valuable service by standing by to pass a hawser if required.

A twin-screw ship with one engine disabled, may usefully employ a tug secured to the disabled side.

A single-screw ship should secure a tug preferably to the port side.

With the thin platting used in the structure of modern ships, the employment of **tugs to push** should be exercised with reserve, although there may be no alternative if the ship has a tendency to fall away from a wharf after proceeding alongside, as it is impossible to hold the ship up to the wharf by towing, owing to lack of manœuvring space. Twin- or multiple-screw ships, can, however, usually be manœuvred close alongside with their own engines and a bow tug. A tug cannot push if the stream is more than slight, or if the ship has way on her.

When a ship cannot be controlled by her rudder alone, and when passing through narrow harbour channels with sharp bends, it is advisable to employ a **tug ahead** to assist the rudder. Ships with large turning circles will also require to use their main engines to check the advance and assist the turns. If an additional tug is available, she should stand by at the bends ready to act in an emergency.

A **bow tug** should be slipped if the speed of the ship rises to within three knots of the maximum available speed of the tug. In practice, a capital ship can usually proceed at 8 knots with a dockyard screw tug towing ahead ; the automatic reduction in speed to about 5 or 6 knots at the end of an alteration of course allows time for the tug to recover position after the turn.

Turning round in confined waters the usual practice is to manœuvre the ship with her own engines assisted by a screw tug ahead. Additional tugs may be used in case of necessity to push at the bow or stern.

A **stern tug** is used in many ports, but it is well to avoid this in order that the ship may not be hampered in the use of her own engines. Space permitting, the ship would turn with slight headway which might endanger the stern tug. The outer propellers would be moving ahead, and should the hawser part or have to be slipped in the tug, the additional risk of fouling the propellers is introduced.

When **hauling off a wharf** with only one tug available, a small ship may haul off bodily by securing the tug's hawser at some convenient bollards midway between bow and stern. When two tugs are available, the stern should leave the wharf slightly in advance of the bows. In this way, the ship offers less resistance than if she were towed broadside, and by hauling off the stern first the propellers are clear for working sooner.

Pilots.—The Regulations and legal decisions indicate clearly that the Captain is ultimately responsible for the handling and safe conduct of his ship even under compulsory pilotage.

The pilot should be regarded as the expert on local conditions, and in certain circumstances the Captain may have to rely entirely on his knowledge, but this does not necessarily mean that the actual handling of the ships should be undertaken by the pilot.

Whilst it is normally desirable for the Captain to handle the ship with the pilot offering the ... ployed ... precise ... f dual ... ains. ... s and

Page 21. *Insert* new paragraphs at end of Chapter IV :—

" *Use of Aircraft.*—Aircraft can be used to assist carriers in turning at rest, or pointing ship, in narrow waters when tugs are not available.

Groups of six or more aircraft are ranged at the appropriate corners of the flight deck and, when their engines are running at high power, the turning moment on the ship is appreciable. Aircraft can also be used to assist the ship in leaving or berthing at a jetty without tugs.

Note.—Aircraft fitted with liquid cooled engines over-heat and cannot be used for prolonged runs."

(*D.N.D. 133/48—A.F.O. P.115/48.*)

CHAPTER V.

A FLEET LEAVING AND ENTERING HARBOUR.

Unmooring and shortening in cable.—Weighing.—Turning together.—Weighing in succession.—Making smoke.—Turning at rest.—Leaving an open anchorage.—Inverting the line on leaving harbour.—Winds and currents in narrow waters.—Responsibilities of the Guide when anchoring.—Two precautions.—Anchoring a column in a cross-current or wind.—Station keeping when approaching an anchorage.—Speed when approaching an anchorage.—Anchoring in pre-arranged berths.—Preparation of an anchorage plan.—Anchoring when berths have not previously been arranged.—Anchoring in line abreast.—Clear or foul berth ?—Example of a fleet entering harbour.

Unmooring and Shortening in Cable.—One of the objects of mooring being to enable ships to berth more closely together, corresponding care is necessary to avoid incommoding one another when unmooring. For example, when a squadron is moored and the ships are lying in line with their anchors, if one ship is quicker than her next ahead, she should delay shortening in on her weather anchor until her neighbour has weighed her lee anchor.

The mooring plan of a squadron should be so arranged that one ship in the squadron may independently unmoor and proceed to sea without difficulty.

The object of a squadron shortening in preparatory to weighing is to ensure that the anchors break ground at about the same time.

Weighing.—The instructions for the conduct of a fleet direct that whenever a unit weighs together, ships should preserve their compass bearings and distances from their guides until further orders are received, each ship keeping her head in the direction in which she was lying before the anchors broke ground. Neglect of this instruction by a ship may hamper the movements of the guide, or those next to her. In a tideway, position relative of the land must be maintained in order not to drift down on ships whose anchors have not broken ground, or incommode others which may be in proximity to shoal water. The flagship or guide will similarly maintain her position by the land, except in a large or open anchorage where this is sometimes unnecessary. Ships must, therefore, be careful to observe the movements of their flagship.

Turning Together.—When weighing together it will often save time if the turning or " point ship " signal is made shortly after the signal to weigh is hauled down. This will avoid risk of ships taking a cant the wrong way.

Weighing in Succession.—In a strong ebb tide or in a confined harbour where there may be risk of ships drifting down towards other ships at anchor, it is sometimes preferable to order ships of a unit to weigh in succession from the rear. The remaining ships will have been instructed previously by signal when their anchors should be tripped ; usually when the ship astern has turned about 45°.

Screw tugs are more suitable for towing ahead and, by reason of the immersion of the propeller, can exert more power in rough weather. **Paddle tugs** are neither intended nor suitable for long tows at [illegible] they are better adapted for towing alongside ; the turning moment [illegible] capable of developing more power astern. [illegible] and certain oth[illegible] they can more [illegible]

Ships shou[illegible] a large angle to [illegible] there is risk of [illegible] the movements [illegible] For this reason, [illegible] the tug is secured alongside.

Ships with steam at command, should not employ **tugs alongside** [illegible] since this involves risk of fouling the propellers, and damage to the ship or tug owing to [illegible] The ship's own engines can usually provide all the astern power and turning moment required, and the manœuvre can be expedited if tugs are not so employed. Moreover a tug in such a position can be of little assistance in preventing a ship from drifting broadside, but she may render valuable service by standing by to pass a hawser if required.

A twin-screw ship with one engine disabled, may usefully employ a tug secured to the disabled side.

A single-screw ship should secure a tug preferably to the port side.

With the thin platting used in the structure of modern ships, the employment of **tugs to push** should be exercised with reserve, although there may be no alternative if the ship has a tendency to fall away from a wharf after proceeding alongside, as it is impossible to hold the ship up to the wharf by towing, owing to lack of manœuvring space. Twin- or multiple-screw ships, can, however, usually be manœuvred close alongside with their own engines and a bow tug. A tug cannot push if the stream is more than slight, or if the ship has way on her.

When a ship cannot be controlled by her rudder alone, and when passing through narrow harbour channels with sharp bends, it is advisable to employ a **tug ahead** to assist the rudder. Ships with large turning circles will also require to use their main engines to check the advance and assist the turns. If an additional tug is available, she should stand by at the bends ready to act in an emergency.

A **bow tug** should be slipped if the speed of the ship rises to within three knots of the maximum available speed of the tug. In practice, a capital ship can usually proceed at 8 knots with a dockyard screw tug towing ahead ; the automatic reduction in speed to about 5 or 6 knots at the end of an alteration of course allows time for the tug to recover position after the turn.

Turning round in confined waters the usual practice is to manœuvre the ship with her own engines assisted by a screw tug ahead. Additional tugs may be used in case of necessity to push at the bow or stern.

A **stern tug** is used in many ports, but it is well to avoid this in order that the ship may not be hampered in the use of her own engines. Space permitting, the ship would turn with slight headway which might endanger the stern tug. The outer propellers would be moving ahead, and should the hawser part or have to be slipped in the tug, the additional risk of fouling the propellers is introduced.

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The pilot should be regarded as the expert on local conditions, and in certain circumstances the Captain may have to rely entirely on his knowledge, but this does not necessarily mean that the actual handling of the ships should be undertaken by the pilot.

Whilst it is normally desirable for the Captain to handle the ship, with the pilot offering the necessary information, occasions may arise where the channel is intricate, tugs are employed or expert local knowledge is necessary, when it is preferable for the pilot to order the precise movements of the rudder and engines, in order to avoid the controversial procedure of dual control. Nevertheless, whatever procedure is adopted, the Captain's responsibility remains.

The procedure regarding British Naval Ports is laid down in King's Regulations and Admiralty Instructions, Article 721.

CHAPTER V.

A FLEET LEAVING AND ENTERING HARBOUR.

Unmooring and shortening in cable.—Weighing.—Turning together.—Weighing in succession.—Making smoke.—Turning at rest.—Leaving an open anchorage.—Inverting the line on leaving harbour.—Winds and currents in narrow waters.—Responsibilities of the Guide when anchoring.—Two precautions.—Anchoring a column in a cross-current or wind.—Station keeping when approaching an anchorage.—Speed when approaching an anchorage.—Anchoring in pre-arranged berths.—Preparation of an anchorage plan.—Anchoring when berths have not previously been arranged.—Anchoring in line abreast.—Clear or foul berth ?—Example of a fleet entering harbour.

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The object of a squadron shortening in preparatory to weighing is to ensure that the anchors break ground at about the same time.

Weighing.—The instructions for the conduct of a fleet direct that whenever a unit weighs together, ships should preserve their compass bearings and distances from their guides until further orders are received, each ship keeping her head in the direction in which she was lying before the anchors broke ground. Neglect of this instruction by a ship may hamper the movements of the guide, or those next to her. In a tideway, position relative of the land must be maintained in order not to drift down on ships whose anchors have not broken ground, or incommode others which may be in proximity to shoal water. The flagship or guide will similarly maintain her position by the land, except in a large or open anchorage where this is sometimes unnecessary. Ships must, therefore, be careful to observe the movements of their flagship.

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Making Smoke.—Special care should be taken to avoid making smoke when entering or leaving harbour in order that navigation marks may not be obscured. The marks on leaving harbour are often astern and if the rear ships make smoke, the leading ship will not see them.

Turning at Rest.—When ships that are stopped are ordered to turn together, it is customary to turn at rest, ships preserving their compass bearings and distances from the guide. Usually ships regulate their rate of turning to that of the slowest ship, but circumstances such as a crowded tidal river may make it desirable for every ship to turn as quickly as possible.

Leaving an Open Anchorage.—When leaving an anchorage in an open bay, a squadron commander may order ships to turn together to the course for leaving harbour, followed merely by a speed signal. Ships will then go ahead together, preserving compass bearings and distances. A forming and disposing signal may be expected on reaching the open sea.

Alternatively, he may hoist formation, course and speed signals, and then proceed ahead under rudder at the speed ordered, turning direct to the course for leaving harbour, without any preliminary point ship signal.

Inverting the Line on Leaving Harbour.—If the flagship led the squadron into harbour in single line and intends to lead it out, it is frequently necessary to invert the line. In these circumstances, it is preferable to turn together 20° short of the course for leaving harbour, each ship will then point clear of her next ahead. When the moment arrives, each ship is in a position to go ahead at once into clear water without having first to turn back 10° or 20°, with consequent risk of unduly closing her next ahead. Figs. 21 and 22 illustrate this point.

Fig. 21.

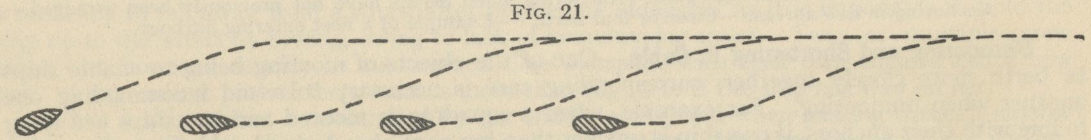
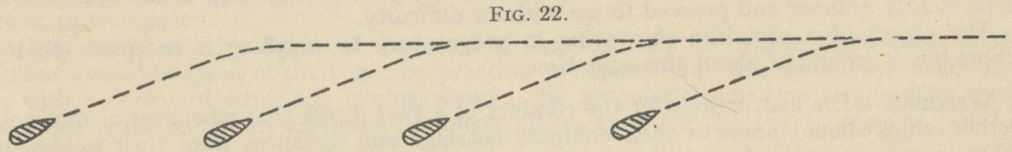


Fig. 22.



When to go Ahead.—Until experience has been gained, a time interval should be used for determining the moment to go ahead when forming astern. For example, a squadron intends to invert the line and proceed to sea at 10 knots. The guide is lying three cables astern of the second ship, and her position after inverting the line, will be three cables ahead. At 10 knots she would run six cables in 3 minutes 36 seconds. The second ship should, therefore, proceed at the speed of the fleet, 3 minutes 36 seconds after the guide, as indicated by the hoisting of her cones or the wash of her propellers. This method will serve only for ships of the same class. A slide rule can be devised for calculating the moment to go ahead in ships of dissimilar classes (Diagram 9.)

To ensure the manœuvre being well performed, there must be a sufficient margin of speed. Should appearances indicate that the ship will drop outside station, a large increase should be made without delay. It is easy to reduce speed if too close, but difficult to regain lost ground.

It is important that no ship should be premature in gathering way. Such action will prolong the manœuvre owing to the ships astern taking longer to pass those ahead. Also, more than two ships may find themselves abreast at a time or otherwise mutually incommoded.

FIGURE 23.

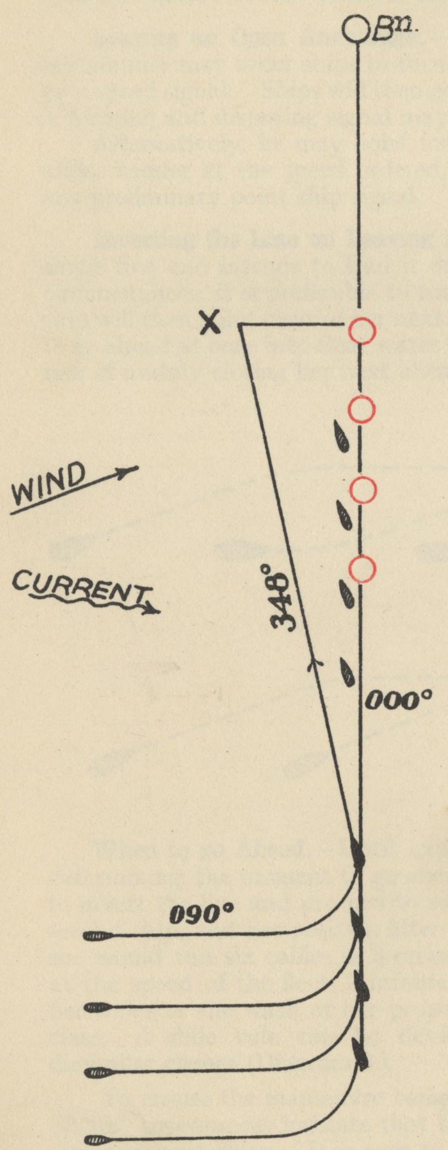
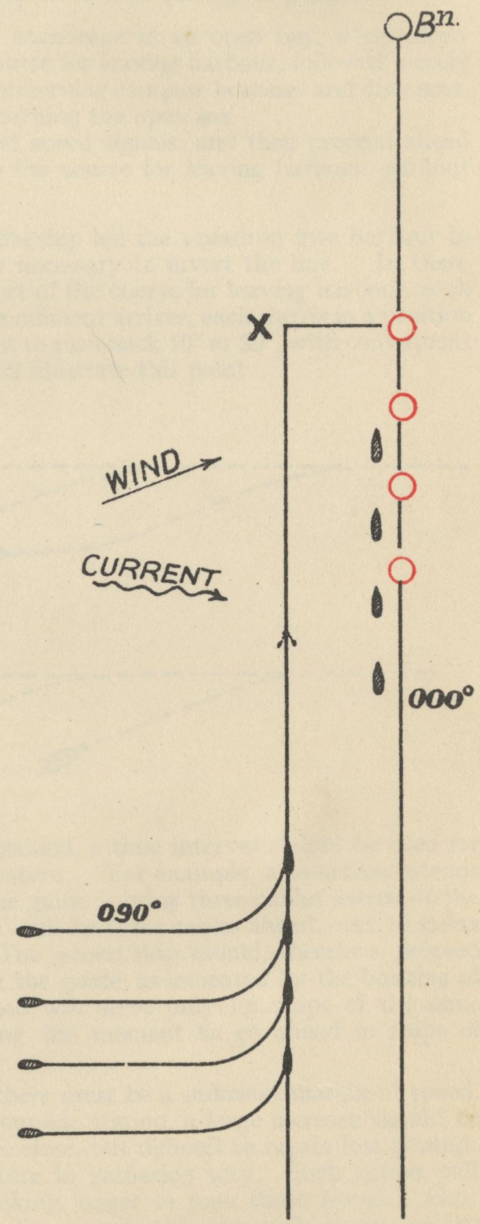


FIGURE 24.



Thus, the temptation to start going slow ahead early in order to be certain of not falling astern of station should be resisted, and the engines ordered direct to the speed of the fleet at the correct interval. Co-operation with the engine room staff is necessary in order to avoid making smoke.

Winds and Currents in Narrow Waters.—Cross currents may embarrass a column of ships passing in single line through a narrow channel, and the first consideration should, therefore, be safe navigation. Ships should endeavour to proceed along the same track as the guide rather than follow in her wake. If the column is being led on a transit or leading mark, it may be helpful to form ships on the reciprocal bearing.

Similarly, when passing from an area of slack water into a strong current and *vice versa*, such as in the Pentland Firth and approaches to Scapa Flow, some disorder may ensue. The commander of the column may take the precaution of placing ships in open order as his flagship enters an adverse current, reverting to close order as soon as the rear ship has entered. Rear ships should be alert to anticipate and make provision for the difficulties that lie ahead of them.

In a strong cross wind, to prevent ships sagging down to leeward, they may be ordered to maintain compass bearings and distances from the guide.

Responsibilities of the Guide when Anchoring.—When the ships of a fleet are about to anchor together, the success of the manœuvre depends largely on the manner in which the flagship or guide is steered. Perpetual alteration of the course, either from lack of supervision of the steering, or from want of judgment in the allowance for wind or tidal stream will enhance the difficulties of the rear ships.

Two Precautions may well be taken by the officer commanding the squadron. Firstly, having arrived on the anchoring course, to look astern frequently and observe the wake of his flagship. Secondly, to make the signal to take up bearings and distances as arranged for anchoring, as early as possible. If, subsequently it is necessary to alter course, even if only 5°, the signal should direct ships to turn together. They will then be on their correct line of bearing whenever they may anchor.

Anchoring a Column in a Cross Current or Wind.—In Fig. 23, the berths to be occupied are shown by *red* circles. The guide approaches the anchoring course steering 090° with ships on a bearing 180°. Allowing for reducing speed and stopping engines, it is estimated that wind and current will set the column three cables to leeward during the final approach. A position " X " is plotted three cables to windward of the flagship's berth and the column turned together on to the anchoring line, but steering a course of 348°. If the estimate has been accurate, the column will find itself slightly to windward on stopping engines. As the speed through the water falls, the correspondingly increased drift should carry the column on to the correct line by the time the signal to anchor is hauled down. It is important that the guide should proceed accurately along the penultimate course as drawn on the chart, or the position of the point " X " will require reconsideration.

Fig. 24 illustrates the procedure when accuracy in anchoring in pre-arranged berths is of secondary importance. The column is turned together to the anchoring course, but three cables short of it.

The first method possesses the advantage that, less sea room is required during the final approach, and the bearing of the beacon ahead will indicate at once whether the desired line of approach is being maintained. If it becomes apparent that the flagship may not arrive in her correct berth and it is not important to anchor the squadron exactly in the berths allocated, it is preferable to sacrifice accuracy rather than to upset the station keeping by altering course within the last mile.

Station Keeping when approaching an Anchorage.—It is of paramount importance to maintain accurate station when approaching an anchorage.

When in line ahead, station may be kept by two officers ; one will conduct the steering or conning, the other the distance and speed. If, however, the ship is on a bearing, since bearing and distance depend so much the one upon the other, the task should be confined to one officer. The other can assist by keeping a continuous setting of the ship's position relative to the guide, on the Battenberg, mooring board or Quartogram, as described in Chapter VI. Although the task of station keeping may be shared, responsibility must rest with one officer only.

The same officers should invariably conduct the station keeping when approaching an anchorage, in order that their familiarity with their own ship, and any characteristics of the flagship, will ensure the best results.

When a ship in the line is allowed to get out of station and then tries to correct her position by a sudden alteration of speed, she may affect all the ships astern of her, with the result that some may anchor out of their proper berths.

The ideal to be aimed at is to be in station and steady on the guide at the moment of stopping engines. If a ship is ahead just prior to stopping, she will have reduced speed and be carrying less way than the flagship. Subsequently, a few revolutions ahead after the latter has stopped, will not unfavourably affect those astern. If, however, a ship is astern of station and increases speed in the last few moments, she will have too much way when the flagship stops. She will then overrun and be unable to correct it without affecting those astern.

Speed when approaching an Anchorage.—The speed at which a unit approaches an anchorage must be regulated to suit the requirements of the heaviest ship, who will carry her way longer than the remainder. A heavy ship should be the guide of a unit consisting of both heavy and light ships. The latter will reduce speed and stop engines later than the heavy ships, and in such cases the Admiral will make use of the signal "Admiral intends to stop engines." When the light ships are formed in separate columns, their commanders may be directed to make their own signals.

Anchoring in pre-arranged Berths.—When pre-arranged berths have been allocated, the method of anchoring should be indicated by signal, but bearings should invariably be laid off in case they are needed. If ships are to anchor independently by shore marks, the usual procedure is for the Admiral to lead the columns into harbour so formed and disposed that each ship will pass through her allotted berth. The signal to "anchor in the manner previously arranged" is then made when convenient. Ships maintain station as far as is practicable up till the moment of anchoring, but they are at liberty to steer for their assigned berths after the above signal has been hauled down.

Preparation of an Anchorage Plan.—In arranging anchor berths, the allowance necessary to ensure that ships will swing clear of dangers will vary with the degree of shelter afforded by the anchorage, the nature of the holding ground, the suitability of marks for anchoring accurately, the reliability of the survey, etc. When preparing mooring berths for heavy ships, allowance must be made for ships lying about 80 yards to leeward of their line of anchors when at open hawse. The anchors must be so placed that the ship can safely weigh either anchor when heading in any direction. A summary of the minimum distances between anchor and mooring berths for various classes of ship, will be found in Table 7.

Anchoring when Berths have not previously been Arranged.—When a large fleet is being anchored together, no previous preparations having been made, the Admiral will, nevertheless, signal bearings and distances for anchoring. His intentions as to the relative positions of ships on anchoring are thus made clear to the fleet.

Ships should take care to maintain their correct compass bearing from their guides. It is not sufficient to follow in the wake when anchoring in line ahead. The column guide may require to adjust her distance slightly from the guide of the fleet after stopping engines, and may alter course a degree or two without signal.

Anchoring in Line Abreast.—When ships of different classes are anchoring together in line abreast, or on a bearing, a small adjustment is necessary to allow for the difference in length from the stem to standard compass.

Clear or Foul Berth ?—When a fleet is approaching an anchorage the following methods may be employed to determine whether the proposed berths are clear of ships already at anchor :—

(*a*) Two widely separated bearings of the anchored ship when she is in transit with two objects marked on the chart.

(*b*) Two widely separated bearings, each with a simultaneous fix of the observer's ship.

(*c*) A single bearing and rangefinder range or masthead angle, with a simultaneous fix of the observer's ship.

Method (*c*) has the advantage of obtaining the position of the anchored ship without waiting for a second bearing.

Example of a Fleet entering Harbour.—Diagram 10 illustrates the anchoring of a fleet in Port Argostoli.

In order that the fleet may be concentrated near the town of Argostoli, the anchorage plan has been prepared so that heavy ships and cruisers shall moor, with the remainder at single anchor.*

Flagships will occupy the southernmost berths in each line, which may necessitate inverting the lines.

The Approach of the Main Body.—The ships occupying A, B and C lines will probably assume a special temporary organisation of three divisions, promulgated in orders, so that they may be manœuvred as a whole.

The main body approaches from the westward, on an 090° course, at a speed of 10 knots, organised in divisions in line abreast, columns disposed astern, and steering so that the northern wing ships will pass about 7 or 8 cables south of Vardiani Island Lighthouse, outside the 10-fathom line.

St. Nikolaos Island may be used as a mark ahead, but it is rather too distant and may be difficult to distinguish against the surrounding background. With the help of the small scale chart there should, however, be no difficulty in selecting suitable marks to fix with on the shore [illegible] of Vardiani Island.

[illegible] pendant to the anchoring course may be determined by [illegible] Island Lighthouse. A bearing of St. [illegible] that [illegible] whilst approaching [illegible] necessitates closing the columns to 2½ cables [illegible] the main body may steer to pass at a greater distance from [illegible] a longer run to the northward.

It will be observed that there are no marks ahead, and ships must, therefore, rely on fixes during the approach.

The leading ship of "A" line will become guide of the fleet and may be ordered to lead into harbour, but the executive signals to reduce speed, stop and anchor, will be controlled by the Admiral, except that the cruiser squadrons may be released at the last moment and ordered to "anchor in the manner previously arranged."

The corner of the quay at Lixuri used as a mark for letting go the flagship's anchors may be difficult to distinguish. Alternative bearings of other objects should, therefore, be laid off.

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* *See* Table 7—Spacing of berths for various units of the fleet.

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Page 24. Preparation of an Anchorage Plan. At end of paragraph add:-

"It should be borne in mind that adjacent ships of different types are liable to drag out their cables in opposite directions under certain conditions of wind and tide."

(Previous amendment No.4.- A.F.O. P.204/41.)

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The main body approaches from the westward, on an 090° course, at a speed of 10 knots, organised in divisions in line abreast, columns disposed astern, and steering so that the northern wing ships will pass about 7 or 8 cables south of Vardiani Island Lighthouse, outside the 10-fathom line.

St. Nikolaos Island may be used as a mark ahead, but it is rather too distant and may be difficult to distinguish against the surrounding background. With the help of the small scale chart there should, however, be no difficulty in selecting suitable marks to fix with on the shore to the northward of Vardiani Island.

The moment to turn by Blue pendant to the anchoring course may be determined by running on by time from a beam bearing of Vardiani Island Lighthouse. A bearing of St. Georgios Point will afford a check.

It will be seen from a persual of the remarks on inverting the line in Chapter VI, that ships have sea room to invert the lines after turning to the anchoring course. For reasons of economy, however, ships may have steam for only 12 knots, which will leave them but little time to settle down after inverting the line.

It may, therefore, be preferable to form ships on their bearings and distances for anchoring whilst approaching from the westward. In any event, the width of the entrance channel necessitates closing the columns to 2½ cables before turning to the northward. Alternatively, the main body may steer to pass at a greater distance from Vardiani Island, in order to obtain a longer run to the northward.

It will be observed that there are no marks ahead, and ships must, therefore, rely on fixes during the approach.

The leading ship of " A " line will become guide of the fleet and may be ordered to lead into harbour, but the executive signals to reduce speed, stop and anchor, will be controlled by the Admiral, except that the cruiser squadrons may be released at the last moment and ordered to " anchor in the manner previously arranged."

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* *See* Table 7—Spacing of berths for various units of the fleet.

The Approach of the Destroyers.—The approach and anchoring of the destroyers in a body present some difficulty, but the example has been chosen deliberately in order to illustrate some of the many problems which may be encountered. They will approach at 12 knots, and may be anchored by three alternative methods :—

(*a*) If they precede the main body into harbour. Ships may take up bearings for anchoring whilst approaching from the westward, and turn by Blue pendant to a northerly course so as to pass close along the western shore. Columns will close to anchoring distance during the run to the north.

They will finally turn to a course of 090° when off Lixuri and anchor in line abreast.

This method may be used if time is of importance, but difficulty may be experienced in keeping accurate station in line abreast on so short a final approach course.

(*b*) Ships may proceed well to the northward towards Livadi Bay, already formed on bearings and distances for anchoring as shown in Diagram 10.

The Senior Officer Destroyers will inform his force that the second ship in "P" line is to consider herself a leader when turning by White pendant, and will thus alter course together with the Senior Officer's ship.

Ground must be gained to the westward in order that ships may have sea room to turn 180° later. Accordingly, a White pendant turn to 345° will be executed 3½ minutes after the rear ship has passed Lixuri North Breakwater. Course will then be reversed by Blue pendant, followed by a White pendant turn to 140° to gain ground to the eastward. Whilst on this course, frequent fixing and careful station keeping will be necessary to guard against the eastern column passing dangerously close to the point south of St. Christopher Church.

Finally a White pendant turn is made on to the anchoring course.

The Senior Officer Destroyers will find S. Theodoro Lighthouse a convenient mark ahead.

(*c*) If destroyers follow the main body into harbour, they may approach in one prolonged single line from the westward or southward, passing between "A" and "B" or "B" and "C" lines. Senior Officers will then take charge of ships in their lines, lead round by Compass pendant and anchor each line independently.

In methods (*b*) and (*c*), the ships occupying the northern berths may have little or no time to settle down on the final course before anchoring, but this cannot be avoided.

The cruiser flagship of the Senior Officer Destroyers may find difficulty in manœuvring with the remainder of his force during the approach in method (*b*). In such circumstances he may hoist the "disregard" during the large turns, subsequently resuming control when his flagship has regained position on the remainder.

Owing to the short distance run by destroyers between stopping engines and anchoring, the Senior Officer Destroyers would probably not let go with the remainder, but turn aside when the anchoring signal is hauled down, subsequently anchoring independently.

Alternatively, the Senior Captain (D) may be directed to conduct the later stages of the operation.

CHAPTER VI.

THE HANDLING OF SHIPS IN A FLEET.*

The art of handling ships in a fleet.—Maintenance of station by minimum alterations of speed and rudder.—Correct station on the Guide.—Measuring distances.—Station keeping at a distance.—Use of speed flags.—Errors in station keeping.—Station keeping in quarter line or on a bearing.—Tactical rudder.—Steering of ships in line ahead.—Altering course in succession.—Handling a column in line ahead.—Taking up and changing station.—The Zig-zag method.—Forming astern of a wing ship.—Inverting the line.—Ships hauling out of line turn outwards.—Taking station from a position ahead or on the bow.—Taking station from a position broad on the bow.

The essence of the art of handling ships in a fleet is good seamanship allied with regard for consorts.

The first edition of this book was issued in pamphlet form by Admiral-of-the-Fleet Sir Geoffrey Phipps Hornby, G.C.B., whilst Commander-in-Chief in the Mediterranean, 1877-1880.

Despite far-reaching changes in ship design, his principles remain fundamentally true today. Briefly summarised, they are as follows :—

(*a*) Steady speed.

(*b*) Accurate steering.

(*c*) Use of equal rudder power.

(*d*) Perfect co-operation born of good comradeship in the line.

(*e*) The cultivation of a trained eye, resulting from experience and a natural aptitude.

(*f*) The ability to act with accuracy, rapidity and boldness, arising from knowledge of one's own ship and of all orders and instructions regarding the conduct of a fleet.

With regard to good comradeship in the line, the officer of the watch must always have present in his mind the direction, **remember your next astern,** and must remember his obligations to other adjacent ships. He will learn from the mistakes of his next ahead, how best he may help his next astern. The officer of the watch of the guide must pay particular attention to the steering. If he notices ships astern steering badly, it may be the fault of his own ship.

Maintenance of Station by Minimum Alterations of Speed and Rudder.—A ship should be kept in station by the smallest possible alterations of speed and rudder. In certain conditions, however, large rudder angles may be unavoidable. This will in turn have some effect on the speed, but the maintenance of a steady course must take precedence.

As regards speed, small alterations applied at the first indication of a ship getting out of station will usually suffice ; unless, however, the officer of the watch is able to give the station keeping his undivided attention, this first indication may be missed, and resolute measures must be taken to regain station. A ship one cable out of station is not justified in taking a quarter of an hour creeping back.

Destroyers and other light craft are more easily affected by wash and other external influences and require larger but briefer alterations of speed than are necessary in heavy ships.

Heavy ships steaming at slow speeds and all ships steaming against steep head seas, require larger alterations of speed and rudder than are normally sufficient.

Correct Station on the Guide.—Ships in column are ordered to maintain the bearing and distance from their guide, but this order is qualified by another which directs them to be guided by the motions of the nearest ship between them and their guide, provided that such ship is

* *See* Signal Manual—Instructions for the conduct of a fleet.

preserving her station. In practice it is often difficult to get frequent and accurate distances of the guide; nevertheless, officers who endeavour only to maintain their distance from the next ship towards the guide, will not keep good station. When ships repeat the mistakes of others, the effect is cumulative down the line and results in increased difficulty for the rear ships.

Measuring Distances.—The distance between ships is the distance measured from stem to stem and allowance must be made for the position of the observer in his own ship, and the mark used in the other ship.

The instruments available for station keeping are :—

Stuart's Distance Meter.

Navigational Rangefinder.

Sextant.

When using a vertical angle of the truck or other object to waterline, the waterline immediately below the object should be observed. When in line ahead, this point cannot be seen, but some equivalent mark can be selected by eye. Alternatively, the waterline may be neglected, and any two well-defined marks, such as the main truck and top of the stern walk, used. The true vertical angle of the truck to stern walk as viewed from the observer's bridge, can then be calculated trigonometrically and used for checking and adjusting the above-mentioned aids to station keeping.

When steaming at night without lights, station is kept by eye assisted by such aids as the varying size of the ships ahead seen in the field of a binocular, and the variations in height between the blue stern light and own jackstaff light. In ships where the jackstaff is not high enough, a faint blue light may be fitted to the fore stay, so that when the ship is in station, the light is coincident with the stern light of the next ahead. The difference in height between the observer and his jackstaff or fore stay light must be sufficient to render the variations sensitive.

In calm weather the first sign of closing or opening on a ship in line ahead, is most readily detected by a mark in the observer's ship moving relatively to an object in the ship ahead.

Station Keeping at a Distance.—When stationed several miles from but in sight of a fleet, a horizontal sextant angle may be employed if the range cannot otherwise be obtained. If ahead of the fleet, the angle between the leaders of the wing columns should be taken; if abeam, the van and rear ships of the nearest column; and on a bearing, the extreme right and left hand ships.

Moderately accurate station can be kept by the Horizon method with the help of " Block Sketch Cards," O.U. 5292. Abnormal refraction may affect the accuracy of this method.

Use of Speed Flags.—Speed flags are of assistance when going in and out of harbour and when specially accurate station keeping is required. It is, however, important to become accustomed to keeping station without them. The change in the wake under the quarter of a ship will sometimes indicate an alteration of speed to a trained eye, especially at high speeds and in destroyers.

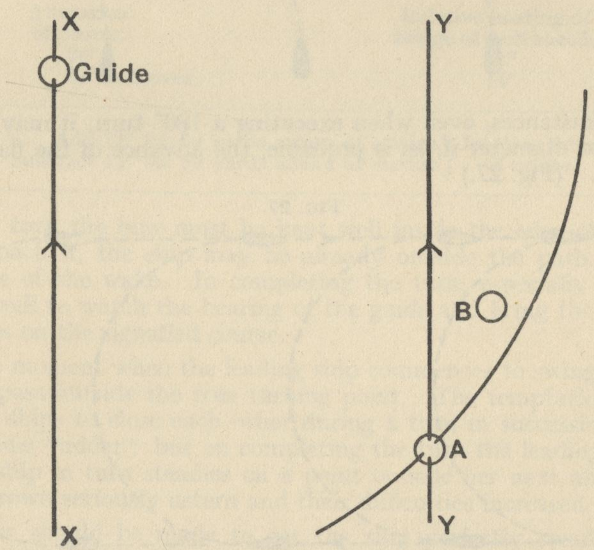
Errors in Station Keeping.—When in line ahead ships must not get astern of station. Not only does it take longer to regain lost ground than to lose it, but any lengthening of a column may inconvenience other columns forming on it or passing astern. Nevertheless, ships that habitually keep much inside distance will at times embarrass the column commander, and may cause delay in carrying out a manœuvre.

In line abreast or quarter line, any error from exact station is least embarrassing when astern of bearing and outside distance. A ship ahead of bearing and inside distance will find herself awkwardly placed if ordered to form astern, particularly in an equal speed manœuvre.

Station Keeping in Quarter Line or on a Bearing.—In line ahead the officer keeping station is concerned principally with maintaining distance. In line abreast or on a bearing, an alteration of either course or speed will affect both the bearing and the distance. Notwithstanding, station keeping on a bearing may be easier than when in line ahead owing to ships being unaffected by the wakes of their consorts. A plot of the correct and actual positions of the ship, on the Battenberg, Mooring board or Quartogram* will assist.

In Fig. 25, " XX " is the guide's track, " A " is the correct position of own ship when in station, and " YY " her correct course.

FIG. 25.



Observations reveal that the ship is ahead of bearing and inside her distance. Without plotting, an officer will be inclined to reduce speed and alter course **outward.** Position " B " in the figure shows the ship ahead of bearing and inside distance, but the correct action is a reduction of speed and a slight alteration **inward.**

The common fault when station keeping on a bearing is the use of too large alterations of course. Once a ship is on the track " YY," it should be possible to keep her there with not more than 2° alteration of course.

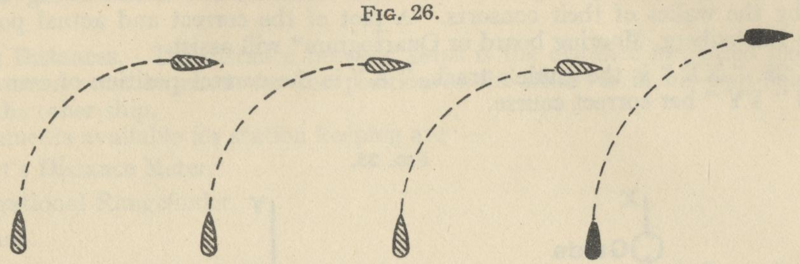
Tactical Rudder.—When ships are of similar class, the Admiral may merely state the rudder angle which he will use, but with ships of different turning capabilities, he will order a definite tactical diameter commensurate with the turning powers of the most unhandy ship of the squadron or fleet.

The Admiral may use less rudder for turns of 30° and under. Though ships of different classes may adjust their rudders to turn with the same tactical diameter, they will not necessarily turn on the same arcs owing to the possibility of their ratios of advance to transfer differing widely. The rudders must, therefore, be varied during the actual turn. For example, the Admiral may indicate that his flagship will use rudder for a tactical diameter of 800 yards.

* *See* Diagram 11.

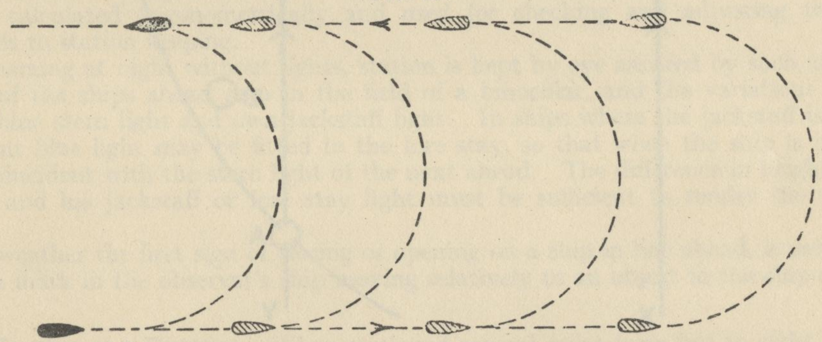
Her advance under tactical rudder for a 90° turn is 750 yards, but the remainder of the squadron, using tactical rudder, may advance only 500 yards for a similar turn. They must, therefore, adjust their rudder angles accordingly. (Fig. 26.)

Fig. 26.



Under such circumstances, even when executing a 180° turn, it may be unsuitable to use rudder for an 800-yard diameter if, as is probable, the advance of the flagship is greater than that of the remainder. (Fig. 27.)

Fig. 27.



The only remedy is to commence the turn under small rudder and increase it considerably later.

Whilst the task of bringing ships into exact station at the completion of a turn is by no means easy, when experience has been gained the errors should be small.

Steering of Ships in Line Ahead.—Ships are steered either by compass or on one of the ships ahead, preferably the leader. When they need not keep in the wake, such as when formed in line of battle, they are steered by compass. They should not stray too far on the quarter and must fall in astern for any alteration of course in succession.

When it is desired to keep in the wake, provided the quartermaster has a view, a ship will often be kept steadier by following the leading ship. It is then possible to meet instantly and prevent the ship's head being thrown off one way or the other by the wake of the next ahead, a disturbing factor at high speed. If ships ahead are steering erratically, maintenance of the correct bearing of the leading ship will produce better results than trying to keep the masts in line.

Altering Course in Succession.—After the ship ahead has put her rudder over, the next ship must steady by compass on the turning point. In ordinary circumstances, the exact moment for putting over the rudder is judged by the position of the "kick" of the next ahead (*i.e.*, the point where her stern started to swing outward). Experience will indicate where the position of this "kick" relative to own ship, should be. The "kick" is a treacherous guide if ships ahead are turning badly; they should then be ignored and attention confined to the leading ship.

Another method of judging when to put the rudder over is by time interval from the moment the rudder goes over in the flagship or next ahead. In ships fitted with steering signal gear, accurate results are obtained.

An even better method is by a relative bearing of the bridge of the leading ship. Tables can be constructed for the different positions a ship may occupy in the line.

"ROYAL SOVEREIGN" CLASS.

Second Ship in the Line.

Alteration of course.	Relative bearing of bridge of next ahead.
30°	12°
55° and over.	14°

Add 1½° for 50 yards astern of station } In close order.
Subtract 1½° for 50 yards ahead of station } 3 cables.

Throughout the turn the bow must be kept well inside the edge of the wake, for should the stem even approach it, the ship may be already outside the path. It is the stern that must be on the edge of the wake. In completing the turn, especially when ships ahead are turning badly, it is well to watch the bearing of the guide and bring the ship on to the correct bearing as she arrives on the signalled course.

To return to the moment when the leading ship commences to swing. A common mistake is to steady by compass outside the true turning point. The temptation to do this is caused by the tendency for ships to close each other during a turn in succession, owing to each ship losing way whilst under rudder; but on completing the turn the leading ship will draw ahead again, and if every ship in turn steadies on a point outside her next ahead, those at the rear of the line will be thrown seriously astern and their difficulties increased.

Every endeavour should be made to get the ship perfectly steady before commencing a turn. A swing, or large rudder on either way will upset the estimation of the right moment, and the path of the ship whilst turning.

In a beam wind or heavy sea, the rudder must be put over earlier or later as the case may be. If the moment has been misjudged and the rudder put over late, more must be given and speed increased. If, despite these measures the ship turns outside, she will be astern of station, and the important rule that the ship must steady outside the track until she can edge into her place at the correct distance, must not be forgotten. Ships which cannot be relied upon to observe this rule will enhance the difficulties of the rear ships.

Turning too early and inside is a fault which can be more easily rectified in the early stages by easing the rudder and reducing speed. The sooner it is done the better, otherwise in a large turn, the ship will find herself in an uncomfortable position.

No column of ships can turn in succession satisfactorily unless the leading ship steadies accurately on the new course. She should habitually ease the rudder and meet with about the same amount so that ships may learn what to expect.* It is still more important that she should not swing past her course or she will ruin a manœuvre otherwise carried out perfectly by the remainder of the column.

Handling a Column in Line Ahead.—The speed of a column altering course in succession should not be altered during the manœuvre if it can be avoided. Large turns should not follow one another so rapidly that ships are not steadied after one turn before commencing another.

* *See* Table 8.—Procedure when steadying ships after altering course.

Taking up and Changing Station.—A new station must be taken up promptly unless the Admiral indicates to the contrary by giving a definite time at which the ship is to be in station, or otherwise controls the action to be taken. The ship should proceed by the shortest route clear of other vessels. If the new station is distant, or ahead she should proceed at maximum speed. When in company speed should be one knot less than maximum to permit station keeping.

When the new station requires ground to be lost, the manœuvre may be performed by :—

(*a*) Reducing speed.
(*b*) Zig-zagging broadly.
(*c*) Making an initial turn of 180° when the ground to be lost is sufficiently great.

When ships in column in line ahead are opening distance by the last-named method, ships must not put their rudders over until the next astern is observed to commence her turn.

The Zig-zag Method* should be employed when the ground to be lost is insufficient for an initial turn of 180°, but great enough to render a reduction of speed a slow and undesirable alternative. Different speeds, rudder angles and alterations of course may be used by a single ship, but if a column is being handled, it is preferable to use tactical rudder and manœuvre at the same speed as the ship on which the column is being formed.

Diagrams similar to that illustrated for a County class cruiser in Diagram 12 may be constructed. The actual path of the ship for different alterations of course, obtained from turning trial data is plotted. The distances lost relative to a ship proceeding on a steady course at varying speeds are then determined and the results plotted graphically.

Forming Astern of a Wing Ship.—This manœuvre may be ordered by an Equal Speed Signal or otherwise.

By Equal Speed Signal. *Restriction.*—The manœuvre must not be performed from a bearing before the beam of the wing ship. Except when ships are formed on a bearing more than 45° abaft the beam, the wing ship will execute a 45° swing outward and then resume the original course, thus reducing her speed and allowing the next ship manœuvring space. When ships are in line abreast or slightly abaft the beam, this reduction in speed may not be sufficient and ships may, therefore, find themselves astern of station. This can be mitigated by cutting off a corner, especially in the ship adjacent to the wing ship. The former may require to use more than tactical rudder. (Fig. 28.)

By Forming and Disposing Signal.—In this case the 45° swing is not carried out by the wing ship. Unless, therefore, the column is on a bearing well abaft the beam, the ships adjacent to the wing ship must reduce speed and edge into line with small alterations of course. Ships further from the wing ship may alter course more boldly.

Inverting the Line may be performed from rest, such as when leaving harbour, or when manœuvring at sea. It may be necessary to consider the time taken, or sea room required to perform the manœuvre.

From Rest.—The rear ship must steam double the distance she is from the leading ship. Thus, if there are six ships in the line, three cables apart, the rear ship must steam 3 miles before the manœuvre is completed.

When Manœuvring at Sea.—The same column, steaming at 12 knots, with steam for 16 knots, is ordered to invert the line. The leading ship will reduce to 7 knots (unless otherwise ordered) and the rear ship will increase to 15 knots (1 knot less than maximum).

Thus the rear ship will steam at a relative speed of 8 knots for a relative distance of 3 miles.
She will accomplish this in 22½ minutes.
In 22½ minutes at her actual speed of 15 knots, she will steam a distance of 5·6 miles.
Originally she lay 1·5 miles astern of the leading ship.
Over 4 miles of clear water ahead are, therefore, required to complete the manœuvre.

* *See* Diagram 12.

Fig. 28.
Forming astern from line abreast.

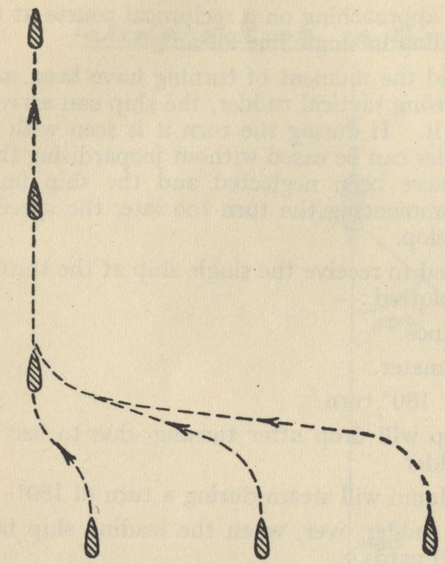
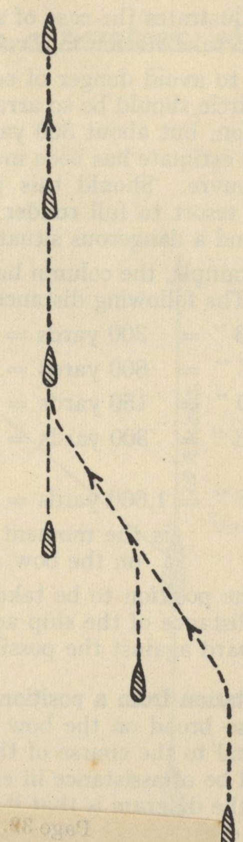


Fig. 29.
Forming astern when more than 45° abaft the beam.



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Taking up and Changing Station.—A new station must be taken up promptly unless the Admiral indicates to the contrary by giving a definite time at which the ship is to be in station, or otherwise controls the action to be taken. The ship should proceed by the shortest route clear of other vessels. If the new station is distant, or ahead she should proceed at maximum speed. When in company speed should be one knot less than maximum to permit station keeping.

When the new station requires ground to be lost, the manœuvre may be performed by :—

(*a*) Reducing speed.
(*b*) Zig-zagging broadly.
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When ships in column in line ahead are opening distance by the last-named method, ships must not put their rudders over until the next astern is observed to commence her turn.

The Zig-zag Method* should be employed when the ground to be lost is insufficient for an initial turn of 180°, but great enough to render a reduction of speed a slow and undesirable alternative. Different speeds, rudder angles and alterations of course may be used by a single ship, but if a column is being handled, it is preferable to use tactical rudder and manœuvre at the same speed as the ship on which the column is being formed.

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Page 32. *Delete* last paragraph headed " When Manoeuvring at Sea " and *insert* :—

" *When manoeuvring at sea.* In this case an allowance for gain and loss of speed must be made, taking into account the following factors—

(*a*) The rear ship does not at once attain her new speed (which for this manoeuvre is laid down as one knot less than the maximum).

(*b*) The leading ship does not at once attain her new speed (which is laid down as 7 knots unless otherwise ordered).

(*c*) The original leading ship will increase from 7 knots to one knot less than the maximum before the original rear ship has reached her new station. If she does not do this she will drop astern of station when the manoeuvre is completed.

The time required to complete the manoeuvre may be found by calculating the time taken to cover, at the relative speed, a distance of—

$2L + 2 \times S \times C$ cables

where, L is the length of the column.
S is the relative speed.
C is the distance correction for gain and loss of speed for the class of ship concerned (see page 9).

Thus if the same column, steaming at 12 knots, with steam for 16 knots, is ordered to invert the line, the leading ship will reduce to 7 knots, and the rear ship will increase to 15 knots. Assuming the ships to be battleships for whom the distance correction is approximately 100 yards per knot, the time to complete the manoeuvre will be—

$2 \times 15 + (2 \times 8 \times \frac{1}{2})$ cables (at 8 knots) =

38 cables (at 8 knots) = $28\frac{1}{2}$ minutes.

In $28\frac{1}{2}$ minutes at 15 knots the rear ship will cover 7·1 miles. Originally she lay 1·5 miles astern of the leading ship, and over $5\frac{1}{2}$ miles of clear water ahead of the leading ship are required to complete the manoeuvre."

Fig. 28.
Forming astern from line abreast.

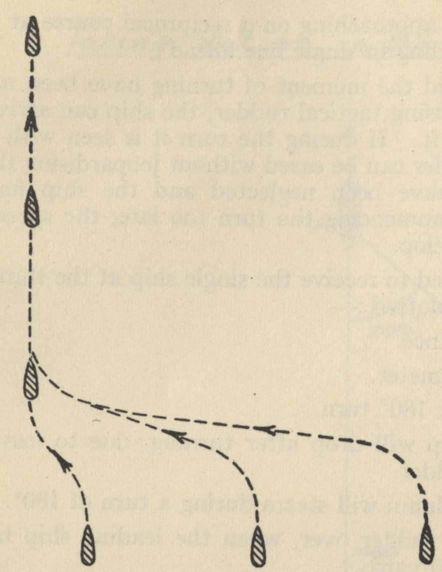
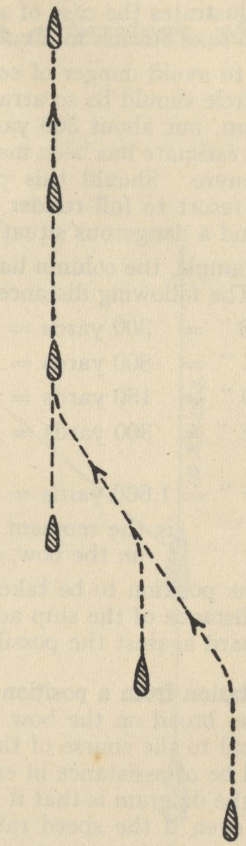


Fig. 29.
Forming astern when more than 45° abaft the beam.



Ships Hauling out of Line Turn Outwards.—When under way steaming in two columns and a ship requires to haul suddenly out of either line, as in the case of man overboard, she should normally turn outwards. Her next astern should steer slightly the opposite way in order to be well placed to lower a boat close to the man.

When there are more than two columns, it is immaterial which way a ship turns from an inner column, except that she will naturally prefer to bring her head towards wind and sea.

Taking Station from a Position Ahead or on the Bow.*—When approaching from the bow or ahead, the estimation of the point at which to put the rudder over so as to take station in the line or on a bearing, requires judgment and accurate timing, and is an occasion where the trained eye should be used as a check on data and plotting.

The basis of the calculation depends on the time taken to turn to the course of the fleet and the percentage of the original speed remaining after the turn. The speed of approach should be greater than the speed of the fleet, preferably by an amount equal to the loss of speed when turning. In the case of a column turning into station in succession, however, the manœuvre would be carried out at the speed of the fleet, observing that it is recommended to avoid altering the speed during a turn. The leader of the column would, therefore, turn early by an amount equal to the ground lost due to the reduction of speed in turning.

*See also Addendum No. 1

The manœuvre is simplified if it is possible to approach on the exact reciprocal course of the fleet. Ranges and bearings will then readily give the distance at which ships will pass abeam.

Fig. 30 illustrates the case of a single ship approaching on a reciprocal course at the speed of the fleet, to take station in a column proceeding in single line ahead.

In order to avoid danger of collision should the moment of turning have been misjudged, the turning circle should be so arranged that, using tactical rudder, the ship can arrive abreast her new station, but about 300 yards clear of it. If during the turn it is seen with certainty that a correct estimate has been made, the rudder can be eased without jeopardising the success of the manœuvre. Should this precaution have been neglected and the ship find herself compelled to resort to full rudder owing to commencing the turn too late, the speed will fall still further and a dangerous situation will develop.

In the example, the column has been opened to receive the single ship at the third position in the line. The following distances are then plotted :—

- " AB " = 300 yards = Safety distance.
- *" BC " = 800 yards = Tactical diameter.
- " CD " = 150 yards = Advance for 180° turn.
- " DE " = 300 yards = Amount ship will drop after turning, due to loss of speed under rudder.
- " EF " = 1,660 yards = Distance column will steam during a turn of 180°.
- " F " is the moment to put the rudder over, when the leading ship bears 50½° on the bow, distant 1,420 yards.†

Should the position to be taken up be near the rear of the line, it is advisable to use the bearing and distance of the ship adjacent to the ordered station, rather than the leading ship, in order to guard against the possibility of intervening ships being out of station.

Taking Station from a position Broad on the Bow.—‡When a ship ordered to take station finds herself so broad on the bow that it is inconvenient to approach her new station on the exact reciprocal to the course of the fleet, a table or diagram prepared from the ship's turning trial data will be of assistance in enabling a direct approach to be made with confidence. The limitation of the diagram is that it will function only for the given speeds. It will not serve for other speeds even if the speed ratios are the same. An example for a ship of the " Royal Sovereign" class is illustrated in Table 9. In Diagram 13, such a ship is taking station from a position 40° on the bow.

When a ship, approaching from a broad angle, is required to turn into a position in the line, such a manœuvre requires more than usual judgment and accuracy, even when furnished with a diagram. At high speeds the difficulty is increased and when turning into a small gap in the line, it may be more prudent or even necessary to execute an initial turn well clear of the line, so that the final approach is within 60° of the course of the fleet.

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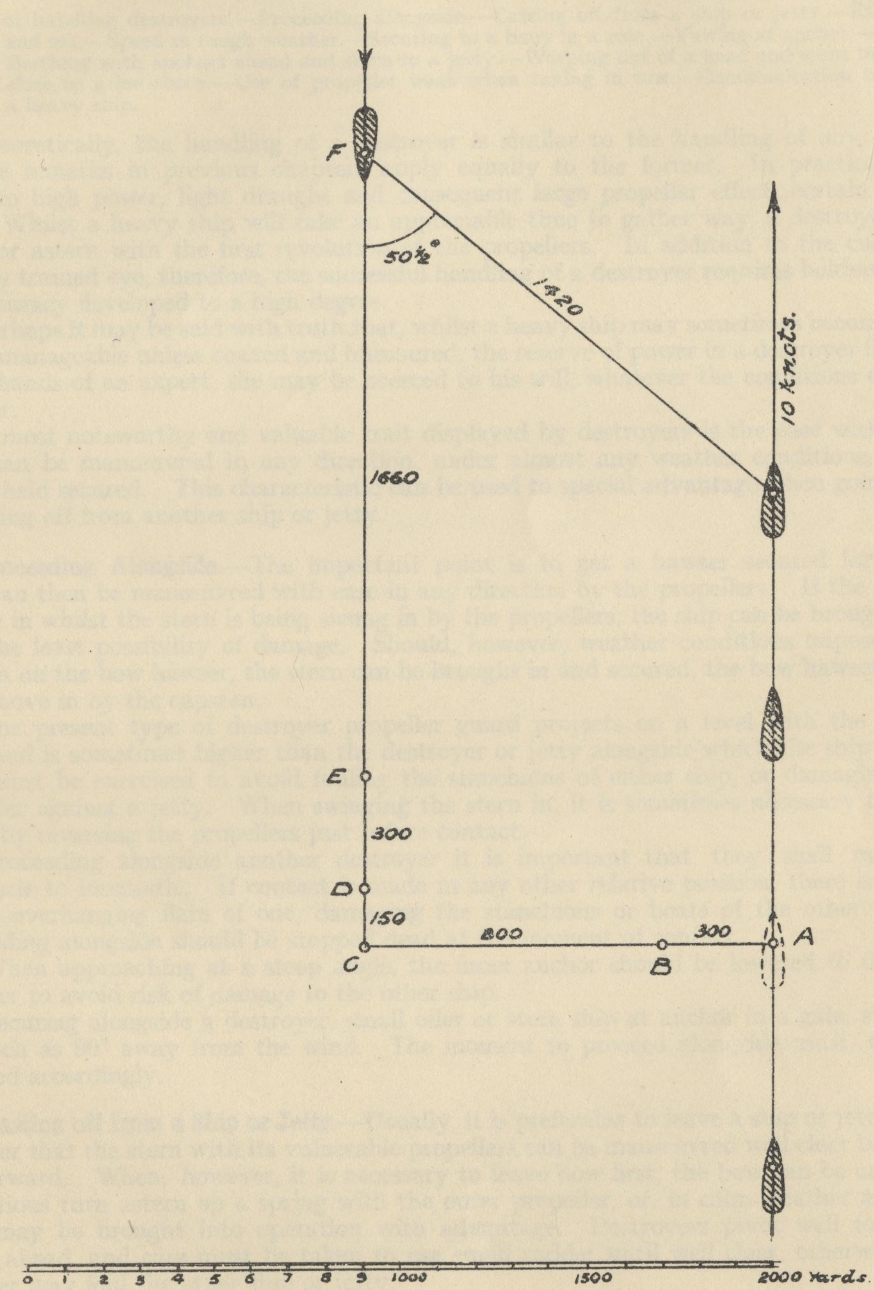
* Alternatively, the intermediate course and distance may be used instead of the advance and transfer.

† In this example a safety distance of 300 yards has been selected, but is intended as a guide only. Whilst 300 yards may be adequate for a handy ship manœuvring singly, a squadron or an unwieldy single ship with a large turning circle may require 400 or even 600 yards to ensure a sufficient margin of safety, especially in heavy weather.

‡ See Table 9 and Diagram 13, and also Addendum No. 1.

Figure 30.

Taking station in the line from a position ahead.



CHAPTER VII.

DESTROYERS.

The art of handling destroyers.—Proceeding alongside.—Casting off from a ship or jetty.—Effect of wind and sea.—Speed in rough weather.—Securing to a buoy in a gale.—Yawing at anchor.—Dragging.—Berthing with anchors ahead and stern to a jetty.—Warping out of a head and stern berth situated close to a lee shore.—Use of propeller wash when taking in tow.—Communication by boat with a heavy ship.

Theoretically, the handling of a destroyer is similar to the handling of any other ship, and the remarks in previous chapters apply equally to the former. In practice, however, owing to high power, light draught and consequent large propeller effect, certain differences arise. Whilst a heavy ship will take an appreciable time to gather way, a destroyer will leap ahead or astern with the first revolution of the propellers. In addition to the cultivation of a highly trained eye, therefore, the successful handling of a destroyer requires boldness, rapidity and accuracy developed to a high degree.

Perhaps it may be said with truth that, whilst a heavy ship may sometimes become obstinate and unmanageable unless coaxed and humoured, the reserve of power in a destroyer is such that, in the hands of an expert, she may be coerced to his will, whatever the conditions of wind and weather.

A most noteworthy and valuable trait displayed by destroyers is the ease with which the stern can be manœuvred in any direction, under almost any weather conditions, whilst the bow is held secured. This characteristic can be used to special advantage when going alongside or casting off from another ship or jetty.

Proceeding Alongside.—The important point is to get a hawser secured forward. The stern can then be manœuvred with ease in any direction by the propellers. If the bow hawser is hove in whilst the stern is being swung in by the propellers, the ship can be brought in bodily with the least possibility of damage. Should, however, weather conditions impose too heavy a strain on the bow hawser, the stern can be brought in and secured, the bow hawser afterwards being hove in by the capstan.

The present type of destroyer propeller guard projects on a level with the upper deck only, and is sometimes higher than the destroyer or jetty alongside which the ship is berthing. Care must be exercised to avoid fouling the stanchions of either ship, or damaging the inner propeller against a jetty. When swinging the stern in, it is sometimes necessary to check the swing by reversing the propellers just before contact.

Proceeding alongside another destroyer it is important that they shall meet exactly forecastle to forecastle. If contact is made in any other relative position, there is always risk of the overhanging flare of one, damaging the stanchions or boats of the other. The ship proceeding alongside should be stopped dead at the moment of contact.

When approaching at a steep angle, the inner anchor should be lowered to the waterline in order to avoid risk of damage to the other ship.

Securing alongside a destroyer, small oiler or store ship at anchor in a gale, she may yaw as much as 90° away from the wind. The moment to proceed alongside must, therefore, be selected accordingly.

Casting off from a Ship or Jetty.—Usually, it is preferable to leave a ship or jetty stern first, in order that the stern with its vulnerable propellers can be manœuvred well clear before casting off forward. When, however, it is necessary to leave bow first, the bow can be canted out by a cautious turn astern on a spring with the outer propeller, or, in calm weather a bearing out spar may be brought into operation with advantage. Destroyers pivot well forward when going ahead, and care must be taken to use small rudder until well clear, otherwise the inner quarter may foul the other ship or jetty.

When leaving stern first, after the stern has been manœuvred clear by the propellers, with or without the aid of a spring, the engines should be stopped, then put astern together. The stern must not be allowed to fly towards the wind too quickly, especially with a beam wind, or the flare of the forecastle may fall athwart awning stanchions, &c., before it has drawn clear.

When one destroyer of a pair secured together at a buoy, requires to slip while the ships are wind or tide bound, it is sometimes advisable to turn the group as a whole before attempting to slip.

Effect of Wind and Sea.—Owing to the construction of destroyers and their comparatively light draught, wind and sea exercise a pronounced effect on turning and leeway. When stopped, it is difficult to keep a destroyer head to wind for any length of time. Owing to the high forecastle and shallow draught aft, the stern can always be thrown into the wind and held there without difficulty. Going astern with both engines and rudder amidships, the stern will invariably fly towards the wind, and in a strong beam wind, the rudder alone may be unable to overcome this tendency.

Speed in Rough Weather.—In a large ship it is difficult to appreciate at what speed the sea may cause damage to a destroyer. Commanding Officers of destroyers in company with heavy ships should inform the senior officer when conditions become such that damage may be sustained if speed is not reduced.

The effect of the sea varies with different classes of destroyers and the most comfortable speed can be found only by experiment. In a short, choppy sea, a comparatively high speed may be more suitable than a moderate speed of, say, 10 knots. A destroyer on patrol on one occasion, eased from 18 to 10 knots to reduce bumping, yet returned to harbour comparatively comfortably at 30 knots in obedience to an urgent recall.

In abnormally heavy weather and circumstances permitting, it may be preferable to allow destroyers to proceed independently at the speed ordered, in order to avoid the need to vary the speed for station keeping, which for the rear ships of a long line, may be considerable under the conditions prevailing.

Securing to a Buoy in a Gale.—It is recommended to approach the buoy down wind, stop engines and slip the whaler with picking up rope, early. The whaler will be assisted by the wind in reaching the buoy and the ship can be kept stern to the wind without difficulty by the propellers.

Yawing at Anchor.—The high forecastles of destroyers cause them to yaw heavily when at single anchor in a strong breeze. A heavy squall under these conditions may cause them to drag. The second anchor lowered under foot will reduce the yaw.

Dragging.—Destroyers often drag when slewed by the wind across a strong tide ; the tide exerts a more powerful influence on the hull than when riding with wind and tide in the same direction. In these circumstances, it is advisable to let go a second anchor, close to the first, and ride with ample scope on each.

Should a destroyer find herself dragging towards a lee shore and in danger of grounding before steam can be brought forward, both anchors should be veered roundly to full scope in the hope that the progress of the anchors over the bottom may be stayed momentarily to enable them to obtain a fresh grip when the strain comes on again.

Berthing with Anchors Ahead and Stern to a Jetty.—This is a frequent practice in foreign ports, and destroyers berthed in this manner are liable to drag in a beam wind. The likelihood can be reduced if ships are berthed together in groups of four. The resistance to the wind is little more than that of a single destroyer, and four or more anchors are available. It will also help if the wing ships lay out their anchors at an angle instead of ahead.

On departure, it has been found speedy and practicable for all ships of a group to weigh together, remaining secured to each other until anchors are aweigh, or, when in narrow waters,

until the group has been turned to the course for leaving harbour, using the propellers of the outside ships. This does not apply in cases where the anchors of the wing ship are laid out at a broad angle.

Warping out of a Head and Stern Berth situated close to a Lee Shore.—In a congested harbour such as Sliema Creek, Malta, head and stern moorings are sometimes placed so close to shoal water that there is insufficient room to pass between the berth and the shoal. A ship requiring to proceed independently from such a berth during a strong onshore wind, may warp herself to windward into the fairway, by running hawsers across to the adjacent windward berth.

Use of Propeller Wash when taking in Tow.—Destroyers, with their enormous reserve of power and large propellers, can produce a heavy wash which may sometimes be used to advantage. Approaching from leeward, stern to the disabled ship, preparations are made to stream a life buoy and grass line aft. When the engines are put ahead to check the stern way, the lifebuoy is cast into the wash, which will then carry it right up to the disabled ship.

Communication by Boat with a Heavy Ship.—If there is any wind a destroyer should approach head or stern on to the ship from leeward, and should be maintained in this relative position whilst communication is in progress. Heavy ships usually lie approximately beam to wind when stopped. The destroyer is in an admirable position to move clear should the heavy ship show signs of setting on to her, but can remain close to her, thus reducing boatwork.

CHAPTER VIII

THE BATTENBERG COURSE INDICATOR.

Invented in 1892.—Closing on a bearing.—Opening on a bearing.—Changing station.—Allowance for turning circle, &c.—A rapid approximation.—Keeping station on a bearing.—Other problems.

The Battenberg Course Indicator was invented in 1892 by Captain H. S. H. Prince Louis of Battenberg, G.C.B., afterwards Admiral-of-the-Fleet The Marquess of Milford Haven, P.C., G.C.B., G.C.V.O., K.C.M.G., LL.D. It is practically the mooring board in mechanical form, and is designed for the rapid solution of a series of ordinary speed and distance triangles frequently met with in fleet work.

A description of the instrument is contained in Fig. 31.

The Guide's Bar, Own Ship Bar and Centre Line provide the solution of the speed triangles.

The Position Bars in conjunction with the Graduated Rule, solve the distance triangles.

For example :—

1. **Closing on a Bearing.** (Fig. 32.)

The observer's ship with steam for 16 knots, bears 130° from the Guide who is steaming 020° at 12 knots. It is desired to close the Guide along the bearing 130°/310°.

The position bars are not required, and the following information should be already set on the instrument in anticipation of events :—

(*a*) The **Guide's Bar** set and clamped at 020°.

(*b*) The **Slide** set at 12 knots.

(*c*) The **Pointer** on **Own Ship Bar** set at 16 knots.

(*d*) The **Metal Disc** slewed so that the **Centre Line** is on the bearing 130°.

Then—

(*e*) Swing **Own Ship Bar** in a direction to close the **Guide** until the **Pointer** meets the **Centre Line.**

(*f*) The **Arrow** on **Own Ship Bar** indicates from the **Small Graduated Circle** that the course to steer is 25° to port of the Guide's course, *i.e.*, 355°.

(*g*) The reading on the **Centre Line** at the point where **Own Ship Bar** meets it, indicates that the observer's ship will close the Guide at a rate of 7 knots.

2. **Opening on a Bearing.** (Fig. 33.)

The observer's ship wishes to open instead of close on the Guide. The procedure is similar except that **Own Ship Bar** is swung in a direction to open from the Guide, until the **Pointer** meets the **Centre Line** on the side opposite to that when closing.

The course to steer will be 086°, and the rate of opening 15·3 knots.

3. **Changing Station.** (Fig. 34.)

The **Position Bars** are employed to mark the positions of the old and new stations in order to find the course and distance required to make good from one station to the other.

The observer's ship with steam for 20 knots, is stationed six cables on the port bow of the Guide and is ordered to take station twelve cables on her starboard beam.

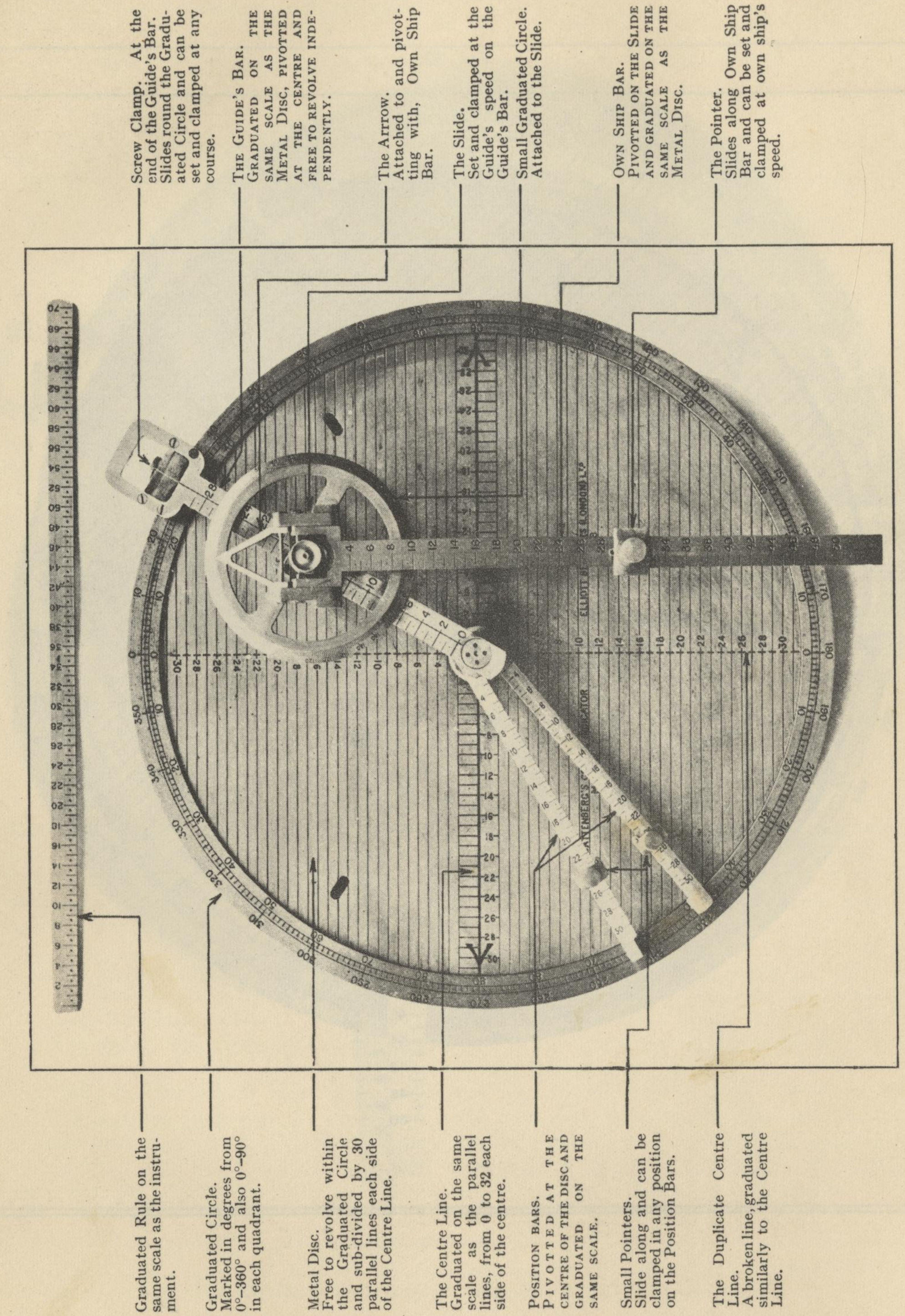
The Guide is steering 295° at 10 knots.

The following information should be already set on the instrument :—

(*a*) The **Guide's Bar** at 295° and the **Slide** at 10 knots.

(*b*) **Own Ship Bar** at 20 knots.

Fig. 31.



Battenberg's Course Indicator, Mark IV.

Note.—In the Mark III instrument the Small Graduated Circle is attached to and pivots with Own Ship Bar.

Fig. 32.

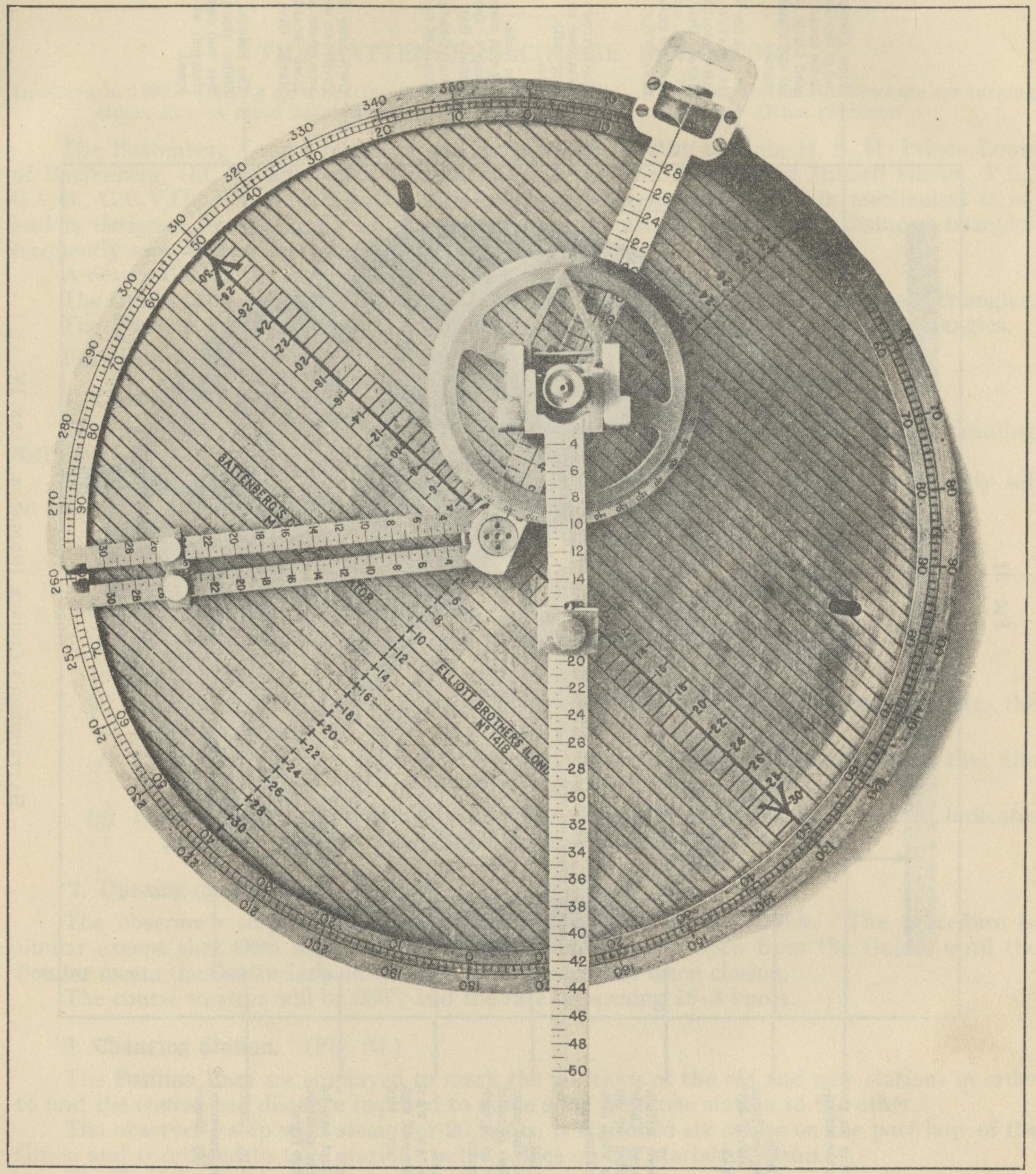


Fig. 33.

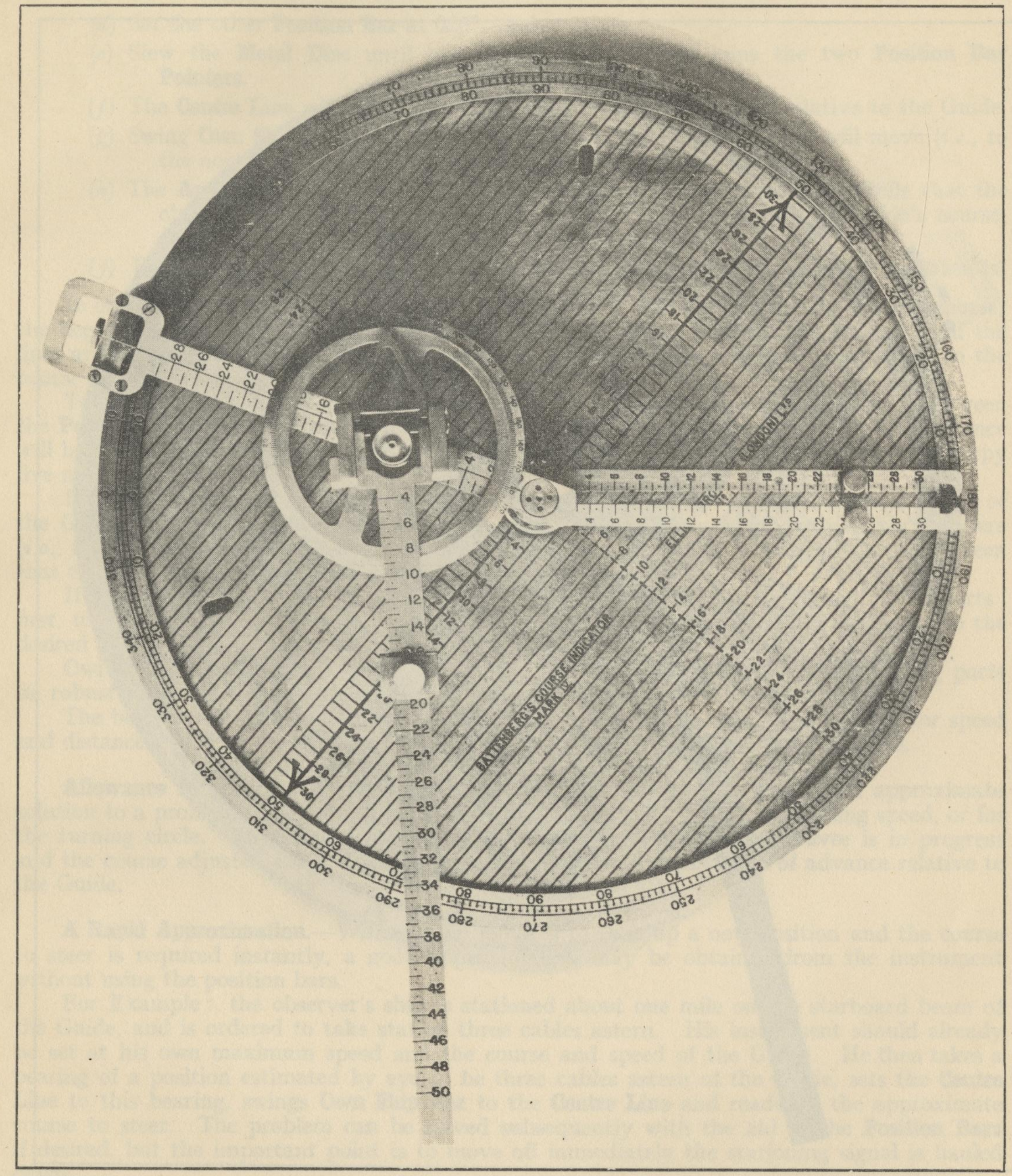
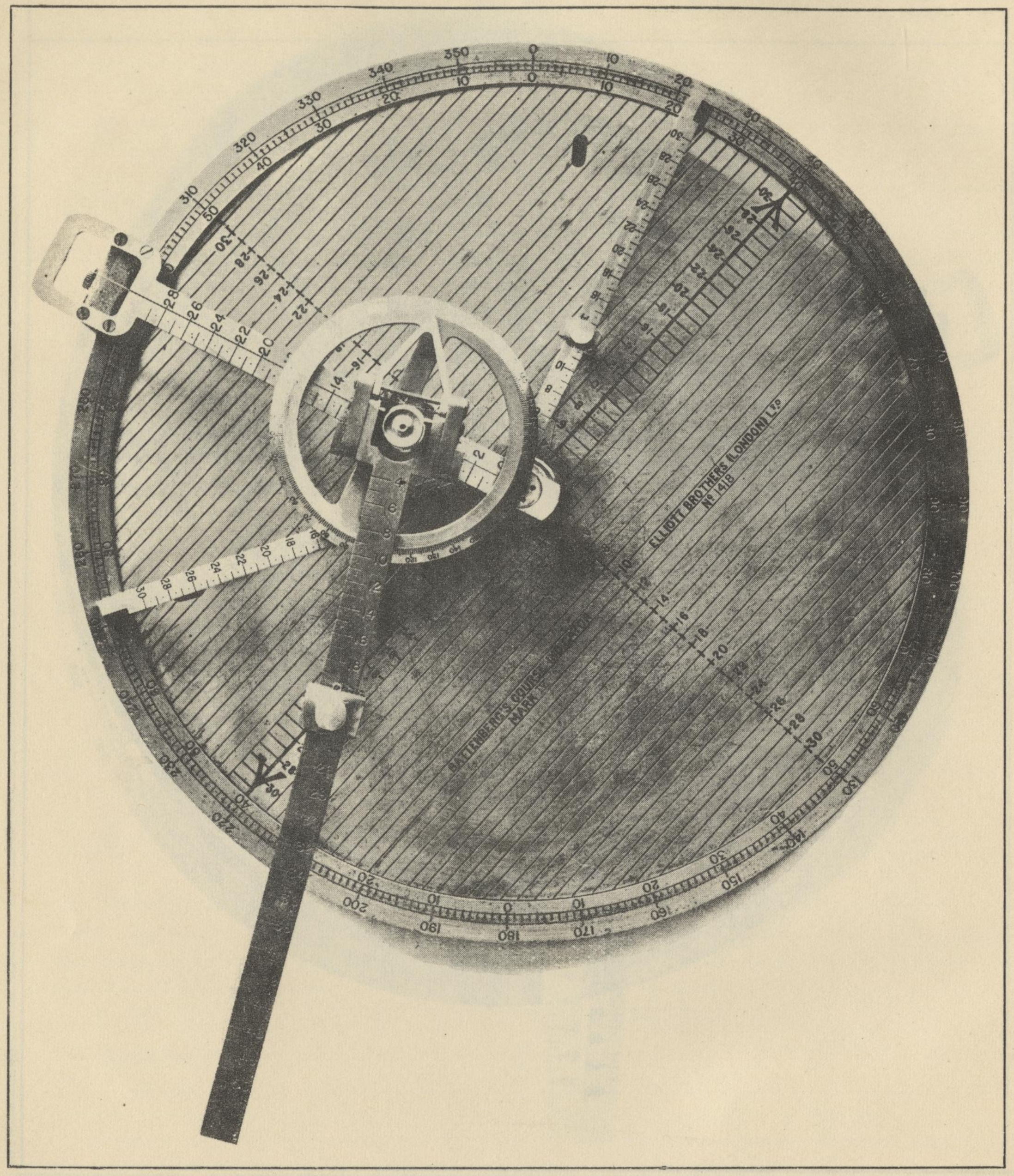


Fig 34.



(*c*) One **Position Bar** at 250°, six cables.

Then—

(*d*) Set the other **Position Bar** at 025°, twelve cables.

(*e*) Slew the **Metal Disc** until one of the parallel lines joins the two **Position Bar Pointers.**

(*f*) The **Centre Line** will now indicate the course to be made good relative to the Guide.

(*g*) Swing **Own Ship Bar** in the direction in which the observer's ship will move (*i.e.*, to the northward), and drop the **Pointer** on to the **Centre Line.***

(*h*) The **Arrow** on **Own Ship Bar** indicates against the **Small Graduated Circle** that the observer's ship must steer a course 76° to the northward of the Guide's course, *i.e.*, 011°

(*j*) From the **Centre Line** it will be observed that the speed made good will be 20 knots.

In order to overcome the inconvenience of adding to or subtracting from the Guide's course, the degrees indicated on the **Small Graduated Circle,** the **Metal Disc** may be trained until the lines are parallel to **Own Ship Bar** ; the arrow on the **Centre Line** will then point direct to the course to steer.

To find the time required to perform the manœuvre, the distance to be made good between the **Position Bar Pointers** must be measured with the **Graduated Rule** supplied. The distance will be found to be 16·7 cables. At a speed made good of 20 knots, the manœuvre will occupy five minutes.

It may be important to know the distance at which the observer's ship will pass ahead of the Guide during the manœuvre. Glancing along the line joining the position bar pointers (*i.e.*, the line along which the observer's ship will travel relative to the Guide), it will be seen that this line cuts the **Duplicate Centre Line** at three cables.

If it is desired to give the Guide a wider berth, the problem must be worked in two parts ; first, to proceed from the original position on the bow to, say, five cables ahead, thence to the desired position twelve cables on the starboard beam.

Owing to the small inaccuracies inseparable from an instrument built with moving parts on robust lines, the answers furnished by individual instruments will vary slightly.

The best results will be obtained by employing as large a scale as possible, both for speed and distance. In the above example, the scale for distance could have been doubled.

Allowance for Turning Circle, &c.—The Battenberg will often give only an approximate solution to a problem owing to the impossibility of allowing for gaining and losing speed, or for the turning circle. Ranges and bearings must be taken whilst the manœuvre is in progress and the course adjusted as far as possible to make good the correct line of advance relative to the Guide.

A Rapid Approximation.—When a ship requires to take up a new position and the course to steer is required instantly, a good approximation may be obtained from the instrument without using the position bars.

For Example : the observer's ship is stationed about one mile on the starboard beam of the Guide, and is ordered to take station three cables astern. His instrument should already be set at his own maximum speed and the course and speed of the Guide. He then takes a bearing of a position estimated by eye to be three cables astern of the Guide, sets the **Centre Line** to this bearing, swings **Own Ship Bar** to the **Centre Line** and reads off the approximate course to steer. The problem can be solved subsequently with the aid of the **Position Bars** if desired, but the important point is to move off immediately the stationing signal is hauled down.

* The Centre Line must not be confused with the Duplicate Centre Line which is at right angles to the former. The Pointer on Own Ship Bar must always be dropped on to the Centre Line.

Keeping Station on a Bearing.—The instrument is set with the **Centre Line** at the course of the Guide, and the correct position of the observer's ship indicated on the metal disc by a small circle in pencil. Ranges and bearings of the Guide can be set on one of the **Position Bars.** A relative picture of the correct and actual positions of the observer's ship is thus obtained, and the requisite action to be taken, indicated at a glance. A pencil circle for the correct position of the observer's ship is preferable to the second position bar owing to the position bars fouling each other at closely adjacent positions.

Other Problems.—This invaluable instrument is capable of solving a variety of other problems which are described in " Instructions for the use of Martin's Mooring Board and Battenberg's Course Indicator."

In ships fitted with catapults, it will be found useful as a ready means of determining the wind down and across the catapult.

The Officer of the Watch need never be caught unawares if he invariably keeps the instrument set at :—

(*a*) The course and speed of the Guide.

(*b*) The speed available in his own ship

(*c*) Her position relative to the Guide.

TABLES.

TABLE 1.

TYPICAL EXAMPLES OF REDUCTION OF SPEED WHEN TURNING.

Ship.	Original speed.	Rudder.	Speed after turning through			
			45°	90°	135°	180°
	kts.		kts.	kts.	kts.	kts.
NELSON.	14	25°	12.0	10.0	8.5	7.7
	14	35°	11.4	8.8	7.6	7.3
	23	35°	18.4	15.0	12.6	11.5
QUEEN ELIZABETH.	14	$12\frac{1}{2}^\circ$	13.6	12.4	11.5	11.3
	14	35°	11.9	9.0	6.8	5.5
	23	35°	19.5	15.6	11.4	9.7
ROYAL SOVEREIGN.	12	15°	11.4	10.4	9.4	9.3
	12	30°	9.7	8.2	7.3	6.8
	15	15°	14.0	11.7	10.5	10.0
HOOD.	14	35°	12.4	10.2	9.5	9.4
	31	15°	29.0	27.3	26.6	26.4
	31	35°	23.3	21.4	19.8	19.5
REPULSE.	15	15°	12.4	11.4	11.2	11.2
	15	35°	11.7	9.5	8.3	7.7
	28	35°	23.8	20.7	18.8	17.4
COURAGEOUS.	14	35°	11.6	11.0	10.2	9.6
	29	35°	23.5	22.8	22.0	21.3
EAGLE.	18	25°	14.7	12.8	12.0	13.2
	18	35°	13.3	10.8	9.5	8.5
HERMES.	14	25°	12.0	11.1	10.4	10.1
	14	35°	11.5	10.4	9.7	9.5
LONDON.	12	25°	10.5	9.3	9.3	9.3
	12	35°	9.7	8.8	8.8	8.8
	31	35°	26.6	23.5	23.0	23.0
YORK.	14	15°	12.7	10.7	9.9	10.1
	14	35°	11.9	10.3	10.0	10.3
LEANDER.	14	15°	14.0	13.6	13.5	13.4
	14	35°	12.6	11.3	10.5	10.2
HAWKINS.	14	25°	12.7	12.0	11.7	11.7
	14	35°	12.4	11.1	10.8	10.8
'D' Class cruiser.	14	25°	13.1	12.4	12.2	12.2
	29	35°	21.2	19.2	18.6	18.3
'C' Class cruiser.	14	25°	12.8	11.9	11.8	12.1
	14	35°	11.3	10.1	9.5	9.1
Post war destroyer.	20	25°	17.0	16.2	15.9	15.7
	20	35°	15.8	15.2	15.1	15.1
Post war sloop.	11	15°	10.0	9.8	9.6	10.0
	11	35°	9.4	8.9	7.6	6.0

The above information has been obtained from various sources and is intended as a guide only. Data for individual ships of the same class will vary.

C.B.L.??(10807-750+18-9.34(2587)

TABLE 2.

EXAMPLES OF TIMES TAKEN TO TURN.

Ship.	Speed.	Rudder.	45°	90°	135°	180°	360°
			m. s.	m. s.	m. s.	m. s.	m. s.
NELSON.	10	20°	2 00	3 10	4 20	5 45	10 30
	14	20°	1 25	2 10	3 05	4 05	8 40
	14	35°	1 02	1 46	2 38	3 45	8 18
	23	35°	0 43	1 12	1 44	2 24	5 04
QUEEN ELIZABETH.	10	15°	1 39	2 36	3 43	5 01	10 31
	14	12½°	1 18	1 59	2 45	3 35	7 04
	14	35°	0 53	1 27	2 08	2 57	6 41
	23	35°	0 37	0 56	1 19	1 48	3 51
ROYAL SOVEREIGN.	10	15°	1 35	2 32	3 42	5 02	10 33
	15	15°	1 13	1 53	2 40	3 32	8 21
	15	35°	0 51	1 21	1 57	2 44	6 06
	19	35°	0 49	1 13	1 34	2 07	4 45
HOOD.	14	35°	1 36	2 51	4 12	5 37	11 18
	20	15°	2 00	3 23	4 47	6 11	11 45
	31	15°	1 26	2 25	3 19	4 13	7 57
	31	35°	0 55	1 34	2 17	3 01	5 59
REPULSE.	15	25°	1 30	2 30	3 45	4 45	11 00
	20	15°	1 38	2 50	4 02	5 13	10 07
	20	35°	1 09	1 55	2 43	3 32	6 49
	30	35°	0 48	1 22	1 58	2 34	4 57
COURAGEOUS.	15	35°	1 30	2 40	3 59	5 21	11 00
	29	35°	1 02	1 36	2 15	3 02	5 53
EAGLE.	14	35°	1 04	2 17	4 04	6 04	13 20
	18	20°	1 07	2 06	3 07	4 11	8 18
	21	35°	0 45	1 19	1 54	2 35	5 25
HERMES.	14	15°	1 23	2 34	3 45	4 55	9 33
	14	35°	1 11	2 02	2 58	3 53	7 35
LONDON.	12	25°	1 35	2 49	4 06	5 21	10 34
	12	35°	1 20	2 27	3 40	4 53	9 23
	31	35°	0 41	1 10	1 41	2 11	4 15
YORK.	14	15°	1 28	2 43	4 35	5 16	10 02
	14	35°	1 00	1 48	2 41	3 36	7 00
	32	35°	0 42	1 10	1 38	2 07	4 10
LEANDER	14	25°	1 14	2 07	3 06	4 05	8 08
	14	35°	1 06	1 54	2 44	3 37	7 07
	31	35°	0 40	1 09	1 37	2 07	4 03
EMERALD.	14	35°	1 08	2 03	3 02	4 03	8 04
	32	35°	0 27	0 58	1 31	2 02	4 12
HAWKINS.	14	15°	1 34	2 42	3 54	5 07	9 57
	14	35°	0 59	1 46	2 38	3 30	6 54
	29	35°	0 40	1 08	1 34	2 02	3 53
'D' Class cruiser.	14	25°	1 11	2 02	2 58	3 53	7 35
	29	35°	0 36	0 58	1 23	1 50	3 34
'C' Class cruiser.	14	15°	1 25	2 34	3 44	4 55	9 38
	14	35°	0 51	1 39	2 24	3 11	6 13
Post war destroyer.	14	35°	0 40	1 09	1 40	2 10	4 20
	20	15°	0 57	1 39	2 19	3 01	5 39
	20	35°	0 26	0 45	1 04	1 24	2 46
	35	35°	0 20	0 34	0 50	1 10	2 16
Post war sloop.	12	35°	0 38	1 16	1 54	2 40	5 21

The above information has been obtained from various sources and is intended as a guide only. Data for individual ships of the same class will vary.

TABLE 3.

EXAMPLES OF EFFECT OF VARIATION IN RUDDER ANGLE.

Ship.	Speed.	Rudder.	Advance for 90°	Tactical diameter.
			yards.	yards.
NELSON.	14	15°	790	830
	14	35°	580	620
QUEEN ELIZABETH.	14	12½°	752	824
	14	35°	537	475
ROYAL SOVEREIGN.	12	15°	735	950
	12	30°	545	650
HOOD.	31	15°	1880	2340
	31	35°	1150	1365
REPULSE.	15	15°	1275	1775
	15	35°	930	1055
EAGLE.	18	15°	950	1390
	18	35°	625	700
HERMES.	14	15°	770	1145
	14	35°	568	777
LONDON.	15	15°	1070	1690
	15	35°	636	893
YORK.	14	15°	899	1188
	14	35°	565	750
LEANDER.	14	15°	1005	1600
	14	35°	605	815
HAWKINS.	14	15°	889	1288
	14	35°	600	750
'D' Class cruiser.	12	15°	635	1235
	12	35°	525	750
'C' Class cruiser.	14	15°	695	1290
	14	35°	510	765
Post war destroyer	20	15°	666	1035
	20	35°	270	425
Post war sloop.	11	15°	483	738
	11	35°	340	424

The above information has been obtained from various sources and is intended as a guide only. Data for individual ships of the same class will vary.

TABLE 4.

Behaviour of ships when (Proceeding ahead from rest. (Stopping engines whilst under steam. (Reversing engines whilst under steam.

Class of ship.	Initial speed.	Speed ordered.	Time taken and distance run to :-					
			Attain speed ordered.		Lose way after stopping.		Lose way after reversing engines.	
	knots.	knots.	Mins.	Yards.	Mins.	Yards.	Mins.	Yards.
NELSON.	Stopped	14	10	2840	-	-	-	-
	7	Stop	-	-	23	2260	-	-
	14	14 Astern	-	-	-	-	5	1177
QUEEN ELIZABETH.	Stopped	12	6½	1350	-	-	-	-
	12	Stop	-	-	17	2315	-	-
	12	12 Astern	-	-	-	-	4	655
ROYAL SOVEREIGN.	Stopped	10	14	3400	-	-	-	-
	12	Stop	-	-	25	3200	-	-
	12	12 Astern	-	-	-	-	5½	1200
HOOD.	Stopped	12	7	1900	-	-	-	-
	12	Stop	-	-	24	3600	-	-
	12	12 Astern	-	-	-	-	3½	770
REPULSE.	Stopped	12			-	-	-	-
	12	Stop	-	-			-	-
	14	14 Astern	-	-	-	-	3¾	872
COURAGEOUS.	Stopped	10	8	2260	-	-	-	-
	10	Stop	-	-	8½	1200	-	-
	14	14 Astern	-	-	-	-		
HERMES.	Stopped	14	4	1040	-	-	-	-
	7	Stop	-	-	10	1060	-	-
	14	14 Astern	-	-	-	-	2½	556
LONDON.	Stopped	14	5	1636	-	-	-	-
	14	Stop	-	-	10	1617	-	-
	14	14 Astern	-	-	-	-	5	760
LEANDER.	Stopped	14	5	1662	-	-	-	-
	7	Stop	-	-	5	630	-	-
	14	14 Astern	-	-	-	-	2	550
HAWKINS.	Stopped	14	5	1370	-	-	-	-
	7	Stop	-	-	8	1140	-	-
	14	14 Astern	-	-	-	-	2	360
'D' Class cruiser.	Stopped	14			-	-	-	-
	10	Stop	-	-	10	995	-	-
	12	14 Astern	-	-	-	-	3	420
'C' Class cruiser.	Stopped	14	4	1218	-	-	-	-
	7	Stop	-	-	10	940	-	-
	14	12 Astern	-	-	-	-	2	375
Post war destroyer.	Stopped	20	3	1220	-	-	-	-
	10	Stop	-	-	7	575	-	-
	20	20 Astern	-	-	-	-	1½	420
Post war sloop.	Stopped	11	5½	1465	-	-	-	-
	7	Stop	-	-	21½	1249	-	-
	11	11 Astern	-	-	-	-	2	416

This information is necessarily approximate only. In most cases of the trials of stopping engines whilst under steam, the ships were still making way through the water at the end of the time given. Figures for individual ships of the same class will vary considerably.

TABLE 5.

REDUCTION IN SPEED DUE TO PARAVANES AT VARIOUS SPEEDS.

Class of ship.	Speed in knots.				
	10	15	20	25	30
NELSON.	.18	.27	.36	-	-
QUEEN ELIZABETH.	.27	.40	.54	-	-
ROYAL SOVEREIGN.	.36	.54	.72	-	-
HOOD.	.08	.12	.16	.20	.25
REPULSE.	.24	.36	.48	.60	-
COURAGEOUS.	.24	.36	.48	.60	.72
EAGLE.	.47	.70	.94	-	-
HERMES.	.21	.32	.42	.53	-
LONDON.	.17	.26	.34	.42	-
YORK.	.18	.27	.36	.45	-
ADVENTURE.	.26	.39	.52	.65	-
HAWKINS.	.20	.30	.40	.50	-
'D' Class cruiser.	.28	.42	.56	.74	-
'C' Class cruiser.	.45	.67	.90	1.12	-

TABLE 6.

DISTANCES AT WHICH SPEED IS NORMALLY REDUCED AND ENGINES STOPPED WHEN APPROACHING AN ANCHORAGE.

Class of ship.	Single anchor.			Mooring.		
	Distance.	Speed.	Stop.	Distance.	Speed.	Stop.
	cables.	knots.	cables.	cables.	knots.	cables.
NELSON.	14	7	7	12	7	5
QUEEN ELIZABETH.	15	7	7	15	7	6
ROYAL SOVEREIGN.	15	7	7	15	7	5
REPULSE.	12	8	6	12	8	6
COURAGEOUS.	20	10	4	20	10	4
LONDON.	7	10	3	7	8	2
'D' and 'C' class cruisers.	5	10	2	5	10	3/4
Destroyers.	10	12	1	10	12	½

NOTE 1. - When coming to single anchor, engines are put astern on letting go.

2. - When mooring, engines are put astern at the first anchor or when 2 or 3 shackles have run out.

3. - When anchoring in deep water and cable is veered during the approach, heavy ships stop one cable later than the distances given above.

TABLE 7.

SUMMARY OF SPACING OF BERTHS FOR VARIOUS UNITS OF THE FLEET.

For the minimum spacing of berths, allow the lengths of two adjacent ships, plus (20 yards when moored. (100 yards when at single anchor.

As stated in Chapter V the allowance necessary to ensure that ships will swing clear of shoal water and other dangers, will depend upon the circumstances of the anchorage.

Class of ship.	Length. feet.	Minimum spacing.	
		Moored. yards.	At single anchor. yards.
HOOD and REPULSE	860 & 794	570	650
REPULSE COURAGEOUS	794 786	550	630
NELSON	710	490	570
QUEEN ELIZABETH	644	450	530
ROYAL SOVEREIGN KENT	626 630	440	520
HAWKINS	605	420	500
YORK EMERALD	575 570	405	485
LEANDER	547	385	465
"D" Class Cruiser.	473	335	415
"C" Class Cruiser.	450	320	400
Flotilla Leaders and Post war destroyers.	332 323	240	320 *
"V" & "W" Class dest.	312	230	310 *

* It is customary to anchor Leaders and Destroyers 1½ cables apart.

TABLE 8.

NORMAL PROCEDURE FOR STEADYING SHIPS AFTER ALTERING COURSE.

Class of ship.	Tactical rudder.	Degrees from new course, when		Amount of opposing rudder.
		Rudder amidships.	Opposing rudder.	
NELSON.	20°	30	15	15°
QUEEN ELIZABETH.	12½°	30	10-15	10°
ROYAL SOVEREIGN.	15°	25	15	10°
REPULSE.	20°	17	7	10°
COURAGEOUS.	30°	20	5	10° or less
LONDON.	25°	13	5	10-15°
'D' and 'C' class cruisers.	25°	15	10	10°
Destroyers.	20°	15	5	10°

TABLE 9.

TAKING STATION FROM A POSITION BROAD ON THE BOW.

EXAMPLE OF TABLE CONSTRUCTED FOR ROYAL SOVEREIGN CLASS.

Speed of own ship 12 knots.

Speed of guide 10 knots.

Rudder 15°.

Alteration of course required.	Relative bearing and distance of turning point from new station.	
180°	23°	10.5 cables.
160°	30°	9.1
140°	37°	7.6
120°	45°	6.2
100°	56°	4.6
80°	68°	3.4
60°	80°	2.3
40°	96°	1.3

See Diagram 13 and also Addendum No. I.

This table allows for the ship turning exactly into the position ordered. When taking station in the line, an allowance for safety to compensate any errors in turning must be made.

This information is intended as a guide only. Figures for individual ships of the same class will vary.

Note:- This form is being revised in accordance with modern tactical requirements.

S.—347. (Revised—August, 1927.)

HOME STATION,

30th August '33 192

Table 10.

REPORT OF TURNING TRIALS

(Which must be made on a fine day with smooth water and little or no tide)

OF

H.M.S. LEANDER.

One copy to be inserted in the Captain's Ship's Book (Folio 6), and one copy forwarded to the Admiralty. Diagrams of each trial drawn to scale, showing each observed position of the ship, are to be attached to this report.

Instructions for carrying out Turning Trials.

A spar buoy, weighted at the lower end sufficiently to keep it upright, and immersed to approximately the draught of the ship, with a small staff above water, should be dropped in not less than 20 fathoms. A boat, with two Officers provided with sextants, should be stationed as close as possible to the buoy without touching it.

Steering to pass about one-half of the expected diameter of circle from the boat, the rudder is put over when the boat bears from four to six points on the bow.

A flag on the mast nearest the compass is to be used, and the altitude of the mast is to be taken. This flag is to be hoisted close up, about a half minute before as a warning, and dipped when the rudder is put over; and if convenient, at the same time, a short blast given on the syren. At this signal, the following records are obtained:—

On board.—1. The direction of the ship's head.
2. The exact time.
3. The compass bearing of observers in the boat.
In the boat.—4. The exact time.
5. The altitude of the masthead by sextant.

For every four points of alteration of the ship's head the signal and observations are repeated, the mast heading of the flag warning the Officers in the boat. The results will be more complete if the observations can also be obtained at every *two points* for the first eight points; the observers in the boat should take the observations alternately.

From these data the path the ship travels can be plotted, and the information required by this form obtained.

N.B.—For some of the turns it is better to turn with the boat outside the circle to avoid the chance of fouling it.

If there is NO tide or wind, the boat can be anchored, and the spar buoy is not then required.

REFERENCE:—(i) Remarks on Handling Ships.
(ii) Instructions for the use of Martin's Mooring Board, &c., Chap. V.

Name of the Officer who made the calculations, &c. ____________________

Approved,

____
Commanding Officer.

S. 2294/27.
6346.WT10807/8205.750.11.34.

TURNING POWERS OF H.M.S. LEANDER

NOTE.—Speed of ship at commencement.—"High" Speed to be :—For ships whose full speed is 30 to 35 knots—25 knots.
" " " " " " 25 " 30 " —21 "
" " " " " " 20 " 25 " —18 "
" " " " " " below 20 " Trials 8 and 9 to be omitted.

For the sake of uniformity in the trials, Engines working at 14 knots to be considered half-speed for trials 1 to 7, 10, 11 and 14; and 7 knots slow speed for trials 12 and 13. For ships whose full speed is below 20 knots trials to be carried out at 12 knots (or at 2/3 of full speed, whichever is the less) instead of 14 knots.

In the case of Torpedo Boat Destroyers, 20 and 10 knots to be considered half-speed and slow speed respectively, and the necessary alterations made in the forms.

N.B.—These speeds and rudder angles are to be *strictly* adhered to.

		Variable Items	Section I. Trials 1 to 3	Section II. Trials 4 to 7	Section III. Trials 8 and 9	Section IV. Trials 10 to 13	Remarks
Length of ship between perpendiculars	522 ft. 0 ins.	Date of Trial	19th April 1933.	19th April '33	29th June '33	24th April '33	-
Breadth, extreme	55 " .5/8ths.	Draught of Water, forward	18' 01"	18' 01"	17' 00"	17' 05"	-
Number of screws and direction of turning	4 out turning	Draught of Water, aft	19' 10"	19' 10"	19' 06"	19' 11"	-
Turbine or reciprocating engines	Turbine.	State of Ship's bottom	2 months out of dock.	2 months out of dock.	1 month out of dock.	2 months out of dock.	-
Rudders No. — Immersed area of each	185 sq. ft.	State of Sea	20-30	20-30	10	10	-
Rudders No. — Greatest breadth	12 ft. 0¾ ins.						
Extreme possible angle of rudder	35½ °						
Engines at 14 knots (half-speed)	116 Revs.						
Engines at 7 knots (slow speed)	58 "						

Trial	Speed of Ship at commencement	Revolutions of engines for Starboard	Revolutions of engines for Port	Angle of rudder	Time of putting rudder over	Time of Turning (s) Points 4	8	12	16	24	32	Transfer (t) Points 4	8	12	16 (d)	24	32	Advance (a) Points 4	8	12	16	24	32	Direction of wind relative to ship at commencement	Force of wind	Remarks
					secs.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	yds.	yds.	yds.	yds.	yds.	yds.	yds.	yds.	yds.	yds.	yds.	yds.			
1	14 knots	14 knots ahead	4 knots ahead	35° P.	17	0106	0153	0243	0335	0521	0707	110	400	692	805	410	-20	493	587	512	242	-180	222	ahead	4	-
2	do.	do.	do.	35° S.	18	0106	0152	0245	0339	0523	0707	117	380	680	825	465	70	487	620	516	240	-195	165	astern	4	-
3	do.	do.	do.	25° P.	See trial No. 6.																					
4	do.	do.	do.	15° P.	9½	0144	0305	0430	0552	0836	1125	240	795	1370	1640	865	20	770	1020	810	230	-545	260	ahead	4	-
5	do.	do.	do.	15° S.	10	0138	0257	0418	0540	0834	1134	240	691	1282	1565	805	-115	760	990	772	221	-600	177	astern	4	-
6	do.	do. (x)	do. (x)	(25°) Tactical P.	13½	0119	0211	0310	0410	0613	0819	160	520	890	1060	430	-50	560	720	580	220	-300	310	ahead	4	Speed was not increased on putting rudder over.
7	do.	do. (x)	do. (x)	(25°) Tactical S.	13½	0109	0204	0302	0401	0600	0757	120	450	895	975	475	-65	500	660	620	190	-340	130	astern	4	
8	25 knots "High"	"High"	"High"	15° P.	10	0111	0218	0322	0429	0642	0854	285	1040	1820	2190	1145	25	890	1275	1000	240	-885	145	Starbd. Quarter	2	Depth 18 Fathoms
9	25 knots. do.	do.	do.	15° S.	10½	0111	0217	0321	0422	0627	0833	245	1010	1780	2130	1140	75	900	1270	970	255	-840	110	Port Bow.	1-2	

Trial	Speed of Ship at commencement	Revolutions Starboard	Revolutions Port	Rudder	Mean speed of ship during 1st min.	2nd min.	3rd min.	4th min.	5th min.	6th min.	7th min	8th min.	9th min.	10th min.	Distance ship travels, and time taken before she has lost her way	Number of points, and direction ship turns before she has lost her way	Remarks
					knots	knots	knots	knots	knots	knots	knots	knots	knots	knots			
10	14 knots	7 knots ahead	7 knots ahead	steady course	11.3	10.2	9.1	7.9	6.8	6.8	-	-	-	-	1511 yds. 4½ mins approx		These figures indicate a rate of losing speed of 90 yds. per knot
11	do.	14 knots astern	14 knots astern	amidships	11.75	60–90 secs. 6.9	90–120 secs. 2.9	-	-	-	-	-	-	-	550 " 1 min.55 sec.	3½ to port.	
12	7 knots	stop	stop	steady course	5.55	4.55	3.7	2.9	2.2	-	-	-	-	-	-	-	Trial not completed.
13	do.	14 knots astern	14 knots astern	amidships	0–30 secs. 7.0	30–60 secs. 4.8	60–90 secs. 2.4	-	-	-	-	-	-	-	240 yds. 1 min. 30 secs.	-	
14	Stopped	14 knots ahead	14 knots ahead	steady course	2.34	7.7	12.3	13.5	14.0	14.1	-	-	-	-	* 1660 yds. 5 mins. approx.		

NOTES.—One section should be completed in a day. If possible, all four sections should be undertaken with the ship under similar conditions of trim, in similar weather. The ship should be steady and have her speed due to revolution before commencing each turn. The engines should be maintained at the proper revolutions, as shown by the telegraph throughout the trial. Trial 3 may, if deemed necessary, be tried turning under Star rudders as well.

(s) From time of ordering rudder to be put over.

(t) The transfer for any number of points is the distance the centre of gravity of the ship is transferred to the right or left, whilst turning that number of points, measured at right angles to the original course.

(d) The Tactical Diameter is the transfer for the first 16 points.

(a) The advance for any number of points is the distance the centre of gravity of the ship is advanced, from the position when putting the rudder over *in the direction of the original course* whilst turning that number of points.

* For this trial (14) the particulars are required to show distance travelled, and time taken, for ship to reach the specified speed.

(x) In trials 6 and 7 speed to be increased 2 knots when rudder is put over.

SECTION I.—Mean of trials 1 and 2

14 knots, 35° rudder

Letters	Number of points turned	Length of the arc	Time taken	Mean speed	Mean speed as percentage of original speed 14.6
		yds.	m. s.	knots	
a	4	513	0106	13.94	95
b	8	823	0154	12.99	88½
c	12	1133	0244	12.43	85½
d	16	1440	0337	11.94	81½
e	0 to 4	513	0106	13.94	95
f	4 to 8	310	0046	11.62	79½
g	8 to 12	310	0050	11.16	76
h	12 to 16	307	0053	10.42	71½

Number of points turned	Speed at end of each octant†	Percentage of original speed remaining at end of each octant
4	12.6	88
8	11.3	78
12	10.7	73
16	10.2	70

Distance to new course, 35° rudder

Number of points turned			
2	4	6	8*
270 yds.	375 yds.	480 yds.	600 yds.

SECTION II.—Mean of trials 4 and 5

14 knots, 15° rudder

Letters	Number of points turned	Length of the arc	Time taken	Mean speed	Mean speed as percentage of original speed 14.6
		yds.	m. s.	knots	
a	4	806	0141	14.36	98
b	8	1412	0301	14.04	96½
c	12	2022	0424	13.79	94
d	16	2662	0546	13.85	95
e	0 to 4	806	0141	14.36	98
f	4 to 8	606	0120	13.47	92
g	8 to 12	610	0123	13.23	90½
h	12 to 16	640	0122	13.88	95

Number of points turned	Speed at end of each octant†	Percentage of original speed remaining at end of each octant
4	13.8	94½
8	13.3	91
12	13.4	92
16	13.9	95

Distance to new course, 15° rudder

Number of points turned			
2	4	6	8*
350 yds.	540 yds.	740 yds.	1000 yds.

NOTES.—Lines *a* to *h* can be completed by measurements of the length of the arc, as plotted (lines *a* and *e* are the same).
Trials 1 and 2 should give practically the same results, therefore the mean is taken to eliminate small errors; the same applies to 4 and 5.
† The speed at the end of each octant is obtained by plotting a curve, using a horizontal time scale, and a vertical speed scale; the mean speeds (lines *e* to *h*) being laid off at the middle time of turning through each octant.
* This distance is equal to the advance.

DIAGRAMS.

Diagram

1.—Typical path described by a ship when turning.

2.—Example of path traversed by a battleship.

3.—Example of path traversed by a battlecruiser.

4.—Example of path traversed by cruisers.

5.—Example of path traversed by an aircraft carrier.

6.—Example of path traversed by a destroyer.

7., 7A. }Starting, stopping and reversing engine trials of a battleship.

8., 8A. }Starting, stopping and reversing engine trials of a cruiser.

9.—Slide rule to determine moment to go ahead when inverting the line from rest with ships of different classes.

10.—Chart of Fleet anchorage at ARGOSTOLI.

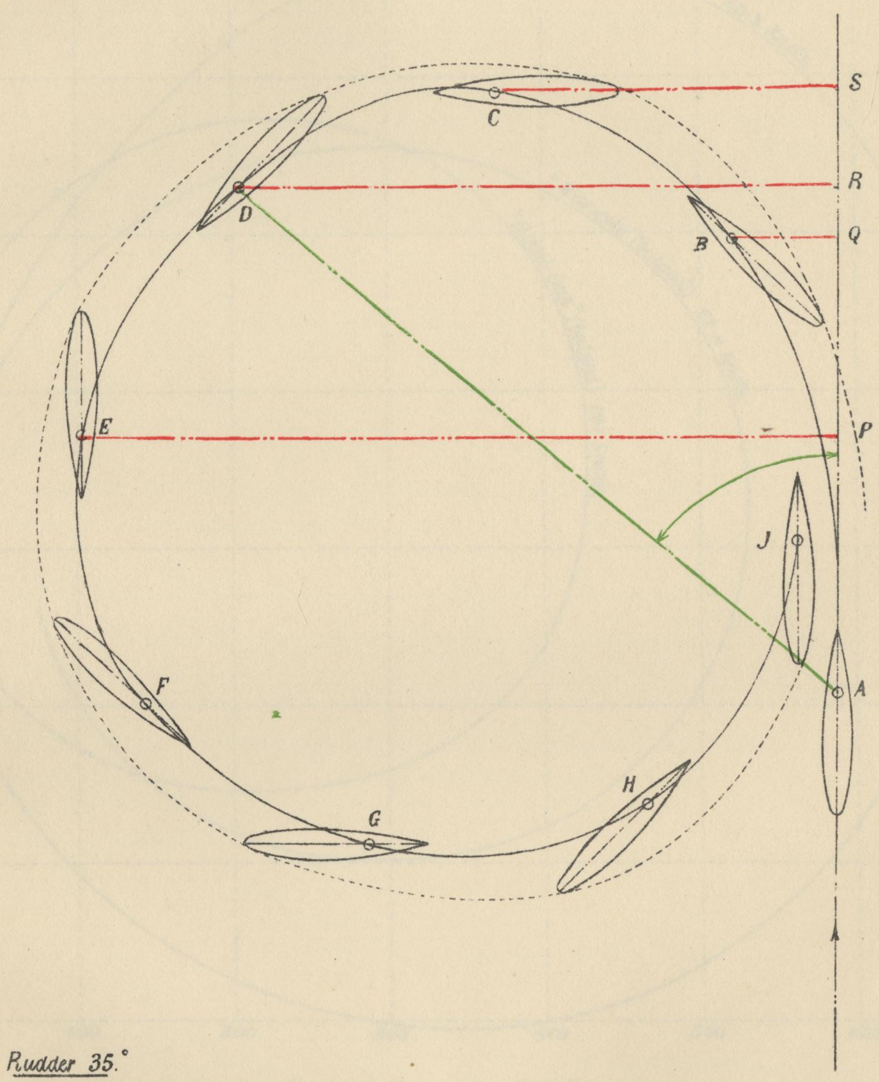
11.—A Quartogram.

12.—Zig-zag method of losing ground when changing station.

13.—Example of taking station in the line from a position broad on the bow.

Diagram I

Typical Path described by a Ship when Turning.



Rudder 35.°

Initial Speed 14 5 knots.

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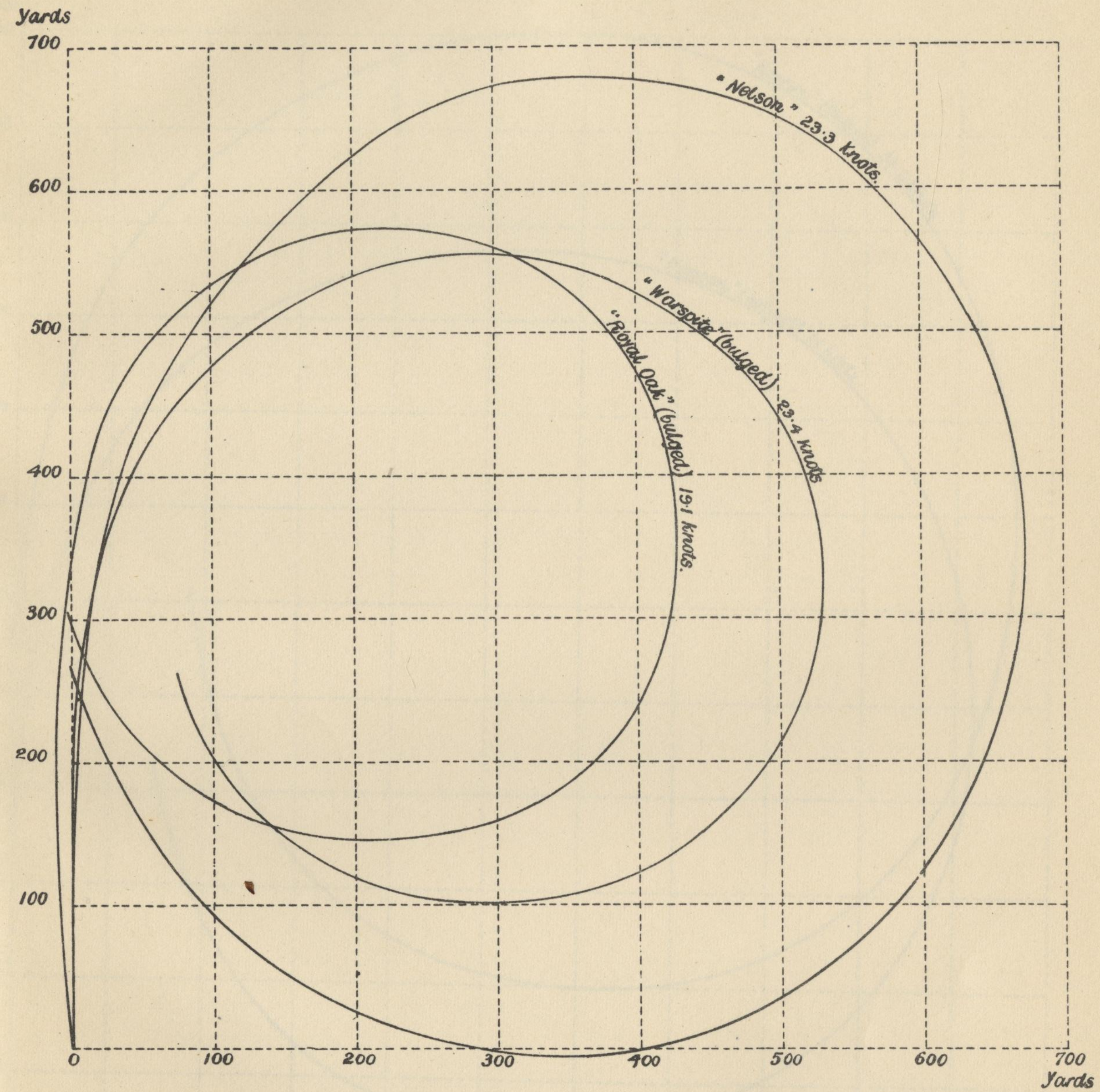
Diagram 2. Examples of Paths traversed by Battleships. Rudder. 35°



Scale 1 Division = 100 Yards.

Diagram 3. Examples of Paths traversed by Battle Cruiser. Rudder 35°

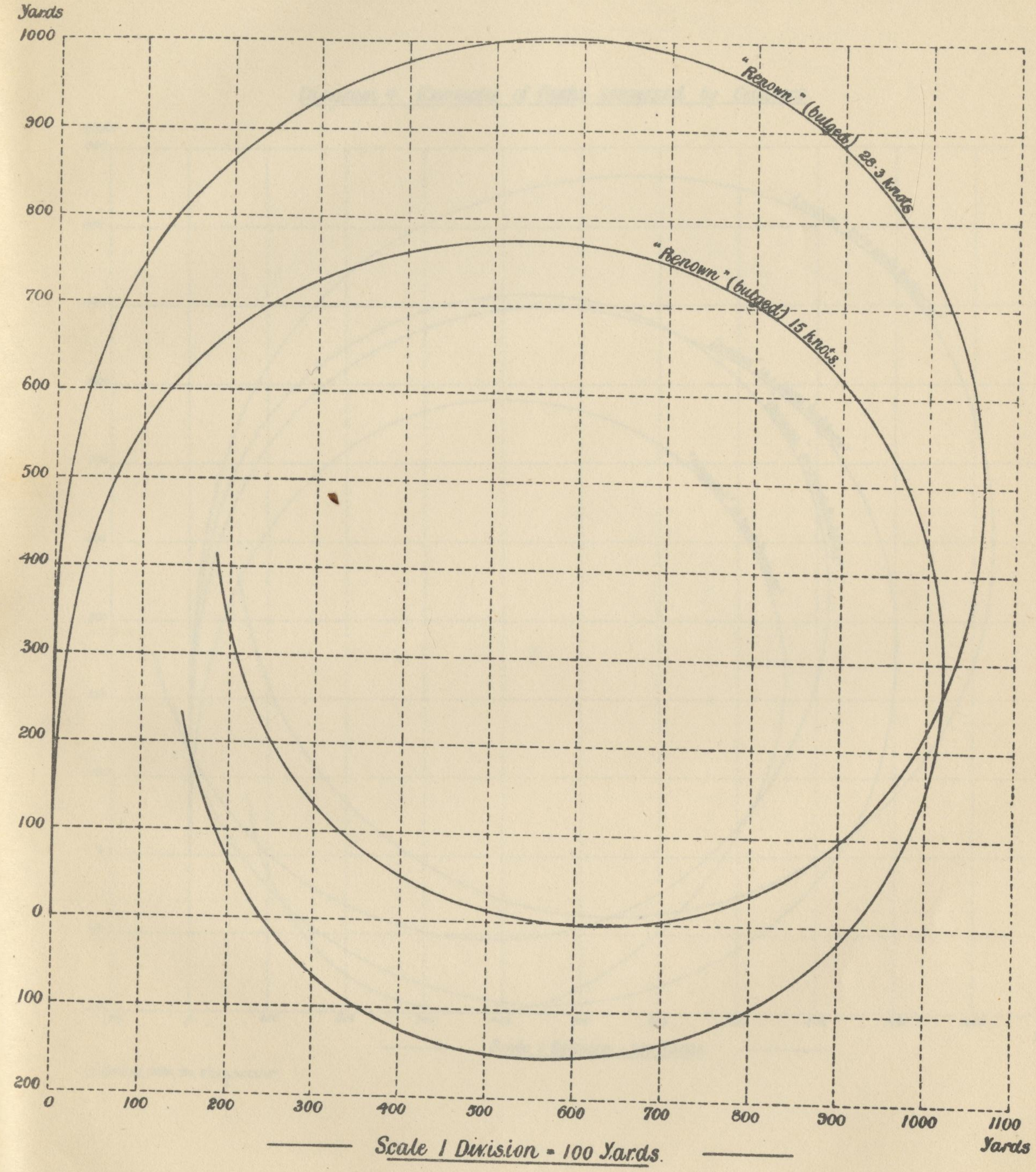
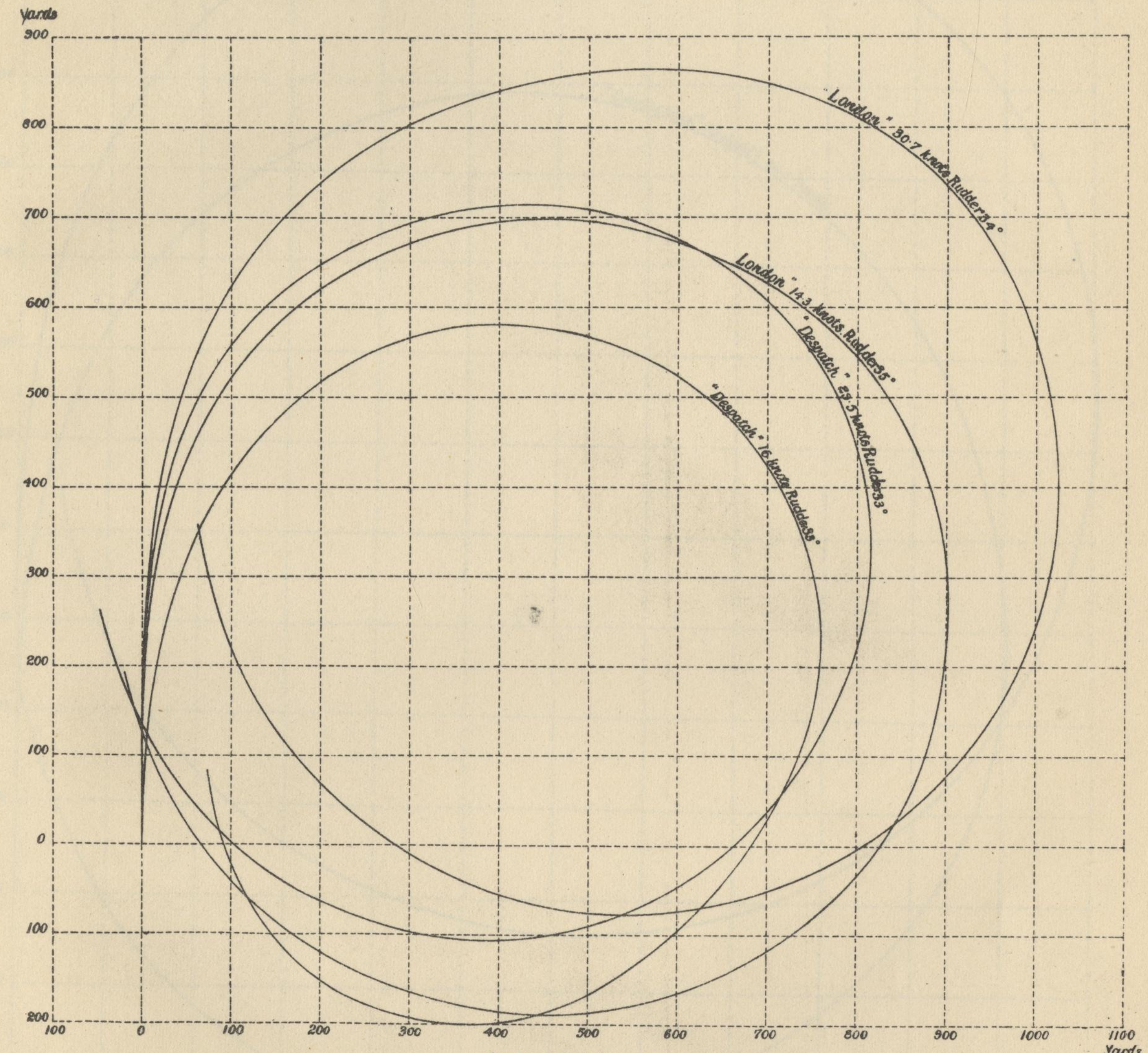


Diagram 4. Examples of Paths traversed by Cruisers.



Scale 1 Division = 100 Yards.

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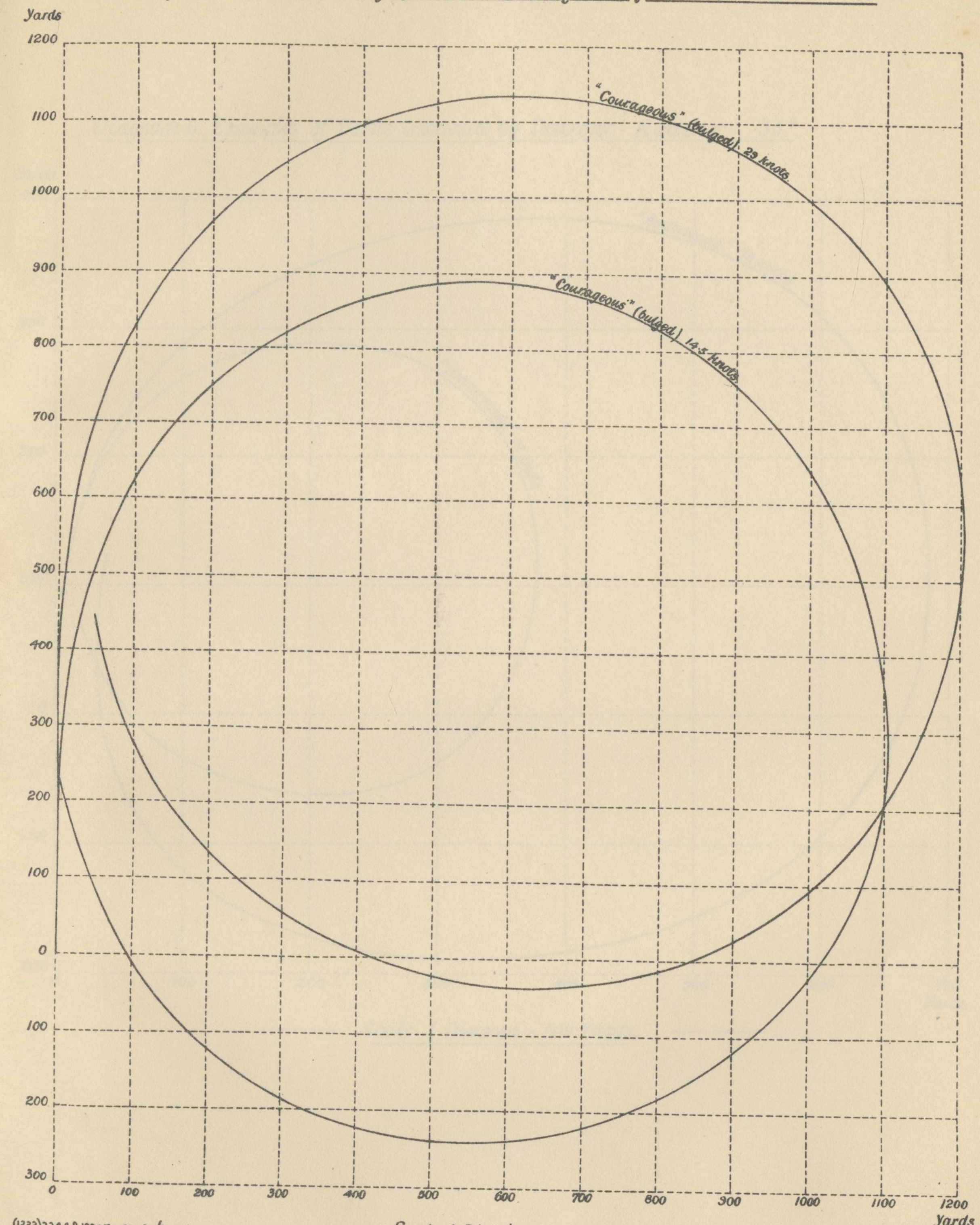
Diagram 5. Examples of Paths traversed by Aircraft Carrier. Rudder 35°



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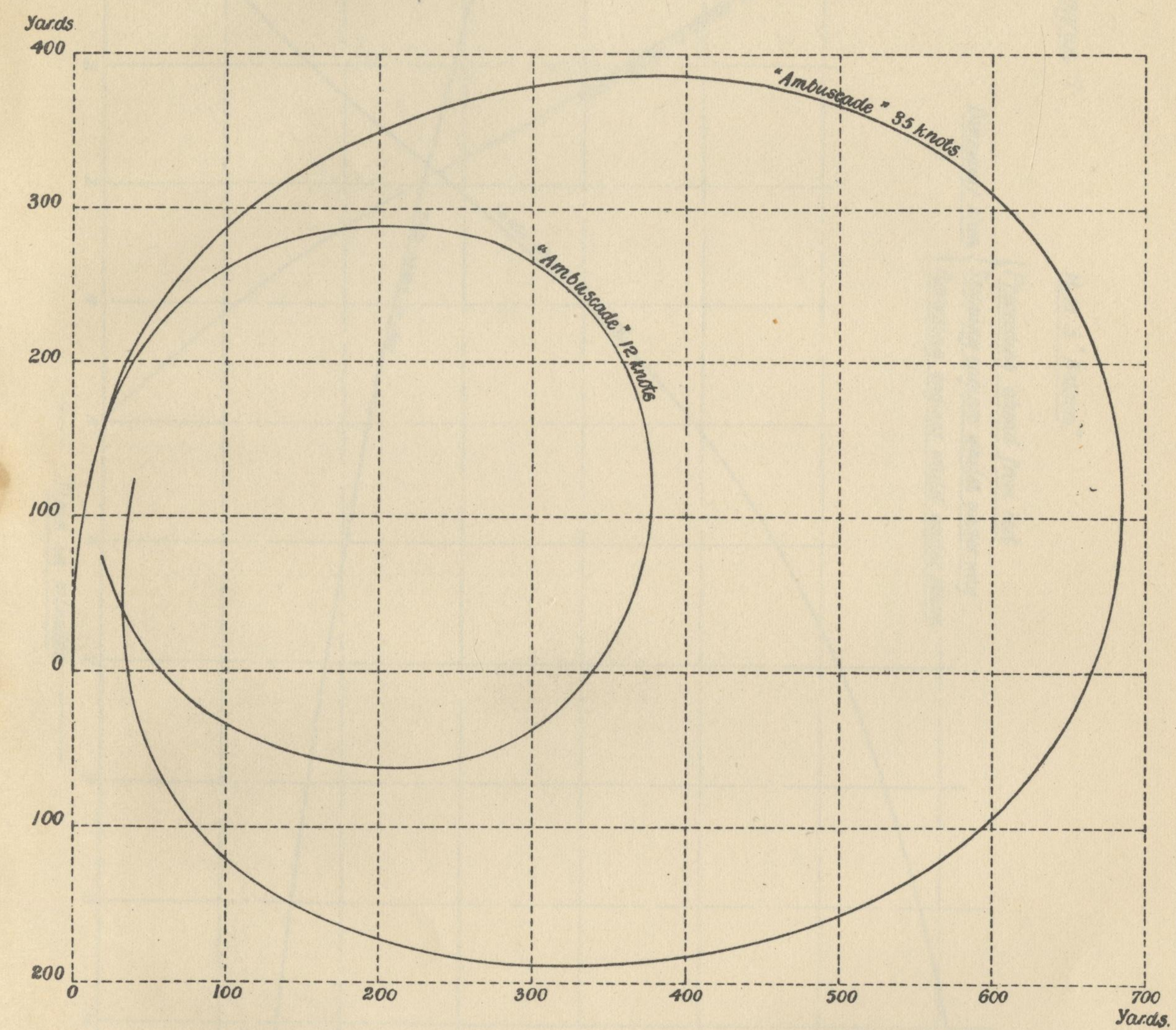
Scale 1 Division = 100 Yards.

Diagram 6. Examples of Paths traversed by Destroyer. **Rudder 35°.**



Scale 1 Division = 100 Yards.

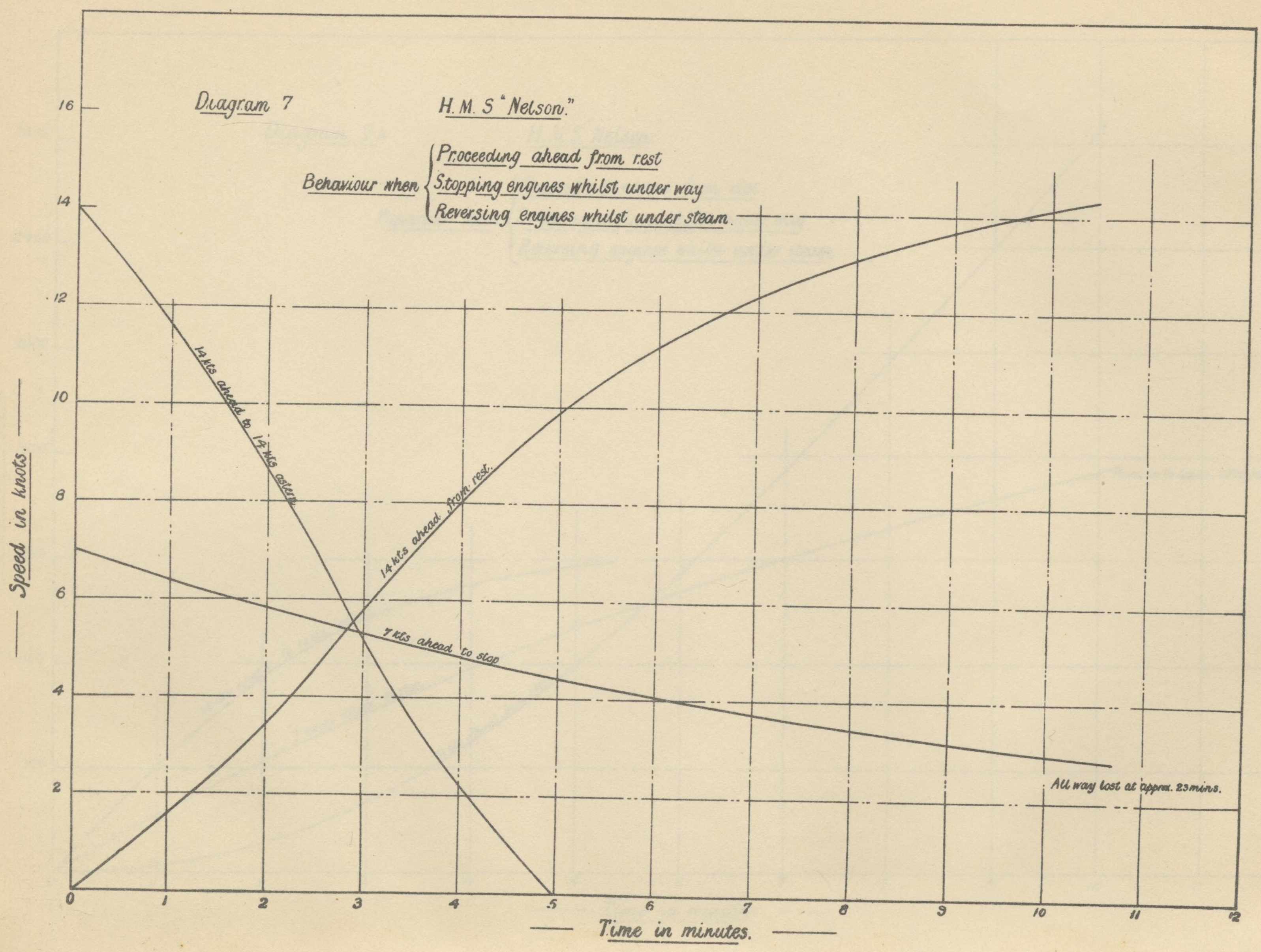


Diagram 7
H. M. S "Nelson."
Behaviour when
Proceeding ahead from rest
Stopping engines whilst under way
Reversing engines whilst under steam.
Speed in knots.
Time in minutes.
14 kts ahead to 14 kts astern
14 kts ahead from rest.
7 kts ahead to stop
All way lost at approx. 23 mins.
0
1
2
3
4
5
6
7
8
9
10
11
12
14
16

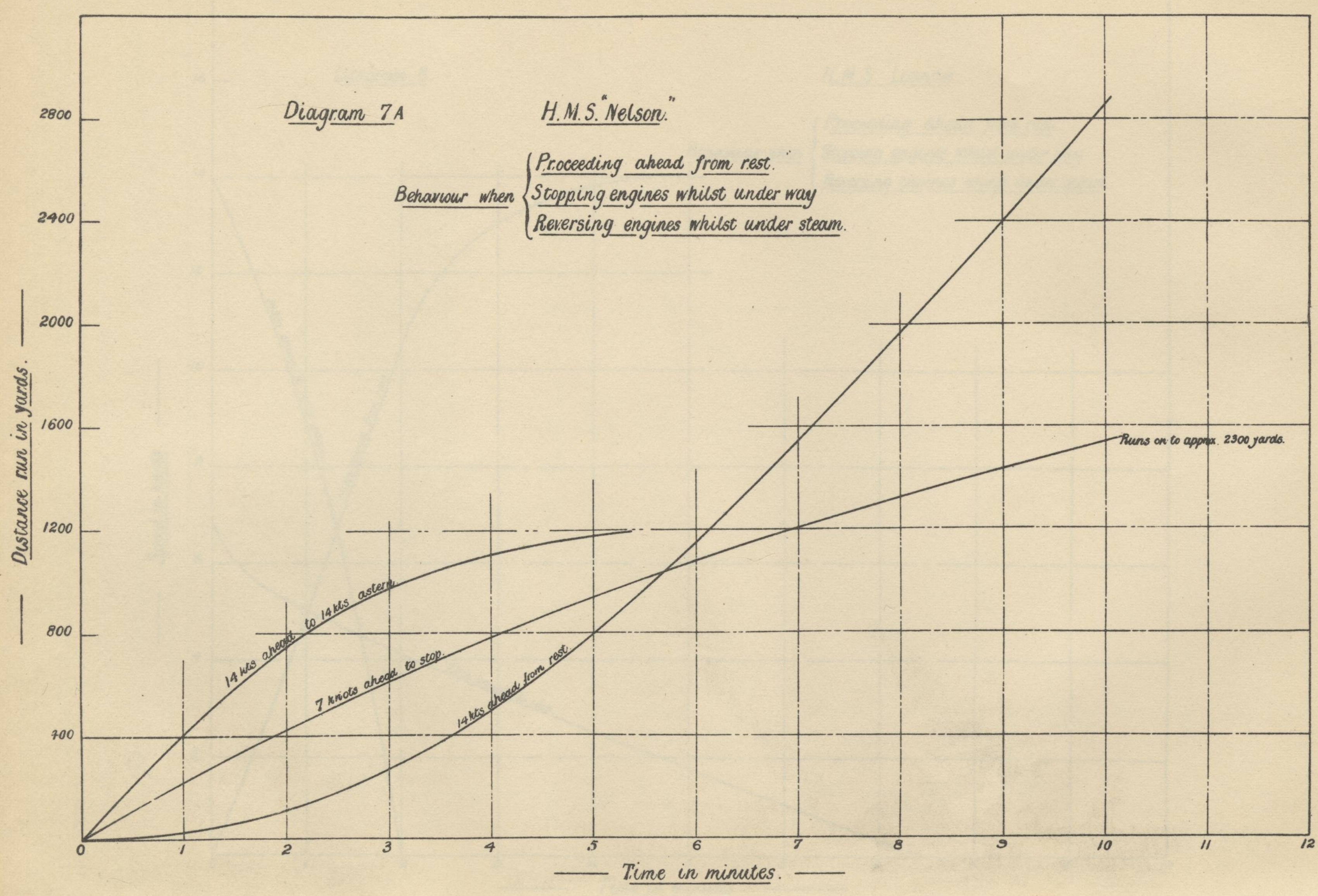


Diagram 7A
H.M.S. "Nelson."
Behaviour when
Proceeding ahead from rest.
Stopping engines whilst under way
Reversing engines whilst under steam.
14 kts ahead to 14 kts astern.
7 knots ahead to stop.
14 kts ahead from rest.
Runs on to approx. 2300 yards.
Distance run in yards.
Time in minutes.
400
800
1200
1600
2000
2400
2800
0
1
2
3
4
5
6
7
8
9
10
11
12

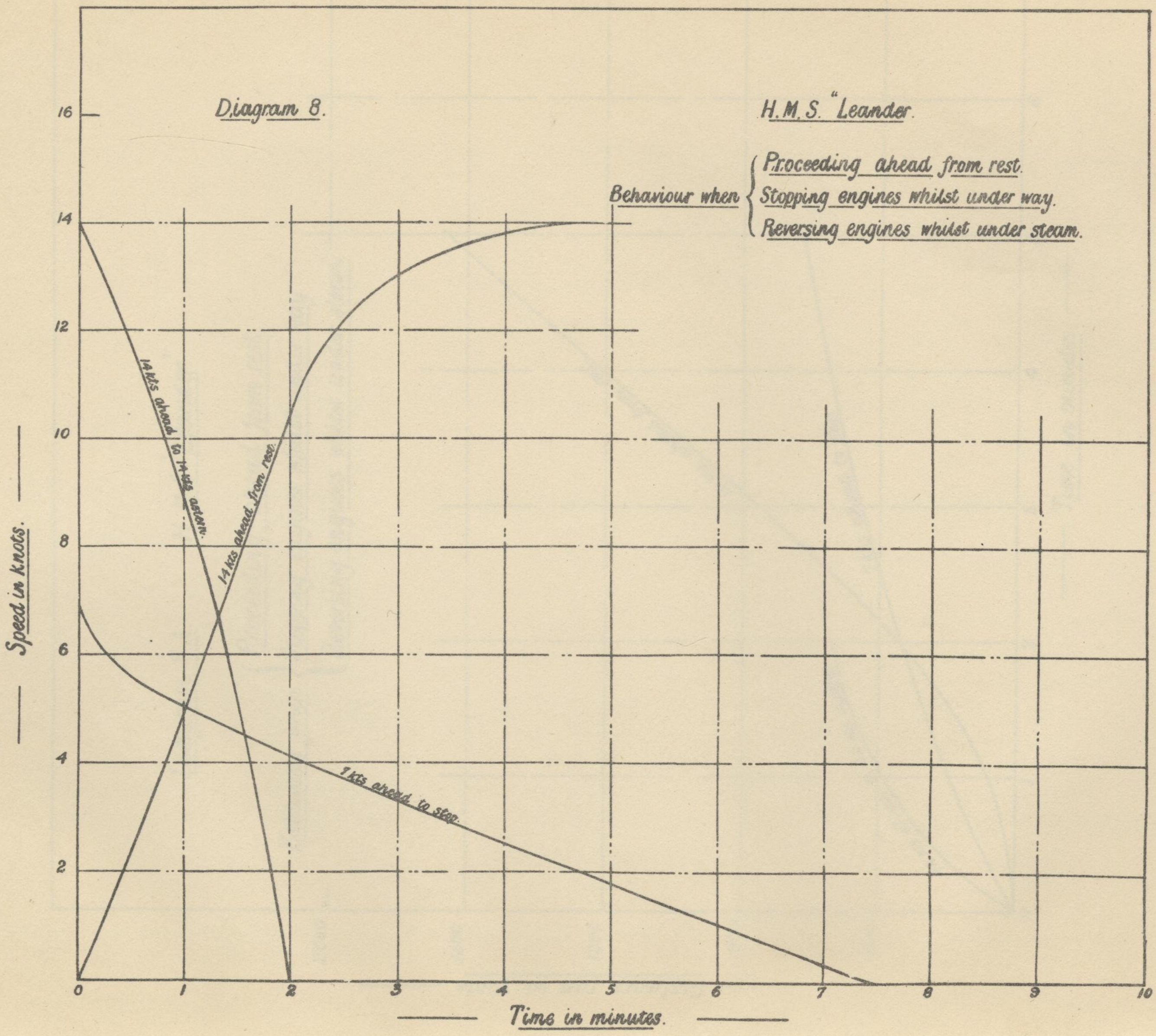


Diagram 8.
H.M.S. "Leander".
Behaviour when
Proceeding ahead from rest.
Stopping engines whilst under way.
Reversing engines whilst under steam.
14 kts ahead to 14 kts astern.
14 kts ahead from rest.
7 kts ahead to stop.
Speed in knots.
Time in minutes.
0
1
2
3
4
5
6
7
8
9
10
12
14
16

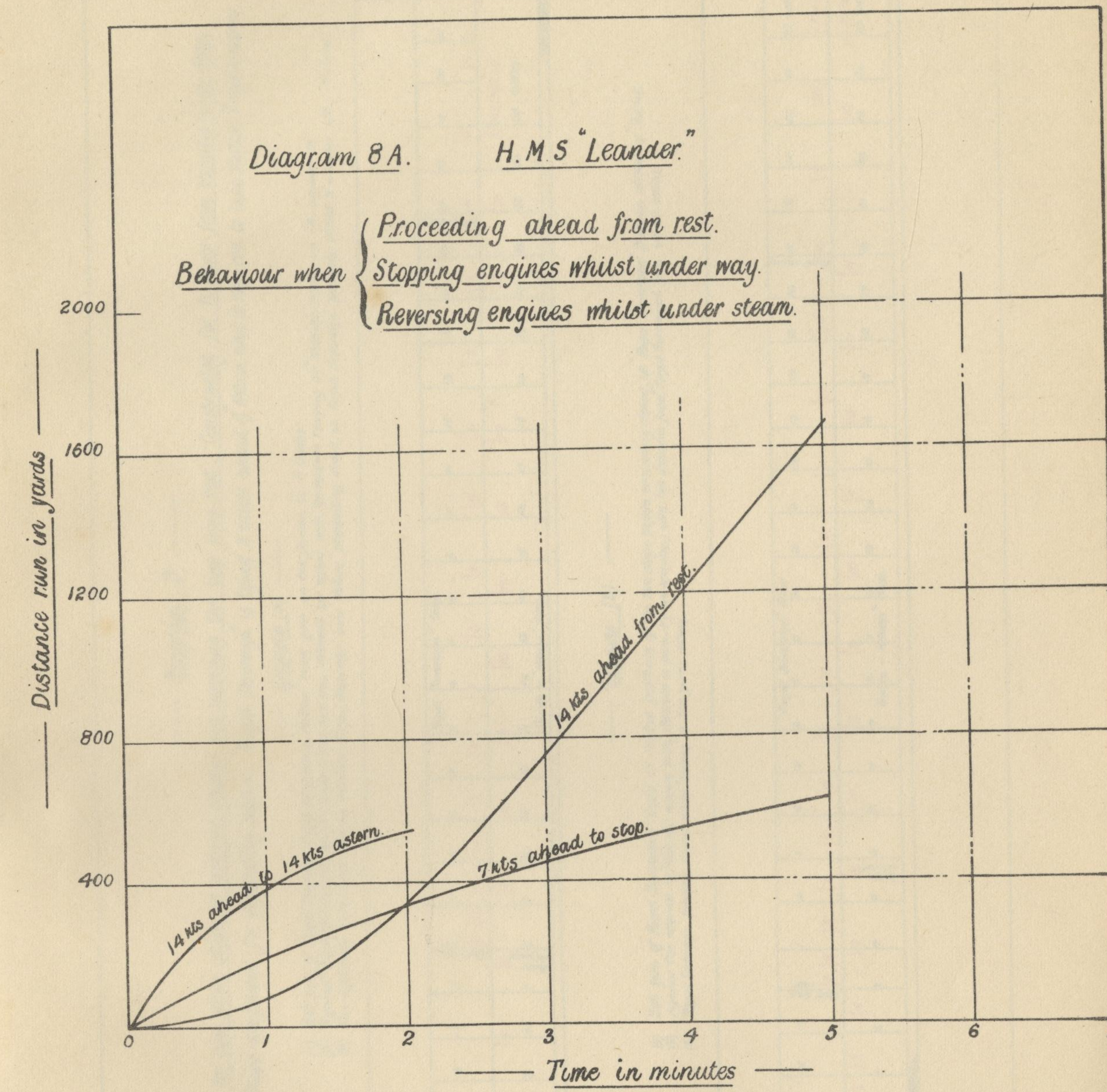


Diagram 8A. H.M.S "Leander."
Behaviour when
Proceeding ahead from rest.
Stopping engines whilst under way.
Reversing engines whilst under steam.
2000
1600
1200
800
400
Distance run in yards
0
1
2
3
4
5
6
7
Time in minutes
14 kts ahead from rest.
7 kts ahead to stop.
14 kts ahead to 14 kts astern.

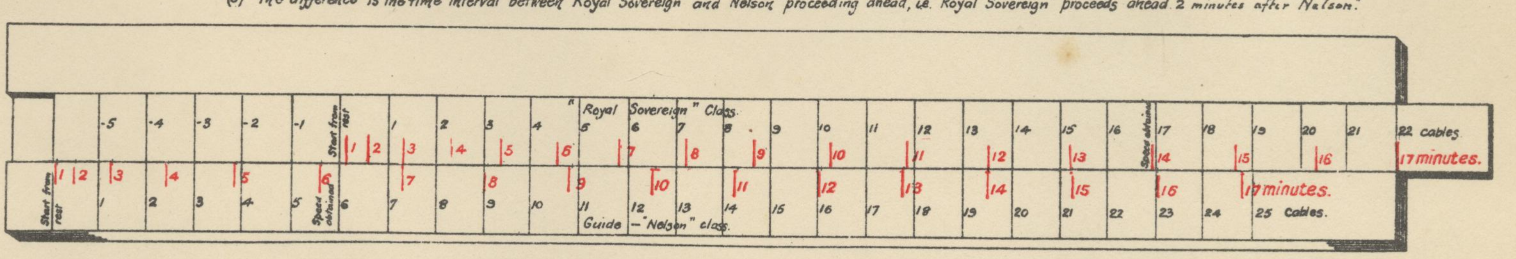
Diagram 9.

Slide Rule for use when ships of different classes are inverting the line from rest. Constructed for 10 knots from turning trial data.

Ships are pointed for proceeding ahead. "Royal Sovereign" is lying 3 cables ahead of "Nelson" and is required to take station 3 cables astern.

Example (a)

(1) Set zero of "Royal Sovereign" scale at distance "Nelson" must gain on the former, i.e. 6 cables.
(2) Against "Royal Sovereign's" minute scale, when she has obtained her speed, note the minute reading on "Nelson's" scale, i.e. 14 against 16.
(3) The difference is the time interval between "Royal Sovereign" and "Nelson" proceeding ahead, i.e. "Royal Sovereign" proceeds ahead 2 minutes after "Nelson".



Example (b)

(4) Set zero of "Royal Sovereign's" scale at relative positions of the two ships before proceeding ahead, i.e. "Royal Sovereign" 3 cables ahead of "Nelson".
(5) Against the interval on "Nelson's" minute scale observed in para. 3 (two minutes) note the distance from "Royal Sovereign's" zero, i.e. $2\frac{1}{2}$ cables.
(6) "Royal Sovereign" proceeds ahead when "Nelson" is 500 yards astern.

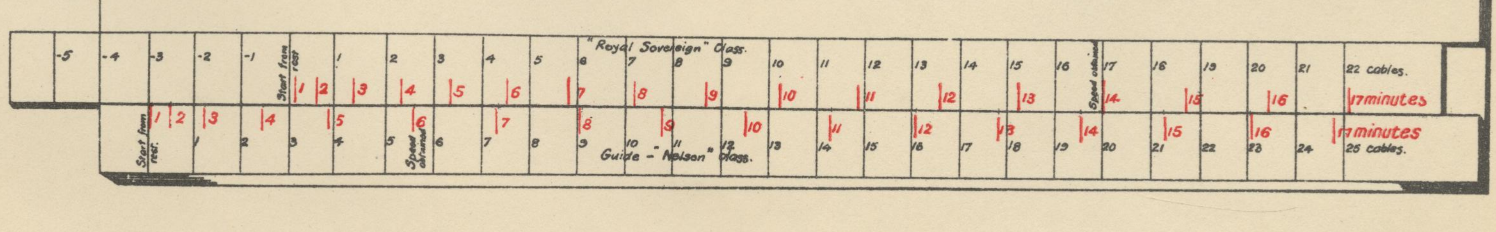


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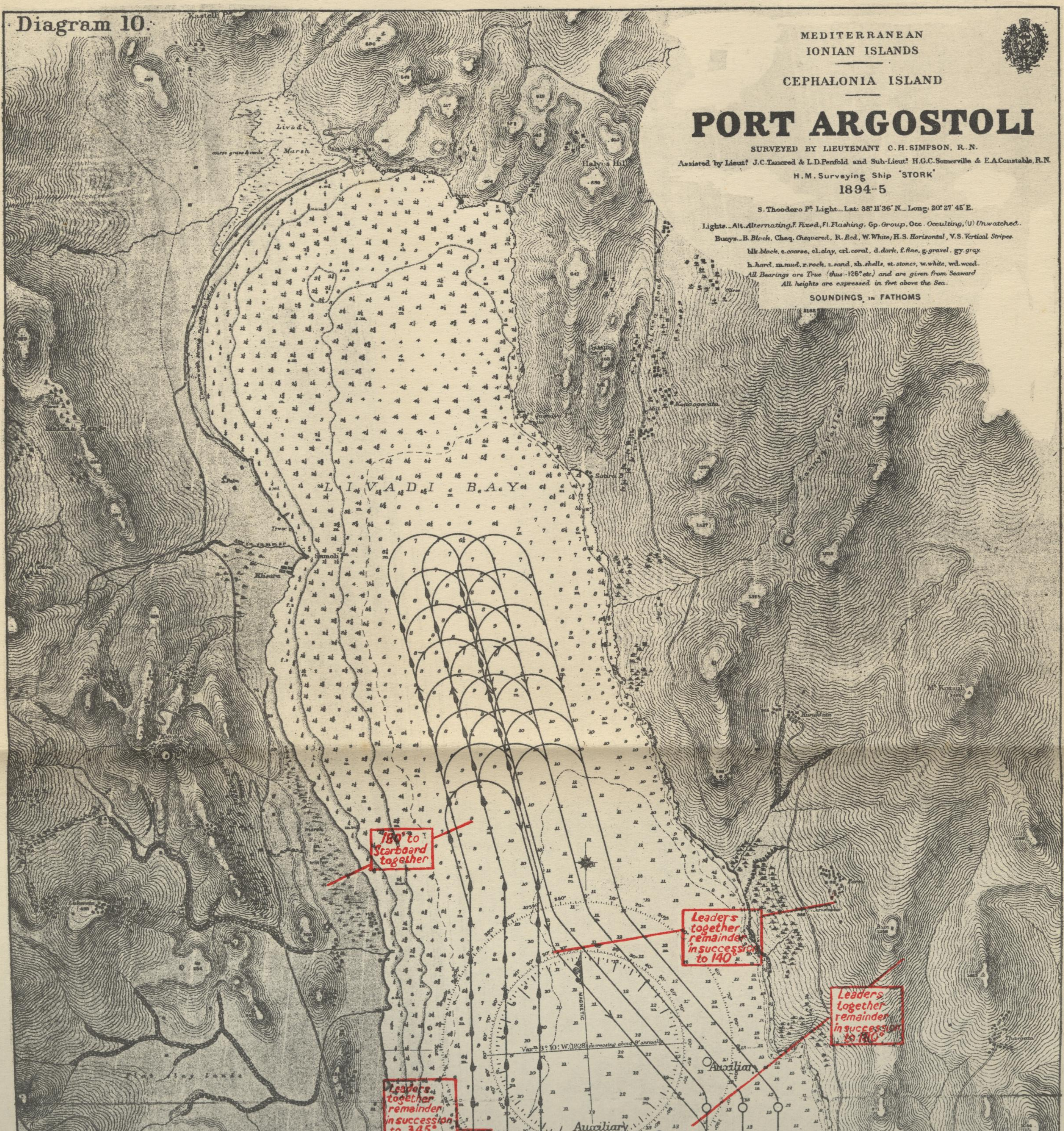
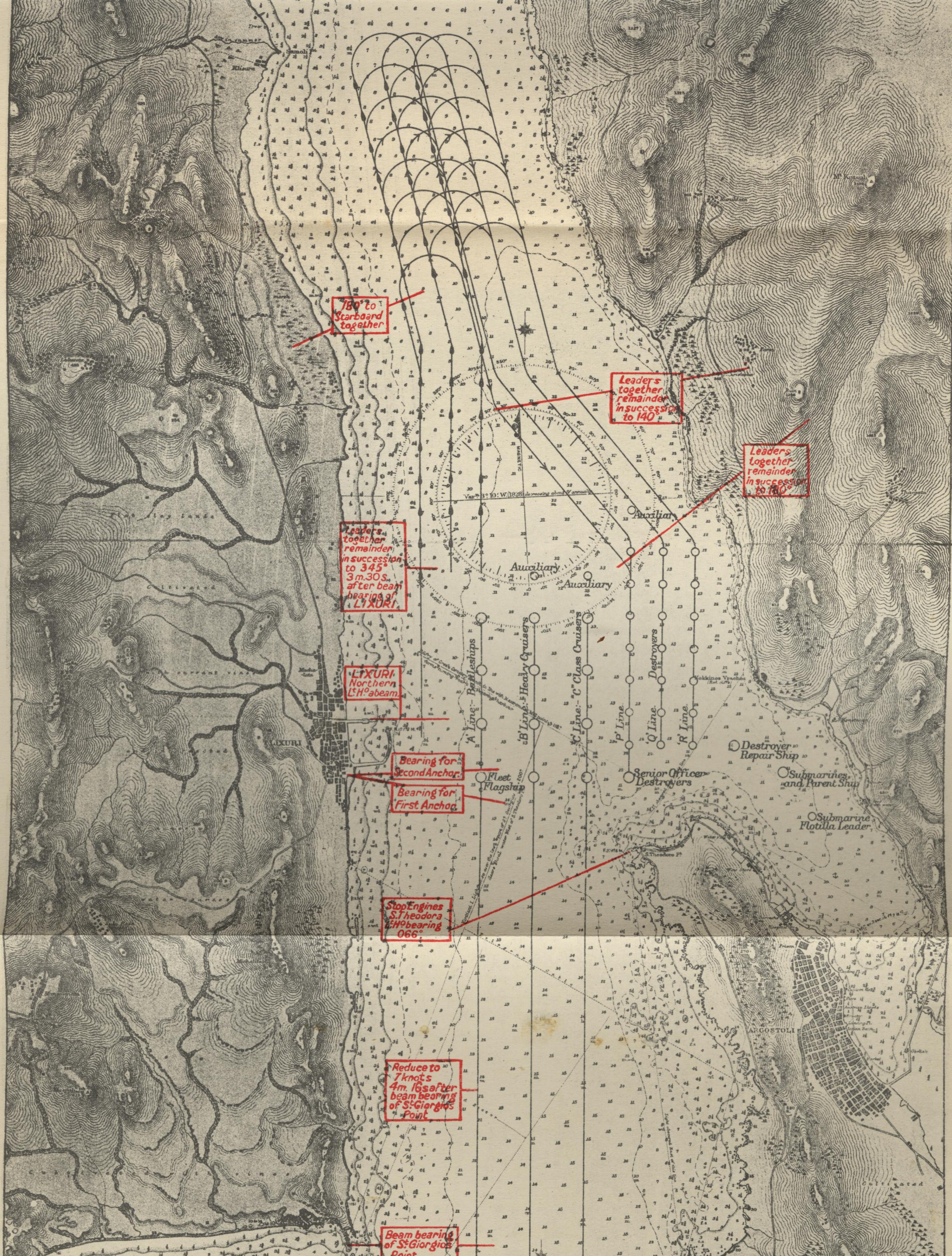
Diagram 10.


MEDITERRANEAN
IONIAN ISLANDS
CEPHALONIA ISLAND
PORT ARGOSTOLI
SURVEYED BY LIEUTENANT C.H.SIMPSON, R.N.
Assisted by Lieut.s J.C.Tancred & L.D.Penfold and Sub-Lieut.s H.G.C.Somerville & E.A.Constable, R.N.
H.M. Surveying Ship "STORK"
1894-5
S. Theodoro Pt. Light_Lat: 38° 11' 36" N._Long: 20° 27' 45" E.
Lights._Alt. Alternating, F. Fixed, Fl. Flashing, Gp. Group, Occ. Occulting, (U) Unwatched.
Buoys._B. Black, Cheq. Chequered, R. Red, W. White; H.S. Horizontal, V.S. Vertical Stripes.
blk. black, c. coarse, cl. clay, crl. coral, d. dark, f. fine, g. gravel, gy. gray.
h. hard, m. mud, r. rock, s. sand, sh. shells, st. stones, w. white, wd. weed.
All Bearings are True (thus -126° etc.) and are given from Seaward
All heights are expressed in feet above the Sea.
SOUNDINGS IN FATHOMS
LIVADI BAY
Livadi Marsh
Samoli
180° to Starboard together
Leaders together remainder in succession to 140°
Leaders together remainder in succession to 180°
Leaders together remainder in succession to 345°
MAGNETIC
Var. 3° 10' W. (1928) decreasing about 9' annually
Auxiliary
Auxiliary



180° to Starboard together
Leaders together remainder in succession to 140°
Leaders together remainder in succession to 180°
Leaders together remainder in succession to 345° 3m.30s. after beam bearing of LIXURI
Auxiliary
Auxiliary
Auxiliary
LIXURI Northern Lt. Ho. abeam
LIXURI
'A' Line:- Battleships
'B' Line:- Heavy Cruisers
'C' Line:- "C" Class Cruisers
'P' Line
'Q' Line
'R' Line
Destroyers
Kokkinos Vrachos
Bearing for Second Anchor
Bearing for First Anchor
Fleet Flagship
Senior Officer Destroyers
Destroyer Repair Ship
Submarines and Parent Ship
Submarine Flotilla Leader
S. Theodoro Pt.
Stop Engines S. Theodora Lt. Ho. bearing 066°
ARGOSTOLI
Reduce to 7 knots 4m. 16s after beam bearing of St. Giorgios Point
Beam bearing of St. Giorgios Point
Kalafati Reefs
Vardiani Sh.
VARDIANI I.
Beam bearing of Lt. Ho.
Rudder over 4m. 36s. after beam bearing of VARDIANI Lt. Ho.
S. Nikolaos Banks
St. Nikolaos I.
St. Nikolaos Pt.
0 5 10 Cables

DIAGRAM 11.

QUARTOGRAM.

This diagram represents a modification of the instrument originally designed during the late war to facilitate station keeping when zig-zagging.

The red lines are engraved on a base plate. The black lines are engraved on a transparent disc pivotted at the centre and free to revolve.

Constructed to fulfil the following requirements:-

(a) Ship stationed 3 cables from the guide on any bearing from 10° on the quarter to 30° on the bow.
The errors introduced when station keeping at 2 and 4 cables are negligible.

(b) Speed of guide, 12 knots. The instrument can be used at other speeds without appreciable error.

(c) Correct station can be resumed in 3 minutes. Practical experience shows that the alterations of course and speed chosen, are those most suitable for a heavy ship.

The black lines indicate the position of the ship; red lines indicate how to correct any error in position.

Example:- Ship stationed 3 cables, 40° on the quarter

(a) If $\frac{1}{4}$ of a cable inside distance and 2° ahead of bearing, reduce speed and alter course slightly outwards.

(b) If $\frac{1}{4}$ cable inside distance and 8° ahead of bearing, reduce speed and alter course inwards.

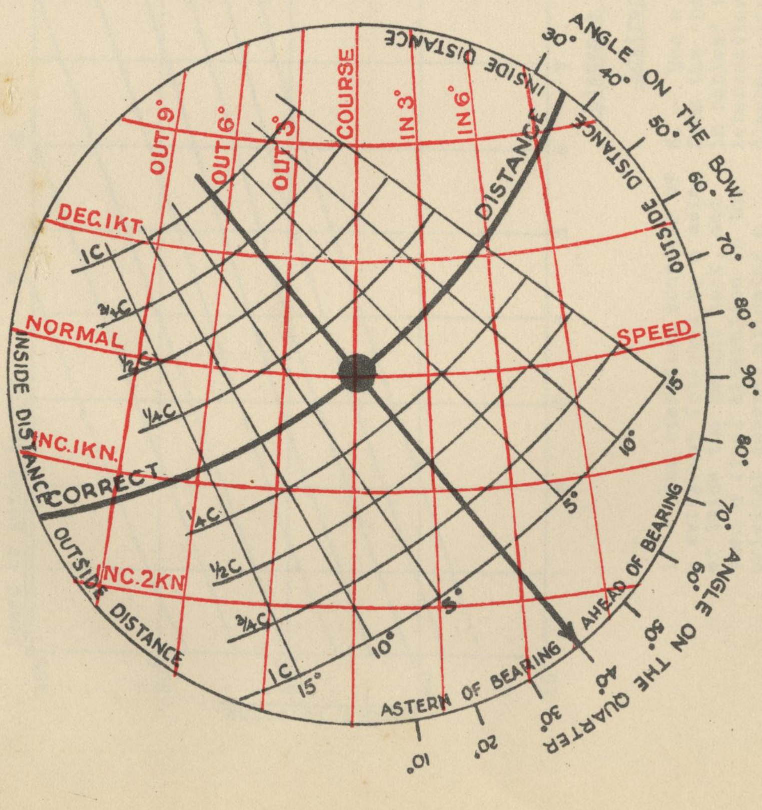
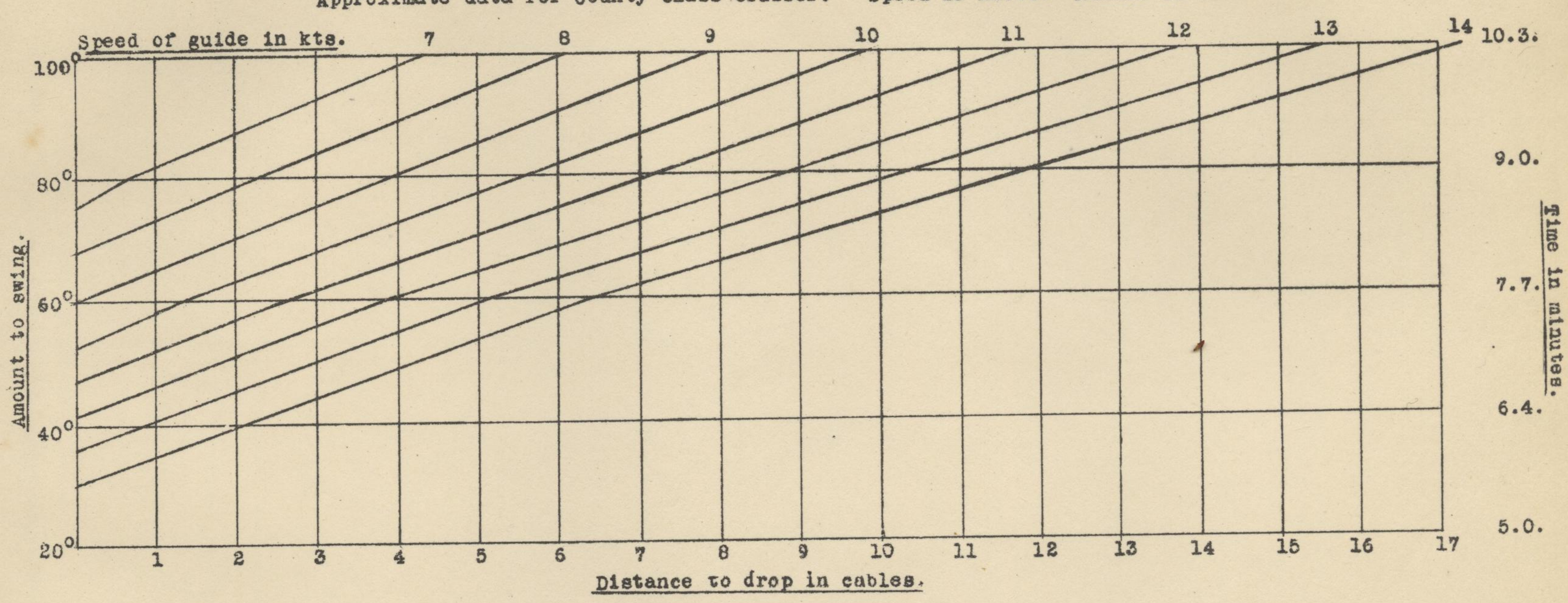


DIAGRAM 12.

ZIG-ZAG DIAGRAM.

TO DETERMINE AMOUNT TO SWING OUT AND BACK TO DROP A GIVEN DISTANCE.

Approximate data for County class cruiser. Speed 13 knots. Rudder 35°.



Instructions for use.

1. - The operation consists of a swing out followed by a swing of twice the amount back, and then a final alteration to the original course, allowing a period of 30 seconds on a steady course between turns. It is important that the ship should not overswing. Revolutions for 13 knots are ordered at the moment of putting the rudder over.

2. - Run a vertical line from the "Distance to drop in cables" to the point of intersection with the diagonal line representing the Guide's speed. From this point, run horizontally and read off "Amount to swing".

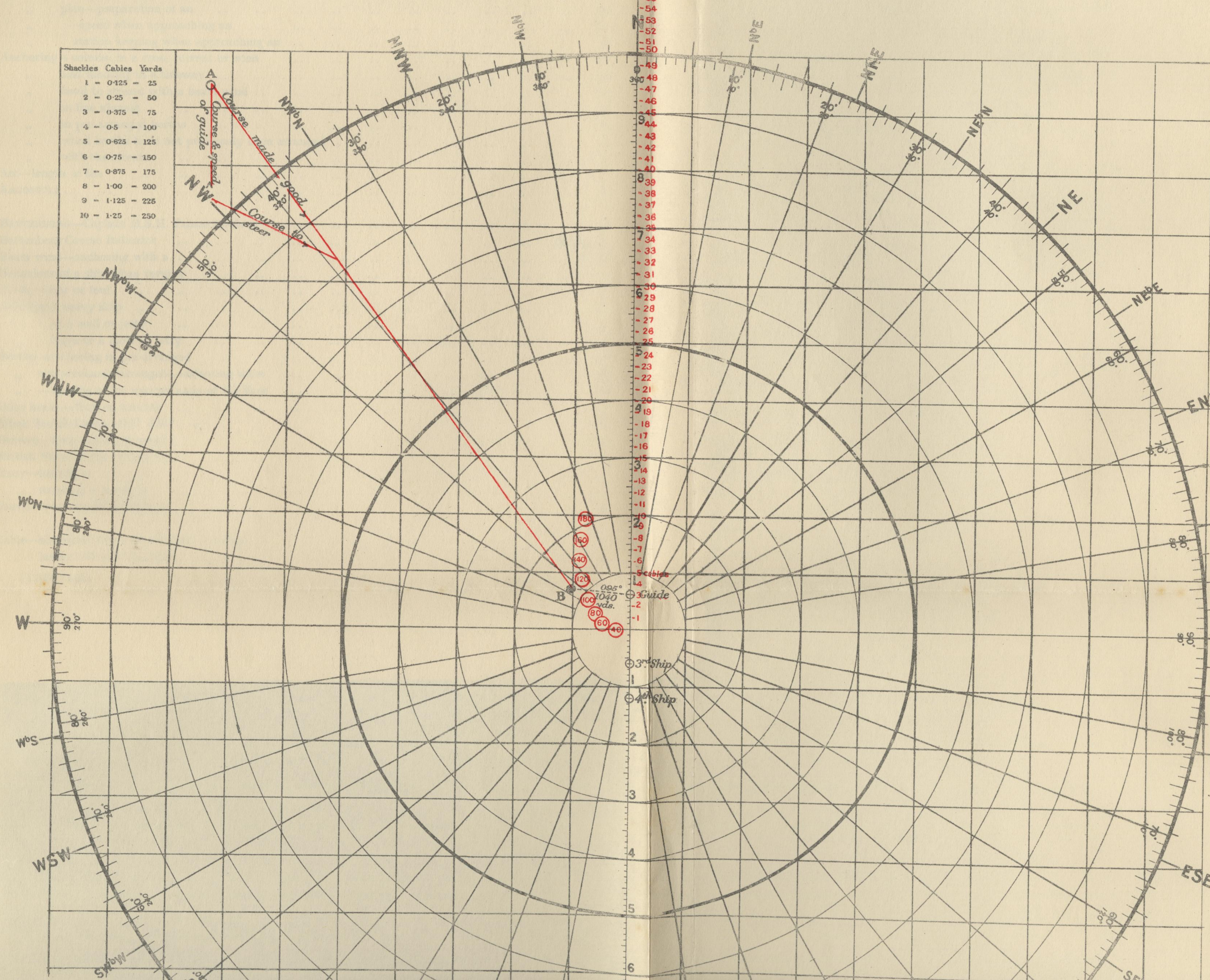
Table for deciding at a glance whether it is preferable to turn 360° rather than to zig-zag.
Ship turns 360° in 9 minutes at 13 knots.

Speed of Guide.	Drop.
7 knots.	10.5 cables.
8 "	12.0 "
9 "	13.5 "
10 "	15.0 "
11 "	16.5 "
12 "	18.0 "
13 "	19.5 "
14 "	21.0 "

6226.

(This should be pasted on a board)

MOORING AND MANŒUVRING BOARD FOR FLEET PURPOSES.



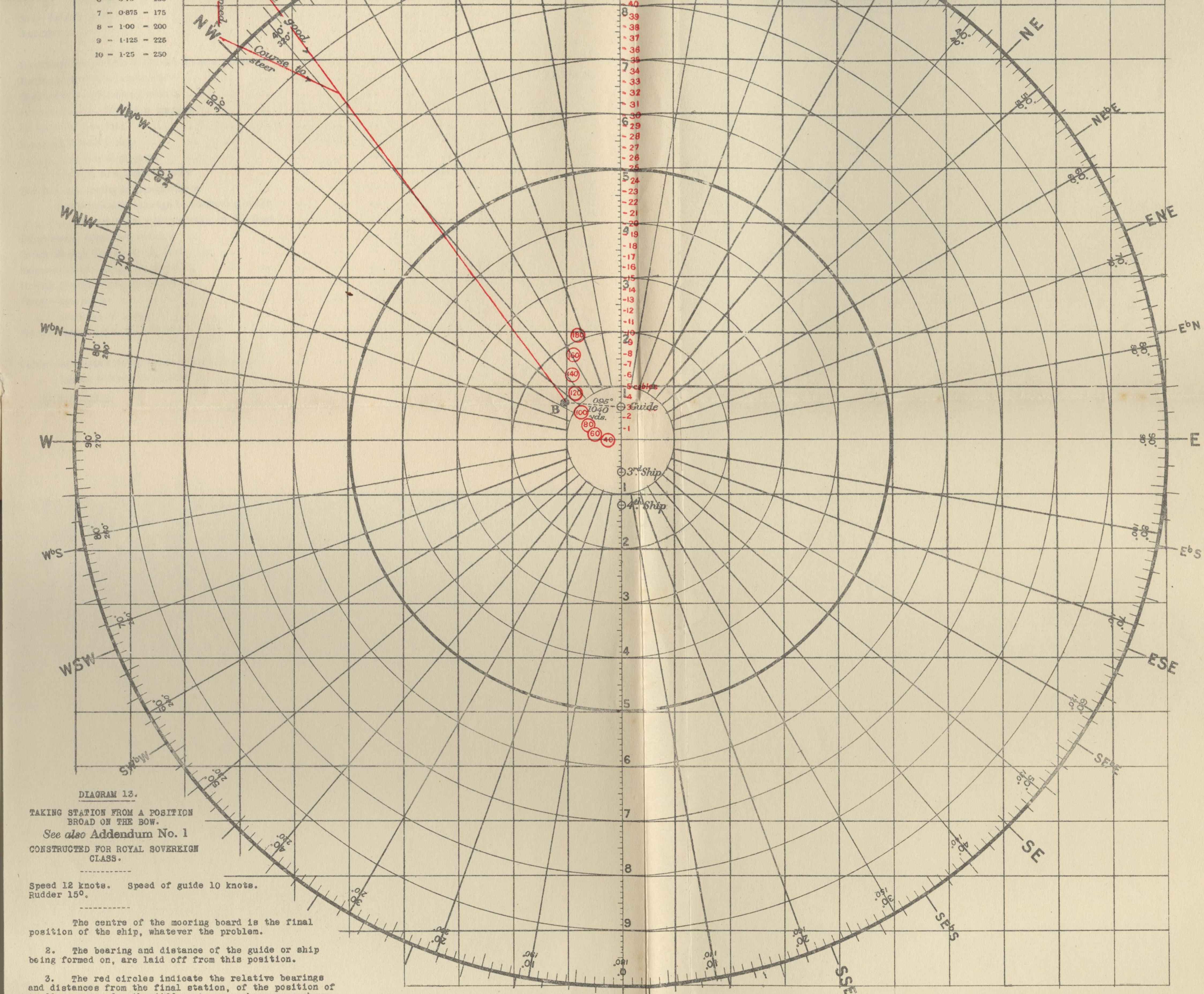


DIAGRAM 13.

TAKING STATION FROM A POSITION BROAD ON THE BOW.

See also Addendum No. 1

CONSTRUCTED FOR ROYAL SOVEREIGN CLASS.

Speed 12 knots. Speed of guide 10 knots.
Rudder 15°.

The centre of the mooring board is the final position of the ship, whatever the problem.

2. The bearing and distance of the guide or ship being formed on, are laid off from this position.

3. The red circles indicate the relative bearings and distances from the final station, of the position of 'rudder over', for the different approach courses shown.

4. The figures within the circles indicate the difference between the approach course and the course of the guide or ship being formed on.

5. In the example, 'A' is the position of the observer's ship at the commencement of the manoeuvre, and she is ordered to take station 3 cables astern of the ship marked 'guide', which is steering 000° at 10 knots.

6. By means of an ordinary speed triangle, it is ascertained that the course to steer direct for the new station makes an angle of 111° with the course of the guide.

7. The position of rudder over, therefore, lies midway between the 120° and 100° circles. A safety distance of 200 yards is allowed and position 'B' plotted.

8. The course to steer for position 'B' is found to be 115°, and the bearing and distance of guide at 'rudder over', 095° - 1,040 yards.

9. Frequent ranges and bearings of the guide will indicate whether the ship is proceeding along the 'course made good'.

10. Rapidity and accuracy are the important factors in the problem. The diagram should, therefore, be pasted on a board. The portion contained within a 5 inch radius of the centre should be cut out and pasted on a separate wood disc, which should be free to revolve, flush with the remainder of the board. The disc is trained on to the course of the guide and the problem simplified by working in actual instead of relative courses.

6226.WT10807/8205.750.9.34.

INDEX.

(A 313/1442) Wt. 10807—8205 750 11/34 H & S, Ltd. Gp. 313

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O.U. 5274 (1)

Addendum No. 1
to
O.U. 5274

Remarks on Handling Ships

1939

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ADMIRALTY, S.W.1.
1939.

The accompanying Addendum No. 1 to O.U. 5274—" Remarks on Handling Ships "—having been approved by My Lords Commissioners of the Admiralty, is hereby promulgated for information and guidance.

BY COMMAND OF THEIR LORDSHIPS.

R. H. H. Carter

D. OF N. DEPARTMENT.
H. 1190/38.

O.U. 5274—Remarks on Handling Ships—Addendum No. 1.

Further consideration has been given to the problem of taking station from a position ahead or on the bow. This is discussed on page 33 of O.U. 5274, but the diagram given therein has the admitted limitation that it applies only to those particular speeds of own ship and guide.

2. The diagram described herewith has been designed to give the required information for any speed of own ship, and for speeds of guide two knots or six knots less than that of own ship. For other speed differences, the result can be readily obtained by visual interpolation.

3. The disadvantage of the diagram about to be described is that plotting of the curves requires considerably more data than are obtainable from the orthodox reports of Turning Trials on Form S. 347 or D. 500. **These at best, and where manœuvring rudder is one of those specified, determine two points only on each of the curves, and curves based on these alone might easily be so much in error that use of the diagram would create a dangerous situation.** To obtain the additional data necessary for the accurate construction of the diagram, it is necessary for the ship to carry out a series of turning trials under manœuvring rudder at a number of speeds other than those used in completing Form S. 347 or D. 500. The specimen diagram accompanying this description shows a list of the trials carried out by H.M.S. PENELOPE in order to obtain the supplementary data from which it was constructed.

4. Details of the construction of the diagram, and instructions for its use, are given herewith.

5. A diagram on these lines will prove of greater general utility than Diagram 13 in O.U. 5274.

Theory of Construction of Diagram.

The specimen diagram has been made out for H.M.S. PENELOPE using 30° of rudder.

The scale is 1″ to 5 cables, and the use of squared paper graduated in tenths of an inch is convenient for inserting positions without recourse to instruments, and for interpolation.

" O " is the final position of own ship when in station, and " OY " her final course.

2. " *A* " *Group of Curves.*—These indicate, for different speeds and alterations of course, the distance from the line " OY " at which the wheel must be put over (to manœuvring rudder angle, in this instance 30°) in order to turn up somewhere on this line.

For convenience the curves are drawn on both sides of " OY."

The curve for 180° is the locus of the transfers for 180° at various speeds, and for 90° is the locus of the advances for 90° at various speeds.

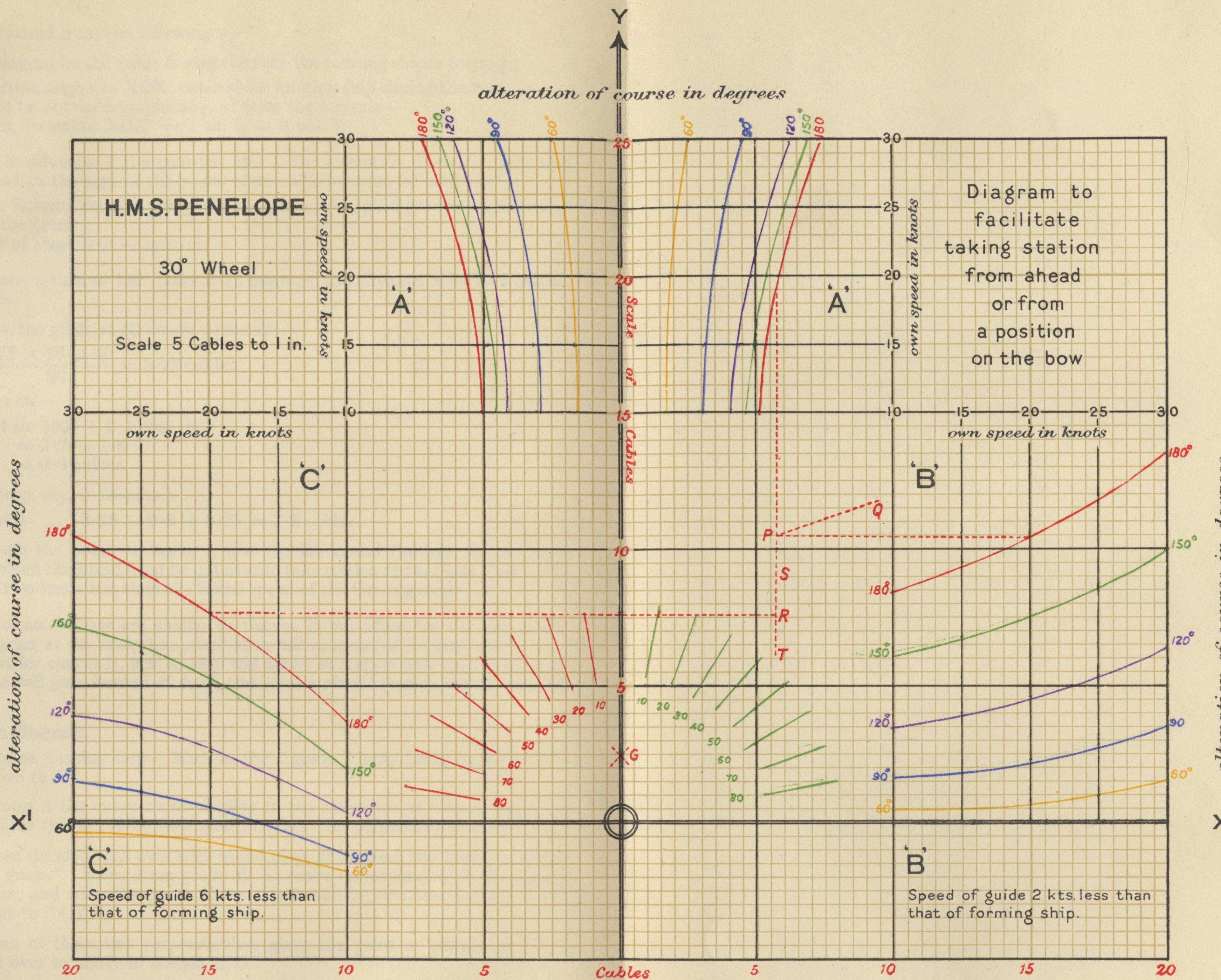
The curve for any other alteration L° can be obtained graphically, or by means of the formula—

$$\text{Distance from OY} = A \sin L - T \cos L.$$

A and T being the advance and transfer respectively, and due regard being paid to the sign of the cosine of an angle between 90° and 180°

3. " *B* " *Group of Curves.*—These indicate, for different speeds and alterations of course, the distance from the line XOX′ at which the wheel must be put over (to manœuvring rudder, in this instance 30°) in order to have completed the turn on virtually reaching this line when it (i.e., the " guide ") is advancing along " OY " at a speed two knots less than that of the forming ship at the commencement of the turn.

DIAGRAM TO FACILITATE TAKING STATION FROM A POSITION AHEAD OR ON THE BOW.



The supplementary trials carried out by H.M.S. Penelope to furnish the data required for the construction of this diagram were:–

(a) Turning trials under 30° rudder at 12, 16, 20 and 25 knots (advance and transfer)
Note, it was found that between 6 and 12 knots circle remained unchanged.

(b) Times to turn 30° 60° 90° etc. at 7, 10, 12, 16, 20 and 25 knots

(c) Constant speed to which reduced after turning 60°.

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These curves are calculated from the following :—

(*a*) the distance advanced by the guide during the time the forming ship is turning ;

(*b*) the distance at right angles to XOX′ covered for forming ship during the turn.

This can be obtained graphically, or from the formula—

Displacement normal to XOX′ = T sin L + A cos. L

where A is the advance, T the transfer, and L the alteration of course, and due regard is paid to the sign of the cosine of an angle between 90° and 180° ;

(*c*) an allowance for forming ship dropping while regaining the speed (two or three knots) lost during the turn.

The cumulative effect of these is (a — b + c).

Example.—At 20 knots, a turn of 150° takes 2·75 minutes, the advance being 2·1 cables, and the transfer 5·4 cables.

(*a*) In 2·75 minutes, the guide at 18 knots, advances—

$$\frac{2{\cdot}75 \times 18 \times 10}{60} = 8{\cdot}25 \text{ cables.}$$

(*b*) Own ship moves on—

$$5{\cdot}4 \sin 150° + 2{\cdot}1 \cos. 150°$$
$$= 2{\cdot}7 - 1{\cdot}8$$
$$= 0{\cdot}9 \text{ cables.}$$

(*c*) Allowance for drop, say, 0·25 cables.

Total ... 8·25 — 0·9 + 0·25 = 7·6 cables.

4. The vertical through the point on curve A and the horizontal through the point on curve B give the *point* at which the wheel must be put over to take station at the point C provided it is advancing at a speed two knots less than the initial speed of the forming ship.

5. " *C* " *Group of Curves.*—These are similar to Curves B but allow for the line XOX (i.e., the " guide ") advancing at six knots less speed than initial speed of forming ship.

They are calculated as for curves B, but, as ship will arrive in station with an excess speed of three or four knots, she will gain instead of drop, and (*c*) therefore becomes subtractive and increased in value.

Instructions for Using the Diagram.

O is the final position of forming ship. Mark in the " guide " (ship being formed on) in the correct position relative to O.

(i) Select from group A the curve corresponding to the alteration of course, and from the point where this is cut by *own* speed, trace a line perpendicular to XOX′.

(ii) Let it have been decided that own ship would close at a speed two knots in excess of that of " guide." Select from group B the curve corresponding to the alteration of course, and from the point where this is cut by *own* speed, trace a line perpendicular to " OY."

(iii) The intersection of these two perpendiculars gives the point at which the wheel must be put over to arrive in station at O.

2. When taking station on or near the " guides " track, an allowance for safety must be made by moving the point for " wheel over " outwards by a suitable amount. For turns of or near 180°, an allowance of not less than four cables from the " guide's " track is suggested.

When this is done, allowance must be made for the ground lost while moving over into station after completing the major part of the large turn.

3. *Example.*—Speed of guide 18 knots, speed of own ship 20 knots. It is desired to make a final turn of 180° to starboard, and to take station two and a half cables astern of guide. Mark in guide two and a half cables ahead of O, and call this point G. Curves A and B for 20/18 knots, and 180°, give an intersection at P. Draw a line from P outwards, and 20° (by eye) above the horizontal, and mark off the distance PQ equal to the selected safety allowance (in this case four cables). The 20° cant allows sufficiently accurately for the ground lost while moving over into station.

QG then represents the bearing and distance of the guide from the position in which the wheel should be put over, and the forming ship should arrange to reach this position on a course opposite to that of the guide.

NOTE.—If it had been desired to take station two and a half cables on starboard beam of guide, a safety allowance of only one and a half cables would give the requisite four cables from "guide's" track.

4. If the excess of forming ship's speed over that of guide is other than two or six knots, points from B and C curves should be plotted, and the result obtained by visual interpolation. For example, if speed of guide had been 16 knots (i.e., four knots less than that of forming ship), point P (for 18 knots speed of guide) is found as shown in the previous example. Point R (for 14 knots speed of guide) is found similarly, but making use of curves C.

The required point S for 16 knots speed of guide is situated halfway between P and R. Similarly, point T for 12 knots speed of guide is situated below R a distance equal to half P.R. Where a safety allowance has to be made, this is laid off from R or S or T just as PQ was laid off from P.

6/39 (399/1534) Wt. 33764—6002 1125 11/39 H & S Ltd. Gp. 399 (1180)

AMENDMENTS TO O.U. 5274 (2).

AFO. P. 428/46. 30-6-48. [signature] T.C.3.

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O.U. 5274 (2)

Addendum No. 2
to
O.U. 5274

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emarks on Handling Ships

1944

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1944.

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BY COMMAND OF THEIR LORDSHIPS.

D. OF N. DEPARTMENT.
H. 1587/44.

O.U. 5274—Remarks on Handling Ships—Addendum No. 2.

Manœuvring Disc for use when Dropping Bearing and/or Distance by Swings and Zigzags.

The construction described hereunder is designed to give an immediate and accurate answer to problems involving the dropping of bearing and/or distance by means of swings or zigzags.

2. If a ship which has been proceeding on a steady course swings out a previously determined number of degrees and then immediately resumes the original course, the new track will be a certain distance (hereafter called the "Transfer") to one side or the other of the old, and the ship's beam bearing will also be a certain distance (hereafter called the "Drop") astern of where it would have been had she kept her original course and speed.

3. If the ship after swinging out had steadied on the new course for a period before resuming the original one, the Transfer and Drop would be proportionately greater.

4. Alternatively she may ~~swing out~~ ZIGZAG OUT and ...
converging ...
resumption ...

The following *amendments* are to be made to O.U. 5274 (2).

Page 4. Paragraph 4 to *read* "Alternatively she may ZIGZAG out and then in .... without transfer". Then *add* "In zigzags it is more satisfactory to steady one minute on the first leg, and one minute or more on the second leg, depending on the converging course. This form of zigzag was used in the trials from which the data was obtained, and should be followed by ships using the zigzag data: *see* example 2."

5. The ...
turning circ...
included in s...
position whi... is a moving point, viz., the ... reached had she kept her original course and speed, instead of a fixed one, *i.e.*, the point at which the wheel was put over, and partly because they depend so much on how the ship is handled. It requires nice judgment to reach exactly the swing intended, neither overshooting it nor failing to reach it, and, further, unless intended, to remain no time on it but immediately commence the swing back.

6. The construction was first evolved in H.M.S. WARSPITE, for a Tactical Diameter of 1,000 yards and at a speed of 16 knots. (This Tactical Diameter was at one time used in the Eastern Fleet when aircraft-carriers, cruisers, and Q.E. class battleships were manœuvring together.) To conform to it, it was necessary in WARSPITE to apply 10° of wheel, reducing it to 5° almost as soon as the ship began to swing—actually, after 2°. This was preferred to the larger diameter of 1,300 yards laid down in Article 106 (C) of "Conduct of the Fleet," because WARSPITE could conform to the larger diameter only by putting the wheel amidships at intervals during the turn, causing "flats" which made it difficult for ships astern to follow in the wake.

7. The requisite data for WARSPITE were obtained from many observations of another ship stationed, before the manœuvre, 4 cables ahead, which maintained her course and speed while the WARSPITE manœuvred and took ranges and bearings of her at sufficiently short intervals for WARSPITE'S positions, courses, and speeds (reduced by the turn(s)) to be plotted, and the DROP and TRANSFER determined.

Construction of the Diagram.

8.—(*a*) The diagram is drawn to a scale of 4 cables to the inch.

(*b*) The GREEN grid is similar to an ordinary mooring board, having vectors every 10°, and circles at every half-inch radius, enabling bearing and distance to be quickly plotted by eye.

(*c*) Superimposed is a RED grid of one cable squares, in which the horizontal lines represent DROP and the vertical lines TRANSFER.

MANŒUVRING DISC

Malby & Sons, Ltd

O.U. 5274—Remarks on Handling Ships—Addendum No. 2.

Manœuvring Disc for use when Dropping Bearing and/or Distance by Swings and Zigzags.

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3. If the ship after swinging out had steadied on the new course for a period before resuming the original one, the Transfer and Drop would be proportionately greater.

The following *amendments* are to be made to O.U. 5274 (2).

Page 4. Paragraph 4 to *read* "Alternatively she may ZIGZAG out and then in .... without transfer". Then *add* "In zigzags it is more satisfactory to steady one minute on the first leg, and one minute or more on the second leg, depending on the converging course. This form of zigzag was used in the trials from which the data was obtained, and should be followed by ships using the zigzag data: *see* example 2."

4. Alte... converging ... resumption ...

5. The ... turning circ... included in such data, partly because the datum to which they refer is a moving point, viz., the position which the ship would have reached had she kept her original course and speed, instead of a fixed one, *i.e.*, the point at which the wheel was put over, and partly because they depend so much on how the ship is handled. It requires nice judgment to reach exactly the swing intended, neither overshooting it nor failing to reach it, and, further, unless intended, to remain no time on it but immediately commence the swing back.

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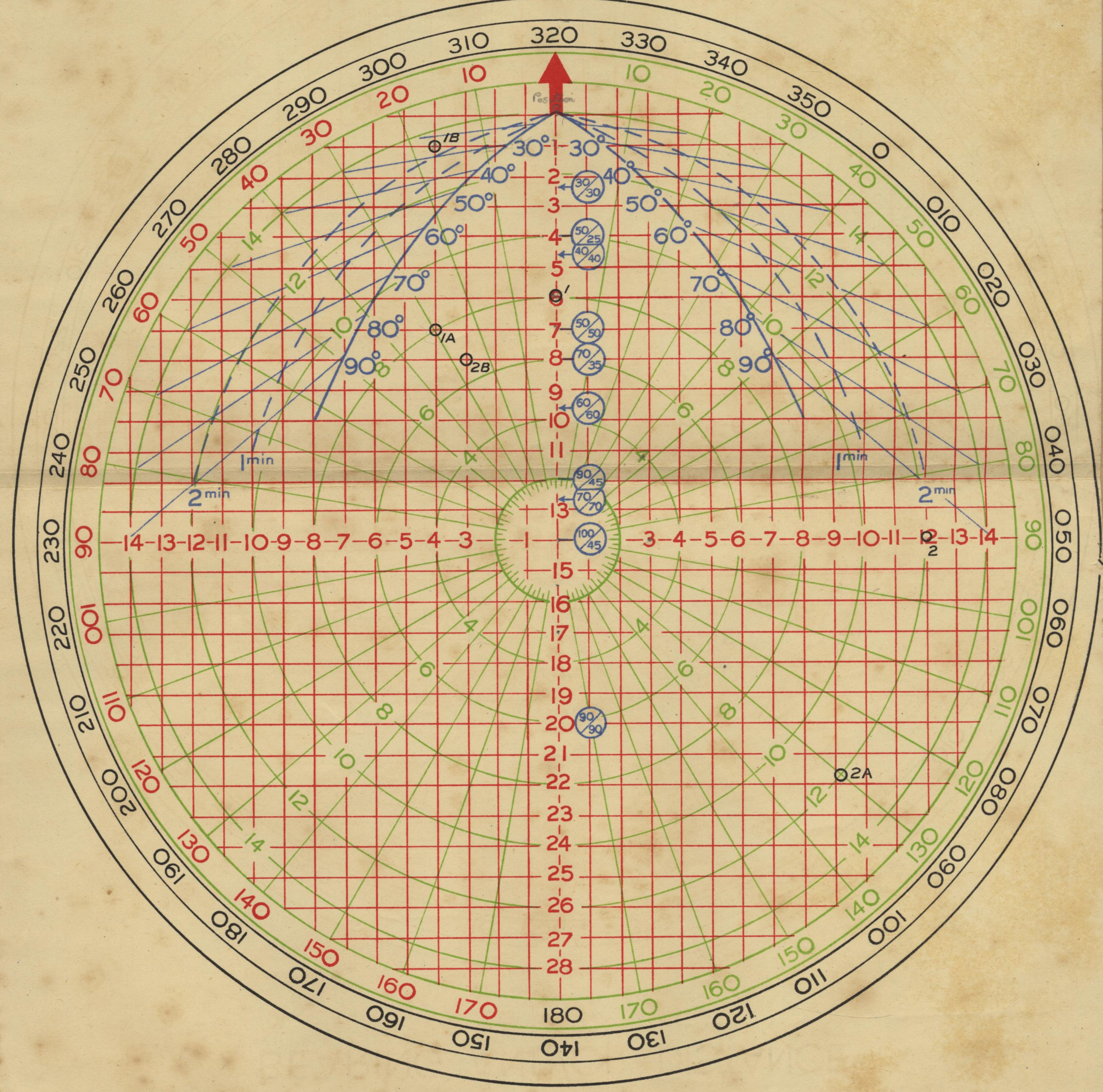
MANŒUVRING DISC.

FOR USE WHEN DROPPING BEARING AND/OR DISTANCE



(*d*) The BLUE grid radiating from the head of the diagram determines the DROP and TRANSFER for various swings and zigzags. (The thick blue curve shows the Drop and Transfer for a straightforward swing. The straight lines diverging from it show the effect of remaining on the new course the number of minutes indicated by the pecked curves.)

(*e*) The disc, the outside edge of which is graduated for every 10° of relative bearing, is pasted on a Torpedo Control Disc having an outer ring graduated in true bearing. The ship's head can thus be set to the true course, and the actual initial course required for any predetermined swing or zigzag can immediately be read off.

Notes on the Diagram.

9.—(*a*) The Target ship, or ship being formed on, is always at the centre of the disc.

(*b*) Rudder and Speed—the rudder and speed used during the trials for determining the … ter of … were … within

Page 5. Paragraph 9(*b*). *Add* " It should be noted that other ships accommodating themselves to 1,000 yard turning circle will probably use more rudder than did the trial ship, and thereby incur a slightly greater loss of speed while turning. In such cases where a ship is manoeuvring individually it should be convenient to increase speed slightly during the manoeuvre, but when a column is being manoeuvred, and it is not desired to alter the speed, it should be convenient to aim to drop a lesser distance (say ¾ cable less)."

… essed as bearing and distance from guide, by means of the Green grid.

(*b*) On being ordered to take up a new bearing and distance from guide, pencil in the new position by means of the Green grid.

(*c*) Use the Red grid to determine DROP and TRANSFER between old and new positions.

(*d*) From the zero point of the Red grid at the top of the disc apply the DROP, and from the centre Red vertical line the TRANSFER.

(*e*) The appropriate swing to achieve this DROP and TRANSFER is ascertained from the Blue grid by inspection.

Notes on Use of the Diagram.

11.—(*a*) The new position will on occasion prove to be within the ship's "Guard," *i.e.*, the Thick Blue curve, so that the manœuvre cannot be executed by a swing only because the ship would finish up outside distance. In such a case a combination of swing and zigzag must be employed (see Example II).

(*b*) When time permits the stations of own and other ships prior to a manœuvre should be checked and replotted, instead of it being assumed that all ships are correctly in station. This applies particularly when forming a column astern of an adjacent column.

Examples.—For the purposes of illustrating examples an outer True Bearing ring has been drawn round the copy of the manœuvring disc showing the ship's head and course of the Fleet as 320°.

Example 1.—*Ship's head and Course of Fleet* 320° *speed* 15 *knots. Initial station, position* 1 *on the disc.*

A column in close order (4 cables) with 7 ships receives the signal—Formation 290° PT blank blank (indicating that the third ship in the line is the ship to be formed on). The problem for the Leading ship is solved as follows :—

(1) On Green grid plot new station (290° 8 cables—Position 1A on the disc).

(2) Inspect the Red grid for Drop (1 cable) and Transfer (out) (4 cables) from old to new station.

(*d*) The BLUE grid radiating from the head of the diagram determines the DROP and TRANSFER for various swings and zigzags. (The thick blue curve shows the Drop and Transfer for a straightforward swing. The straight lines diverging from it show the effect of remaining on the new course the number of minutes indicated by the pecked curves.)

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Notes on the Diagram.

9.—(*a*) The Target ship, or ship being formed on, is always at the centre of the disc.

(*b*) Rudder and Speed—the rudder and speed used during the trials for determining the data from which to construct the Blue grid were rudder such as to give a Tactical Diameter of 1,000 yards (see para. 6 above) and speed the same as the unit being formed on. (The tests were carried out at 16 knots, but the construction applies with sufficient accuracy to speeds within 4 knots either side of this.)

Use of the Diagram.

10.—(*a*) Set ship's head arrow to true course, and mark present station in pencil, expressed as bearing and distance from guide, by means of the Green grid.

(*b*) On being ordered to take up a new bearing and distance from guide, pencil in the new position by means of the Green grid.

(*c*) Use the Red grid to determine DROP and TRANSFER between old and new positions.

(*d*) From the zero point of the Red grid at the top of the disc apply the DROP, and from the centre Red vertical line the TRANSFER.

(*e*) The appropriate swing to achieve this DROP and TRANSFER is ascertained from the Blue grid by inspection.

Notes on Use of the Diagram.

11.—(*a*) The new position will on occasion prove to be within the ship's "Guard," *i.e.*, the Thick Blue curve, so that the manœuvre cannot be executed by a swing only because the ship would finish up outside distance. In such a case a combination of swing and zigzag must be employed (see Example II).

(*b*) When time permits the stations of own and other ships prior to a manœuvre should be checked and replotted, instead of it being assumed that all ships are correctly in station. This applies particularly when forming a column astern of an adjacent column.

Examples.—For the purposes of illustrating examples an outer True Bearing ring has been drawn round the copy of the manœuvring disc showing the ship's head and course of the Fleet as 320°.

Example 1.—*Ship's head and Course of Fleet* 320° *speed* 15 *knots. Initial station, position* 1 *on the disc.*

A column in close order (4 cables) with 7 ships receives the signal—Formation 290° PT blank blank (indicating that the third ship in the line is the ship to be formed on). The problem for the Leading ship is solved as follows :—

(1) On Green grid plot new station (290° 8 cables—Position 1A on the disc).

(2) Inspect the Red grid for Drop (1 cable) and Transfer (out) (4 cables) from old to new station.

(3) On the Red grid Drop 1 cable from position O at the top of the diagram and Trans (out) 4 cables. Mark this point. (Position 1B on the disc.)

(4) Inspect the Blue grid to find the necessary alteration to attain this Drop and Trans to the new Station. (27° to port for 2¼ minutes and resume original course.)

(5) Read off the course (27° to port) on the relative (Green) ring against the True bear (Black) ring to give True course 293°.

Example 2.—*Course and speed of Fleet* 320° 16 *knots.*

Two columns disposed abeam to starboard, 3 ships in each, manœuvring distance 12 cabl The Commander of the starboard column is ordered to dispose his column on the bearing 090 (Initial station, position 2 on the disc.)

(1) Plot new station on Green grid (090° 12 cables, position 2A on the disc).

(2) Inspect Red grid for Drop (8 cables) and Transfer (in) (3 cables) from old to ne station.

(3) Apply Drop from point O at the top of the diagram and Transfer from the centre li and mark this point (position 2B on the disc).

(4) Inspect Blue grid for most suitable manœuvre. A zigzag 50° out 50° in drop 7 cables. From the swing curves, steady 1½ minutes on 50° in drops 1 cabl and transfers 3 cables. These two movements combined give the required Dro and Transfer to obtain new station. (50° in, steady 2½ minutes (1 minute allowe in Z Z), then 50° out, steady 1 minute (allowed in Z Z), and resume origir course).

(5) By comparison of Relative (Green) ring and True Bearing (Black) ring alter cours to 270° steady 2½ minutes, alter course to 010°. Steady 1 minute, then resum original course 320°.

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