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TREASURY DEPARTMENT,
UNITED STATES COAST AND GEODETIC SURVEY,
HENRY S. PRITCHETT,
SUPERINTENDENT.

SPECIAL PUBLICATION NO. 6.

NOTES

RELATIVE TO

THE USE OF CHARTS

ISSUED BY THE

UNITED STATES COAST AND GEODETIC SURVEY.

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INTRODUCTORY NOTE.

These "Notes" were suggested by, and the material is largely taken from, a small but most excellent pamphlet, entitled "Notes bearing on the Navigation of H. M. Ships," 4th edition, issued by the authority of the Lords Commissioners of the Admiralty. Modifications have been made to suit the practice of this Office, and some additional material, which seemed desirable, has been included.

D. B. WAINWRIGHT,
Assistant, Coast and Geodetic Survey.

WASHINGTON, *August, 1900.*

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NOTES RELATIVE TO THE USE OF CHARTS

ISSUED BY THE

U. S. COAST AND GEODETIC SURVEY.

There are four kinds of publications issued by the United States Coast and Geodetic Survey as guides to navigation—the Charts, the Coast Pilots, the Tide Tables, and the Notices to Mariners.

1. CHARTS.—When issued from the Office, the artificial aids to navigation, such as light-houses, lighted beacons, buoys, spindles, etc., have been corrected for important information received to date of issue, which is stamped at the bottom of each chart. When the amount and importance of new material warrant it, a new edition is issued and the old edition called in from the agents and canceled. The date of the edition is given in the title.

To find the corrections to be applied to any chart, note the date in the lower left-hand corner; then examine the monthly Coast and Geodetic Survey "Notice to Mariners," published subsequently to that date. If the locality covered by the chart is not referred to, the chart can be used with confidence to the date of the last "Notice to Mariners," and, by applying corrections indicated, can be kept corrected for use until worn out, or until the issue of a new edition.

All notes on the charts should be carefully read, as they may call attention to important dangers or aids to navigation that can not be clearly represented on the chart.

2. CHART CATALOGUE.—Copies of this catalogue can be obtained, free of charge, on personal application at any of the sales agencies, or by letter addressed to the Superintendent of the U. S. Coast and Geodetic Survey, Washington, D. C.

The charts embraced in the catalogue are classed as "Finished" and "Preliminary." The "Finished" charts are

printed from engraved plates, and embody all information furnished by the Survey. The "Preliminary" charts are those issued as soon as possible after the surveys, in whole or in part, have been made, and are used to supply the pressing demands of navigation pending the publication of the "Finished" charts. They are either engraved or photolithographed.* The preliminary and finished charts differ only in regard to the amount of information which they furnish, not in the correctness of that which is given.

The charts are various in character, according to the objects which they are designed to subserve. The most important distinctions are the following:

1. *Sailing Charts*, mostly on a scale of $\frac{1}{1200000}$, which exhibit the approaches to a large extent of coast, give the offshore soundings, and enable the navigator to identify his position as he approaches from the open sea. Published on both the mercator and polyconic projections.

2. *General Charts of the Coast*, on scales of $\frac{1}{400000}$ and $\frac{1}{200000}$. In these, intended especially for coastwise navigation, are shown the configuration of the shore, the positions of islands, rocks, and shoals, the light-houses, life-saving stations, and other natural and artificial landmarks.

3. *Coast Charts*, on a scale of $\frac{1}{80000}$, by means of which the navigator is enabled to avail himself of the channels for entering the larger bays and harbors, and to recognize the beacons, buoys, and light-houses by their distinctive features and positions.

4. *Harbor Charts*, on large scales, intended to meet the needs of local navigation.

In the first part of this catalogue the charts are arranged in regular geographical sequence, the reader being supposed to start at the northeast corner of the United States and to follow the shore southward along the Atlantic, westward along the Gulf, and northward along the Pacific coasts; thence to the islands in the Pacific Ocean. In the second part there is a numerical index to the first part, without regard to geographical position.

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* Marked "L" in the catalogue when photolithographed.

The "Aids to Navigation" are corrected on the charts as issued, to conform with the latest information.

3. COAST PILOTS.—A series of volumes containing full nautical descriptions of the coast, the shores of the harbors, dangers, and sailing directions for entering harbors, and coastwise navigation, with general charts, descriptions of lights, etc.

These, on account of their nature, can not be fully corrected before issue, and in all cases when they differ from charts of a later date, the charts must be taken as the guide. From time to time, as the material accumulates, supplements are issued containing all the information obtained, up to date, since the publication of the volume to which they refer. They are printed on one side of the paper only, to be cut up into slips and pasted in at the appropriate places.

4. NOTICES TO MARINERS.—On Coast and Geodetic Survey charts the "Aids to Navigation" are corrected from important information received at the office to date of issue, which is stamped at the bottom of each chart. To assist those using the charts in keeping up to date, corrections to be applied are published monthly in "Notices to Mariners." These can be obtained, free of charge, on application, from the agencies of the United States Coast and Geodetic Survey, from United States Custom-houses, from the Branch Hydrographic Offices of the Navy Department, in the principal seaboard cities of the United States, from United States Consulates in foreign ports, or from this Office.

5. TIDE TABLES.—The predicted time and height of the tide at the principal ports of the United States and at many foreign ports are given in these tables for every day of the year, with a table of tidal differences, by means of which the times and heights at intermediate ports may be ascertained. A set of tables for the ports of the Atlantic Coast is published separately, and also one for the ports of the Pacific Coast.

6. CAUTIONARY NOTE.—In using the tables it should be borne in mind that slack water must not be confounded with high tide, or with low tide. Nor must an ebb current be confounded with an ebb tide, nor a flood current with flood

tide. In certain localities the rise or fall may be at a stand, and yet the current may be at its maximum velocity. (See notes in par. 17, Tidal Currents.)

7. **AGENCIES** for the sale of these Charts, Coast Pilots, and Tide Tables have been established in many ports of the United States, and in some foreign ports. They can also be purchased in the Office of the Coast and Geodetic Survey, Washington, D. C. If ordered by mail, prepayment is obligatory. Remittances should be made by postal money order or express order, payable to the "Assistant in Charge of the Office." Postage stamps, checks, and drafts can not be accepted. The sending of money in an unregistered letter is unsafe. Only catalogue numbers of charts need be mentioned.

8. **ACCURACY OF A CHART.**—The value of a chart must, manifestly, depend largely upon the accuracy of the survey on which it is based; and this becomes more important the larger is the scale of the chart. In this respect, the source from which the information has been compiled is a good guide.

This applies particularly to the charts of the Aleutian Islands, Bering Sea, and those of our newly acquired insular possessions. The early Russian and Spanish surveys were not made with great accuracy, and until they are replaced by newer surveys these charts must be used with caution.

It may, indeed, be said that, except in well-frequented harbors and their approaches, no surveys yet made have been so minute in their examination of the bottom as to make it certain that all dangers have been found. The fullness or scantiness of the soundings is another method of estimating the completeness of a chart, bearing in mind that all the soundings obtained in making a survey are not shown on the chart. When the soundings are sparse or unevenly distributed, it may be taken for granted that the survey was not in great detail.

Large blank spaces among soundings mean that no soundings have been obtained in these spots. When the surrounding soundings are deep, it may with fairness be assumed that

in the blanks the water is also deep; but when they are shallow, or it can be seen from the rest of the chart that reefs or banks are present, such blanks should be regarded with suspicion. This is especially the case in coral regions and off rocky coasts, and it should be remembered that in waters where rocks abound it is always possible that a survey, however detailed, may have failed to find every small patch.

A wide berth should therefore be given to every rocky shore or patch, *and this rule should be invariably followed, viz, that instead of considering a coast to be clear unless it is shown to be foul, the contrary should be assumed.* It should not be forgotten that in waters where sand and mud prevail, changes are continually occurring to a greater or less extent, and important ones may have taken place since the date of the last survey. In localities which are noted for frequent and radical changes, such as the entrance to a number of estuaries on the South Atlantic and Gulf coasts, notes are printed on the chart calling attention to the fact.

9. DANGER CURVES.—The curves of depths will be found useful in giving greater prominence to outlying dangers. It is a good plan to trace out with a colored pencil the curve next greater than the draft of the vessel using the chart, and regard this as a "danger curve," which is not to be crossed without precaution. For vessels drawing less than 18 feet the edge of the sanding is a well-marked danger line; for greater drafts, the 24-foot and the 30-foot curves can be used. For the deepest drafts the 36-foot curve is valuable in open waters where the swell is a factor.

Isolated soundings shoaler than surrounding depths should always be avoided, as there is always the possibility that the shoalest spot may not have been found.

10. CAUTION IN USING SMALL SCALE CHARTS.—In approaching the land or dangerous banks, regard must always be had to the scale of the chart used. A small error in laying down a position means only yards on a large scale chart, whereas on a small scale the same amount of displacement means large fractions of a mile. This is particularly to be

observed when coming to an anchor on a narrow ledge of convenient depth at some distance from the shore.

For the same reason, bearings to objects near should be used in preference to objects farther off, although the latter may be more prominent, as a small error in bearing or in laying it down on the chart has a greater effect in misplacing the position the longer the line to be drawn.

11. DISTORTION OF PRINTED CHARTS.—The paper on which charts are printed has to be damped. On drying, distortion takes place from the inequalities in the paper, which greatly varies with different paper and the amount of the original damping; but it does not affect navigation. It must not, however, be expected that accurate series of angles taken to different points will always exactly agree, when carefully plotted upon the chart, especially if the lines to objects be long. The larger the chart the greater the amount of this distortion.

12. BUOYS.—It is manifestly impossible that any reliance can be placed on buoys always maintaining their exact position. Buoys should therefore be regarded as warnings and not as infallible navigating marks, especially when in exposed positions; and a ship should always, when possible, be navigated by bearings or angles of fixed objects on shore and not by buoys.

13. LIGHTS.—All the distances, given in the "List of Light-Houses and Lighted Beacons" and on the charts, for the visibility of lights are calculated for a height of an observer's eye of 15 feet. The table of distances of visibility due to height, at the commencement of each volume, affords a means of ascertaining how much more or less the light is visible should the height of the bridge be more or less. The glare of a powerful light is often seen far beyond the limit of visibility of the actual rays of the light, but this must not be confounded with the true range. Again, refraction may often cause a light to be seen farther than under ordinary circumstances.

When looking out for a light at night, the fact is often forgotten that from aloft the range of vision is much increased.

By noting a star immediately over the light a very correct bearing may be afterwards obtained from the standard compass.

The actual power of a light should always be considered when expecting to make it in thick weather. A weak light is easily obscured by haze, and no dependence can be placed on its being seen.

The power of a light can be estimated by remarking its order, as given in the Light Lists, and in some cases by noting how much its visibility in clear weather falls short of the range due to the height at which it is placed. Thus, a light standing 200 feet above the sea and only recorded as visible at 10 miles in clear weather, is manifestly of little brilliancy, as its height would permit it to be seen over 20 miles if of sufficient power.

14. FOG SIGNALS.—Sound is conveyed in a very capricious way through the atmosphere. Apart from the wind, large areas of silence have been found in different directions and at different distances from the origin of a sound, even in clear weather. Therefore too much confidence should not be felt in hearing a fog signal. The apparatus, moreover, for sounding the signal often requires some time before it is in readiness to act. A fog often creeps imperceptibly toward the land, and is not observed by the people at a light-house until it is upon them, whereas a ship may have been for many hours in it, and approaching the land. In such a case no signal may be sounded. When sound has to travel against the wind, it may be thrown upward; in such a case a man aloft might hear it when it is inaudible on deck.

Taken together, these facts should induce the utmost caution in closing the land in fogs. The lead is generally the best guide.

15. TIDES.—A knowledge of the tide, or vertical rise and fall of the water, is of great and direct importance whenever the depth at low water approximates to or is less than the draft of the vessel, and wherever docks are constructed so as to be entered and left near the time of high water. But,

under all conditions such knowledge may be of indirect use, as it often enables the mariner to estimate in advance whether at a given time and place the current will be running flood or ebb.

The Coast and Geodetic Survey Tide Tables give the predicted times and heights of the high and low waters, or differences by which they may be easily obtained, for all the important parts of the world. If the height at any intermediate time is required, it may be obtained for all stations in the United States by the aid of Table 2 of the Tide Tables. Where this table can not be applied, the intermediate height may be obtained by plotting the predicted time and heights and connecting them with a curve.

16. PLANES OF REFERENCE FOR SOUNDINGS ON CHARTS.—It should be remembered that whatever plane of reference is used for a chart, there may be times when the tide falls below it. For instance, on Coast and Geodetic Survey charts of the Atlantic Coast the plane of reference is *mean low water*, and about half the time there should be low waters lower than that plane.

If the level of *low-water ordinary springs* is used as the plane of reference, as is the case on most of the British Admiralty charts, when a new or full moon happens to occur at the time of perigee the low-water spring tide will fall below the average. At the time of equinoxes the spring range is also increased.

On the Pacific Coast of the United States, from the Mexican boundary to the Straits of Fuca, the plane of reference is *the mean of the lower low water* of each tidal day.

On the Pacific Coast of North America, from Puget Sound, Wash., northward to Alaska, this Survey has adopted *the harmonic or Indian tide plane* for its plane of reference. This plane is roughly that of the lowest low waters observed, and it is usually somewhat lower than low-water ordinary springs.

The wind may at times cause the water to fall below the plane of reference, even if that plane is quite a low one.

17. TIDAL CURRENTS.—In navigating coasts where the tidal range is considerable, caution is always necessary. It should be borne in mind that there may be indrafts into all bays and bights, even when the general run of the current is parallel to the shore.

The turn of the tidal current off shore is seldom coincident with the time of high and low water on the shore.

At the entrance to most harbors without important tributaries or branches the current turns at or soon after the times of high and low water within. The diurnal inequality in the velocity of current will be proportionately but half as great as in the height of the tides. Hence, though the heights of the tide may be such as to cause the surface of the water to vary but little in level for ten or twelve hours; the ebb and flow will be much more regular in occurrence.

In long, shallow tidal channels and rivers the slack of the current frequently occurs at half tide, the flood current being greatest at high water, and the ebb current being greatest at low water.

The diurnal inequality in the velocity of current will be about proportional to that in the height of the tides.

Along most shores not seriously affected by bays, tidal rivers, etc., the current usually turns soon after high and low waters.

In broad bodies of water, tide rips usually occur off salient or angular points of land, and also over shoals which are not too extensive.

The swiftest current in straight portions of tidal rivers is usually in the center of the stream, but in curved portions the most rapid current is toward the outer edge of the curve.

Counter currents and eddies may arise near the shores of straits, especially in bights and near points.

A swift current often occurs in narrow openings in the barrier between two bodies of water, because the water at a given instant may be on different levels on the inside and outside of such barriers.

18. CURRENT ARROWS on charts only show the most usual or the mean direction of a tidal stream or current. It must never be assumed that the direction of a stream will not vary from that indicated by the arrow. In the same manner, the rate of a stream constantly varies with circumstances, and the rate given on the chart is merely the mean of those found during the survey, possibly from very few observations.

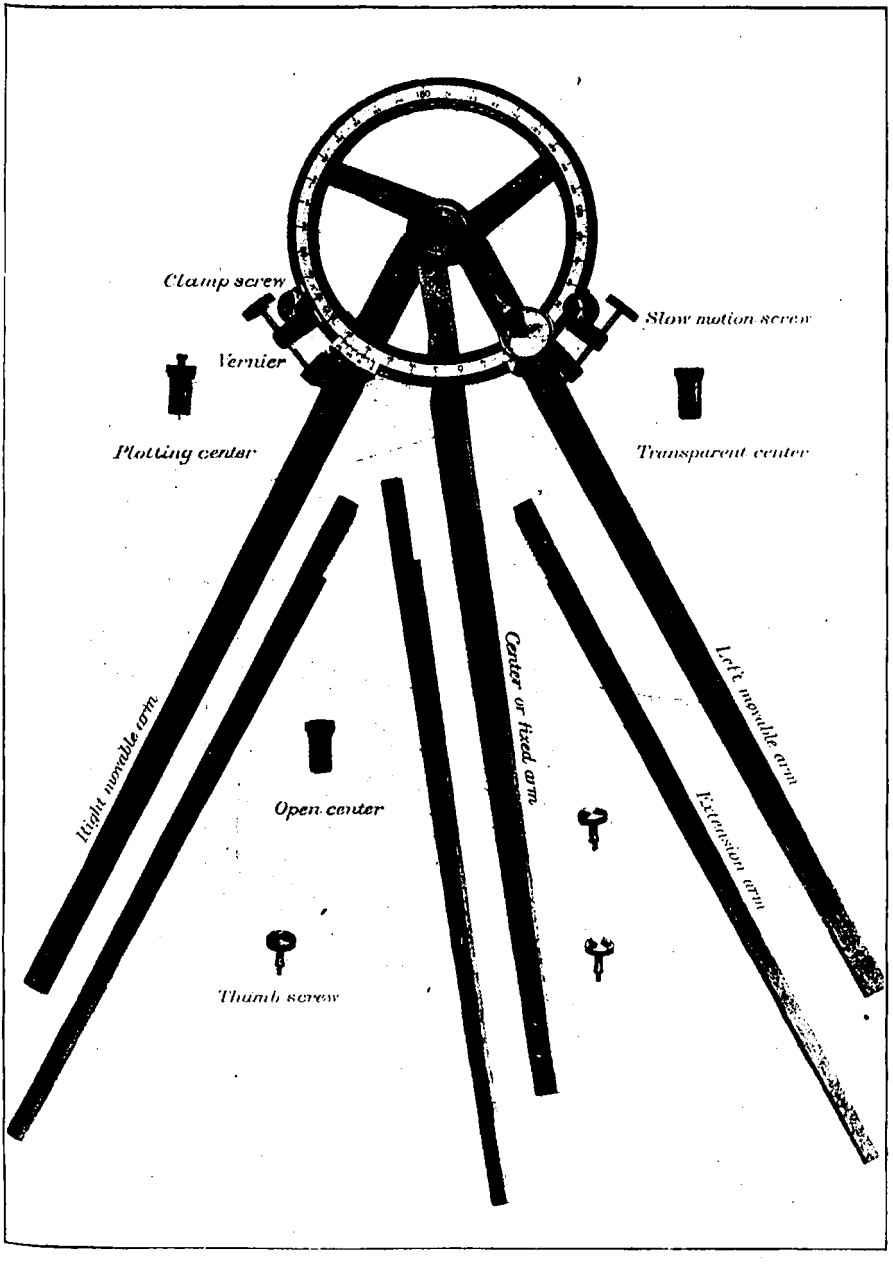
19. FIXING POSITION.—The most accurate method of fixing a position relative to the shore is by angles between well defined objects on the chart, and plotting the same by means of a protractor.

Two things are, however, necessary to its successful employment. First, that the objects be well chosen, positively identified, and at moderate distances; and second, that the observer is skillful and rapid in his use of the sextant.

In many narrow waters, also, where the objects may yet be at some distance, as in coral harbors or narrow passages among mud banks, navigation by sextant and three-arm protractor is invaluable, as a true position can be obtained only by its means. A small error in either taking or plotting a bearing under such circumstances may put the ship ashore.

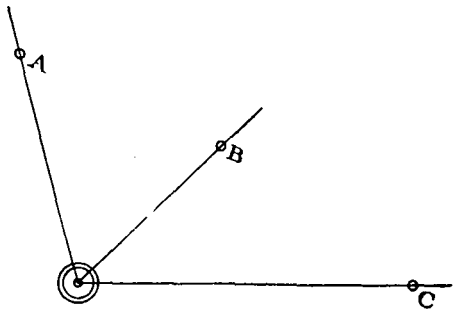
20. THE THREE-ARM PROTRACTOR.—The three-arm protractor is an instrument consisting of a graduated brass circle having one fixed and two movable arms or rules, radiating from its center. One edge of each rule is beveled, and lines drawn along these edges if produced will always intersect at the center of the instrument. The zero point of the circle is opposite the beveled edge of the fixed rule and as the movable rules are turned away from it they measure constantly increasing angles. To read the size of these angles a vernier is attached to each movable rule, and to set it to any required angle a clamp and slow motion, or tangent screw, is also provided.

21. TO PLOT THE POSITION of a vessel by means of a protractor, three objects are selected, which are laid down on the chart and can be identified, such as light-houses, small islets



THE THREE ARM PROTRACTOR.

or rocks, conspicuous houses or buildings, or a tangent line of sight to the high-water line of some distant point. The three objects being chosen, A, B, C in the diagram, two observers, if the ship is under way, measure the two horizontal angles, AB and BC, with a sextant. If stationary, one observer can take both angles. Having read the sextant, the right-hand rule is turned away from zero and set for the right-hand angle, AB. In like manner, the left-hand rule is set for the left-hand angle, BC.



The instrument is now laid down on the chart so that the bevel edge of the fixed rules passes through B whilst the edges of the other rules pass, respectively, through A and C. The center of the instrument will then represent the position of the ship and may be pricked on the chart through the small hole for the purpose.

A little practice soon overcomes the difficulty which is at first experienced in fitting the edges of the rules over the three points.

The right rule of the protractor does not shut close home, owing to mechanical difficulties, so that the angle observed on the right may be smaller than its rule will close to. When this occurs set the left rule to the small angle and then bring the right rule around and set it to the sum of the two observed angles, counting from zero to the left.

22. TRACING PAPER PROTRACTOR.—Tracing paper on which a graduated circle has been printed, is at times an excellent substitute for the protractor, and in some cases preferable to the instrument itself. When, for example, the objects used for the angles are very near the observer, they will come within the brass circle of the protractor and be more or less hidden by it. Plain tracing paper may also be used if there is available a single arm or other protractor large enough for laying off the angles.

23. COMPARATIVE VALUE OF DIFFERENT RELATIVE POSITIONS OF OBJECTS.—Seven cases are given of the relative positions of the three objects on which angles are observed. These will be found to cover nearly all the conditions which are liable to occur, and will serve as a guide in making a selection to obtain the best conditions available. They are as follows:

CASE 1.—*Within the triangle formed by lines connecting the three objects.* Unusual, but affording the strongest conditions.

CASE 2.—*On or near the line between two objects.* The strength of this position decreases with the increase of distance of the middle object (*A*).

CASE 3.—*Outside the triangle or outside the circle on which the three objects are situated, the middle object being the most distant.* Like Case 2, the strength of the position decreases with the increase of the distance of the middle object.

CASE 4.—*Outside the circle on which the three objects are situated, the middle object being the nearest.* The strength of the position depends upon the size of the angles, acute angles giving a weak determination.

CASE 5.—*Two objects in range intersected by a line from the third.* Affording the strongest conditions when the distance between the objects in range is equal to or greater than that to the third object or to the position of the observer.

CASE 6.—*The three objects situated on or near the same straight line.* The larger the angles the better the determination of position. In practice it will be found that the objects will approach this arrangement more frequently than any other. When the middle point diverges some distance from the straight line it then becomes either Case 3 or 4.

CASE 7.—*When the position sought to be determined lies on the circle passing through the three objects observed upon.* Indeterminate. Will plot all around the circle. In selecting objects care should be exercised to avoid making use of such an arrangement or an approach to it.

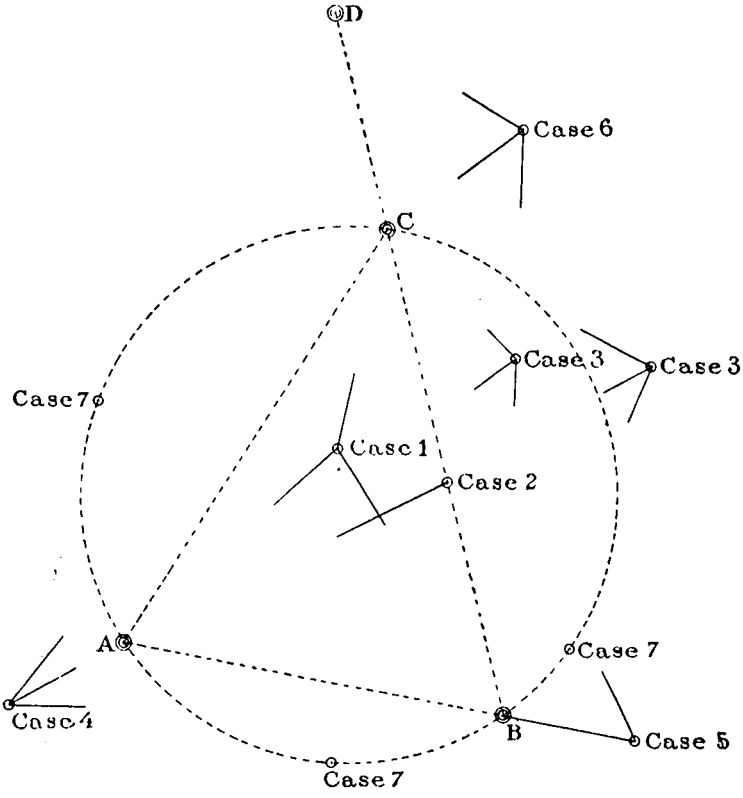


Diagram illustrating the value of different arrangements of three objects for the determination of a position by horizontal sextant angles.

Note:- *The larger circles next to the letters* A, B *and* C *denote the objects observed upon in every case except* Case 6 *where the objects are* B, C, D. *The small circles with short lines drawn towards the larger circles indicate the positions of the vessels in the several cases.*

It is not intended that the use of the compass to fix the ship should be given up; there are many circumstances in which it may be usefully employed, but errors more readily creep into a position so fixed. In all cases where great accuracy of position is desired, angles should invariably be used, such as the fixing of a rock or shoal, or of additions to a chart, as fresh soundings or new buildings. In all such cases angles should be taken to several objects, the more the better; but five objects is a good number, as the four angles thus obtained not only prevent any errors, but they at once furnish a means of checking the accuracy of the chart itself. In the case of ordinary soundings, it is only necessary to take a third angle now and then; firstly, to check the general accuracy of the chart as above stated; secondly, to make certain that the more important soundings, as at the end of a line, are correctly placed.

Sometimes, when only two objects are visible, a compass bearing and sextant angle may be used with advantage.

24. TWO AND FOUR POINT BEARINGS.—In passing near a point of land, or an island, the method of fixing by doubling the angle on the bow is invaluable. The ordinary form of it (the so-called "four point bearing") when the bearing is taken four points on the bow, and on the beam, the distance from the object at the latter position being the distance run between the times of taking the two bearings, gives an excellent fix for a departure, but does not insure safety, as the point, and probably the rocks off it, are abeam before the position is obtained.

By taking the bearings of two points and four points on the bow, a very good position is obtained before the object is passed; the distance of the latter at the second position being, as before, equal to the distance run in the interval, allowing for current.

25. DANGER ANGLE.—The use of a danger angle in passing outlying rocks with land behind should also not be forgotten. In employing this method, however, caution is necessary, as should the chart be not accurate, *i. e.*, should the objects selected be not quite correctly placed, the angle taken off from

it may not serve the purpose. It should not, therefore, be employed when the survey is old or manifestly imperfect.

In fixing by the compass, it must always be remembered that two bearings only are liable to error. An absolute error may be made in either bearing observed; errors may be made in applying the deviation; or errors may creep in in laying them onto the chart. For these reasons, a third or check bearing of some other object should be taken, especially when near the shore or dangers. The coincidence of these three lines will prevent any mistakes.

26. SUMNER LINE.—Amongst astronomical methods of fixing a ship's position, attention is drawn to the great utility of Sumner's method. A Sumner line, that is, a line drawn through two positions obtained from two assumed latitudes, and longitude by chronometer (and which is at right angles to the bearing of the sun, as obtained from the azimuth tables), gives at times invaluable information, as the ship must be somewhere on that line, provided the chronometer is correct. A deep cast at the same time may often serve to get an approximate position on the line. An early and very accurate position can also be obtained by Sumner's method, by getting longitude by a bright star at daylight when the horizon is well visible, and another longitude by the sun when a few degrees above the horizon, or by observing two or more stars at twilight. The Sumner lines drawn through the two positions thus obtained will, if the bearing of sun and star differ three points or more, give an excellent result.

27. CHANGE OF VARIATION OF THE COMPASS.—The gradual change in the variation must not be forgotten in laying down positions by bearing on charts. The magnetic compasses placed on the charts for the purpose of facilitating plotting become in time slightly in error, and in some cases, such as with small scales, or when the lines are long, the displacement of position from neglect of this change may be of importance. The compasses are reengraved for every new edition if the error is appreciable. Means for determining the amount of this error are provided by printing the date of constructing the compass and the annual change in variation near its edge.

The geographical change in the variation is on some parts of the coast of the United States sufficiently rapid to need consideration, particularly in Alaska.

28. LOCAL MAGNETIC DISTURBANCES OF THE COMPASS ON BOARD SHIP.—The term "local magnetic disturbance" has reference only to the effects on the compass of magnetic masses external to the ship in which it is placed. Observation shows that disturbance of the compass in a ship afloat is experienced only in a few places on the globe.

Magnetic laws do not permit of the supposition that it is the visible land which causes such disturbance, because the effect of a magnetic force diminishes in such rapid proportion as the distance from it increases that it would require a local center of magnetic force of an amount absolutely unknown to affect a compass half a mile distant.

Such deflections of the compass are due to magnetic minerals in the bed of the sea under the ship, and when the water is shallow, and the force strong, the compass may be temporarily deflected when passing over such a spot, but the area of disturbance will be small, unless there are many centers near together.

The law which has hitherto been found to hold good as regards local magnetic disturbances is, that north of the magnetic equator the north end of the compass needle is attracted toward any center of disturbance; south of the magnetic equator it is repelled.

It is very desirable that whenever a ship passes over an area of local magnetic disturbance, the position should be fixed, and the facts reported as far as they can be ascertained.

29. VERIFICATION OF THE SHIP'S POSITION BY SOUNDINGS.—Several soundings, taken at random, will seldom fix a ship's position, and, indeed, under certain circumstances might seriously mislead. Lord Kelvin, in his "Lecture on Navigation,"* mentioned the only plan whereby the lead can be expected to determine the ship's position with any degree of certainty:

"Take a long slip of card or stiff paper, and mark along one edge of it points at successive distances from one another, equal,

* Popular Lectures and Addresses, vol. III, p. 113.

according to the scale of your chart, to the actual distance estimated as having been run by the ship in the intervals between successive soundings. If the ship has run a straight course, the edge of the card must be straight, but if there has been any change of direction in the course, the card must be cut with a corresponding deviation from the original direction. Beside each of the points thus marked on the edge, write on the card the depth and character of bottom found by the lead. Then place the card on the chart, and slip it about [parallel to the supposed course] until you find an agreement between the soundings marked on the chart and the series marked on the card."

* "Instead of cardboard, tracing paper may be used upon which the courses and distances have been ruled, with corresponding depths and character of bottom.

"The advantages consist for one thing in the transparency of the tracing paper, admitting of the chart soundings being visible in every direction underneath it, which greatly facilitates the task of making the actual soundings "tally" with those on the chart."

30. MERCATOR AND POLYCONIC PROJECTIONS.—The greater number of the charts of the Survey are on such a large scale that, so far as a navigator is concerned, it makes no difference on what projection they are laid down; since the position of the ship on them is not fixed by astronomical observations, the meridians and parallels play no part in shaping its course and could be dispensed with. Besides navigational purposes the charts are designed to meet the wants of a number of other interests, such as military defense, harbor improvements, etc., where a knowledge of distances and areas is an important factor. A polyconic projection is best suited to obtain such measures, and the charts are, therefore, constructed according to that method.

The sailing charts are on a small scale, their limits generally extending to a distance over 400 miles from the coast line and covering an area where the position of the ship would be fixed by astronomical sights. For these limits the navigator is given his choice of either the mercator or polyconic projection, the Survey publishing both.

As the polyconic projection is little understood by most navigators, a comparison with the mercator is given here.

* Wrinkles in Practical Navigation, Lecky, p. 172.

On the mercator chart the meridians are drawn as parallel straight lines and at equal distances from each other, instead of converging toward one of the poles of the earth, as they do on a globe. The parallels of latitude are also represented by straight lines at right angles to the meridians, and their distance apart, instead of being practically equal as on a globe, is increased from the equator toward the poles in an inverse ratio corresponding to the natural convergence of the meridians.

On the polyconic chart the meridians converge toward the pole, and are theoretically curved lines, but it is only on very small scale charts that this curvature is apparent. The parallels are also curved, and this is apparent, except on the large scale charts. The construction is based on a series of cones, a different one for each parallel, hence the name "polyconic" projection.

The difference between the two projections can best be shown by contrast.

31. DIFFERENCE SHOWN BY CONTRAST:

MERCATOR CHARTS.	POLYCONIC CHARTS.
1. A straight line on the chart makes the same angle with all meridians, or the true course remains the same from end to end.	2. A straight line on the chart makes a slightly different angle with successive meridians, or the true course changes slowly from end to end.
3. A straight line on the chart is a part of a rhumb line on the surface of the earth, and is not the shortest distance between two points.	4. A straight line on the chart represents a great circle, or the line along which the distance is shortest, between two points on the surface of the earth.
5. It gives a very inaccurate notion of the relative magnitudes of the areas of its northern and southern parts.	6. It preserves closely the relative magnitudes of all the areas represented.
7. No two consecutive miles are of the same length except on parallels, the scale increasing from the equator to the poles.	8. The minutes of latitude are all practically of the same length. One scale of distance may be used for any part of the chart.
9. Positions can be plotted with the parallel ruler from the margin of the chart.	10. Certain meridians and parallels are subdivided within the margin of the chart as well as those on the margin, the ones nearest being used to plot a position.

Owing to the fact that a vessel's course can rarely be made good, and has to be frequently changed on account of magnetic variation, compass deviation, steering errors, leeway, and currents, the difference in the method of using two charts, one made on the mercator and the other on the polyconic projection, amounts to very little in actual practice. Take, for an example, a run to the eastward or westward, which would bring out the chief points of difference between the two.

32. SHAPING THE COURSE.—In both cases a straight line would be drawn from the point of departure to destination. The initial course is taken from the nearest compass diagram for both and in the same way.

On the polyconic, after a run of 75 or 100 miles, the course must be changed on account of the angle between the meridians and also on account of the magnetic variation. If the position, as determined from dead reckoning or astronomical observations, plots on the line laid down, a new course is simply taken from the nearest compass diagram, as was done at the point of departure. If the position plots off the line it is to be considered as a new point of departure and a new line drawn to destination, the course being taken as before from the nearest compass. In plotting the position from astronomical data the subdivisions of the nearest parallel and meridian must be used instead of the marginal subdivisions, which are employed for all cases on the mercator.

On the mercator projection, after a similar run, the course would also need correction on account of a change in magnetic variation. If the vessel's position is obtained from dead reckoning or astronomical observations, and plots on the straight line, the proper allowance can be directly applied to the old course, but as the careful navigator will not be content without some check, he will verify the new course by means of the nearest compass diagram. If the position plots some distance off the line it must be treated as a new point of departure.

It will be perceived from the above that the process of shaping a course on the two projections differs very little in practice.

Within the limits of 15 or 20 degrees of longitude the straight line on the polyconic chart is, for practical purposes,

a great circle. When it covers a wider area the course of the great circle must be computed, or more simply, plotted from a gnomonic chart, pursuing almost exactly the same operations as would be employed for the mercator.

It should be borne in mind that lines of sight are great circles, and, therefore, in higher latitudes, several cross bearings of distant objects can not be expected to intersect at one point on a mercator chart.

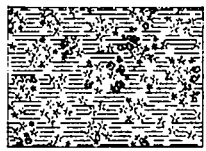
33. SYMBOLS USED ON CHARTS.—The following five plates show the symbols used on the charts of the U. S. Coast and Geodetic Survey, together with their explanation.

PLATE No. 2243

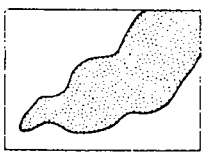
Topographic Signs

Salt Marsh

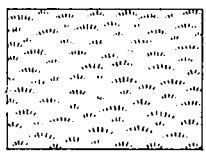
Cypress Swamp



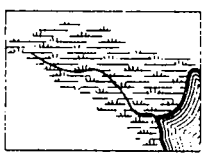
Salt Pond



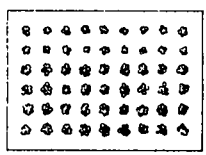
Grass



Fresh Marsh and Fresh Pond

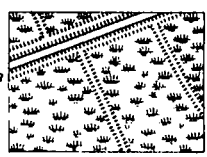


Orchard



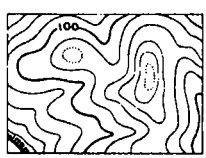
Oyster Bed

Rice Dikes & Ditches

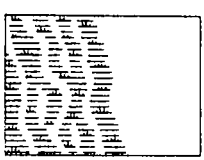


Wooded Marsh

Curves of equal elevation and intermediate curves

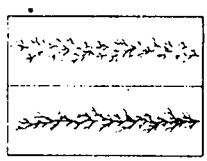


Submerged Marsh



Eel Grass

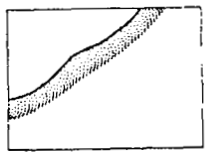
Kelp



Topographic Signs

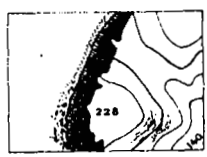
PLAT No. 2242

Shoreline Low Water

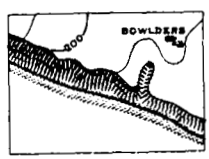


Rocky Ledges

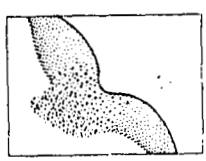
Rocky Bluff



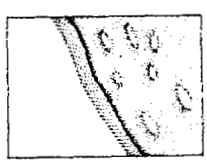
Eroded Bank



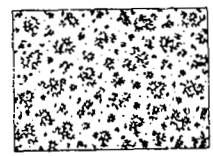
Sand and Shingle



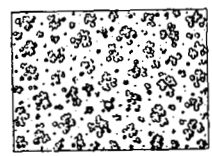
Sand Dunes



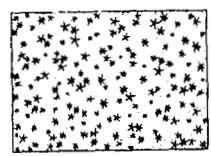
Oak



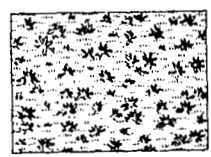
Deciduous and Undergrowth



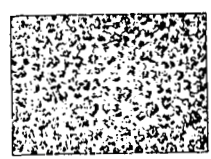
Pine



Palmetto



Mangroves



Cacti

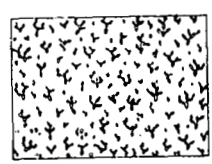
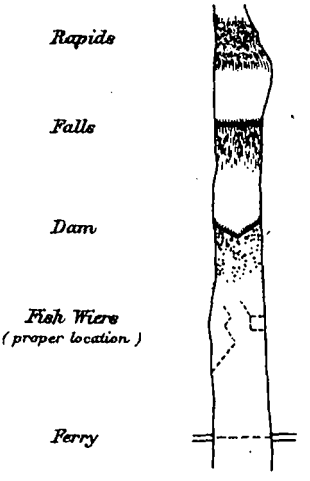


PLATE No. 224b

Topographic Signs



Topographical Station .....

Triangulation Point .....

Dwelling House .....

Barn .....

Shed and Pen .....

Ruins .....

Windmill .....

Church .....

Cemetery .....

Fence .....

Public Road .....

Road fenced on one side .....

Telegraph Road .....

Topographic Signs

PLATE No. 2244

Railroad (each track)

Railroad (large Scale)

Road not fenced

Path or Trail

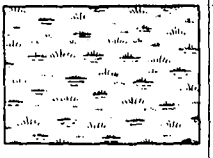
Stone Wall

Hedge

Embankment

Canal and Lock

Tundra



Hydrographic Signs

PLATE No. 2665

Lighthouse ..... ✡

Lighthouse on small scale chart • *Old light tower* ..... ●

Beacon, lighted ..... ☆ *Beacon, not lighted* ..... ▲

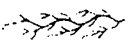
Spindle (or stake) ..... | *add word Spindle if space allows.*

Lightship ..... ✹

Anchorage ..... ⚓ *Wreck* ..... ⊣⊢

Rock awash at low water ..... * *Sunken rock* ..... +

Life Saving Station ..... ✦ L.S.S. (T) ..... *signifies connection with telegraphic system.*

Kelp ..... 

No bottom at 20 fathoms ..... 20° *etc.*

Red buoy ⚲ *or add word white or yellow as required.*

Black buoy ..... ⚲

Horizontally striped buoy ..... ⚲

Perpendicularly striped buoy ..... ⚲

Buoys with perch and square .....

Buoys with perch and ball .....

Lighted buoy ..... ✱, *in place of* •, *as* ..... *etc.*

Mooring buoy ..... ⊖

Landmark, as Cupola, Standpipe, etc ..... ○

Whirlpool .....

Tide rip .....

Current, not tidal, drift in knots as ..... ⟶⟶ 2.0 ⟶

" , *flood, first quarter, drift in knots, as* ..... 0.4 ⟶⟶

" , " , *second* " " " " " ..... 1.0 ⟶⟶

" , " , *third* " " " " " ..... 0.3 ⟶⟶

" , *ebb,* ..... ⟶ , *otherwise like flood.*