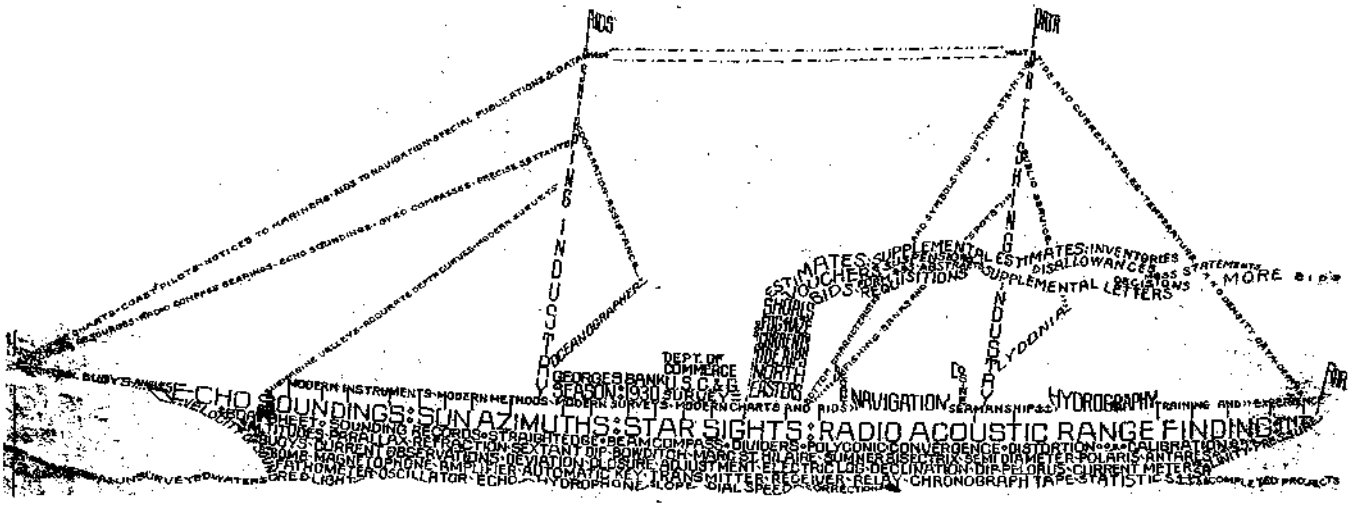
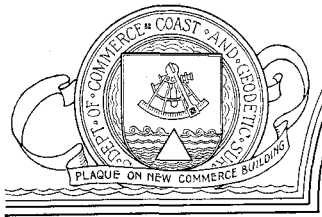
ASSOCIATION
OF
FIELD ENGINEERS
U.S.COAST & GEODETIC SURVEY

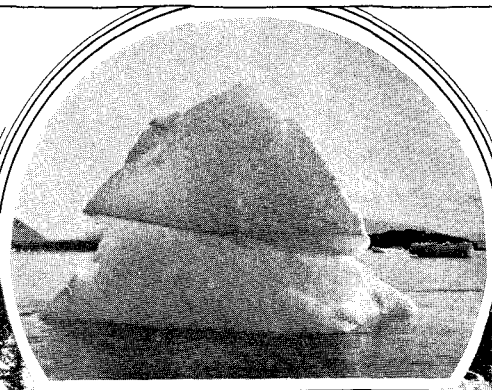


THE GEORGES BANK PROJECT - 1930.
PURPOSES, HANDICAPS, METHODS, AND ACCOMPLISHMENTS

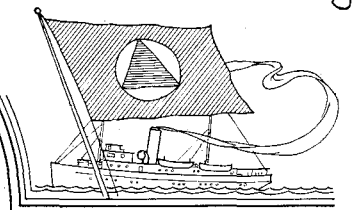
BULLETIN
DECEMBER 1930

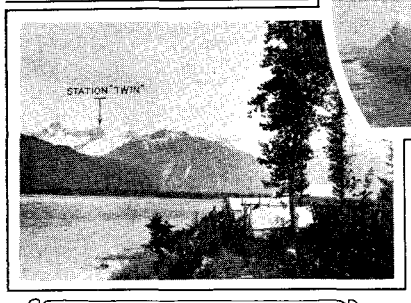
FIELD ACTIVITIES AND ENVIRONS.





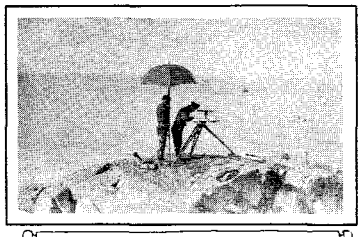
STRANDED ICEBERG - S.E. ALASKA
EXPLORER - 1929



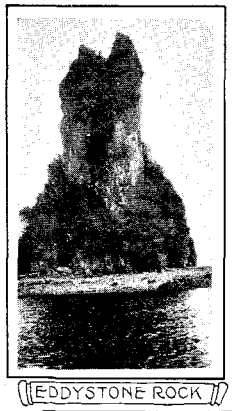


BASE CAMP ON TAKU RIVER
PARTY OF W. M. SCAIFE - 1929

VICINITY OF TAKU GLACIER
PARTY OF W. M. SCAIFE - 1929

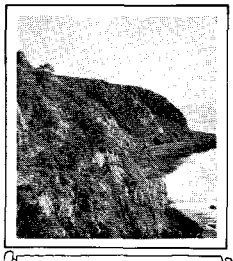


AN IDEAL TOPOGRAPHIC SET UP
EXPLORER - S. E. ALASKA

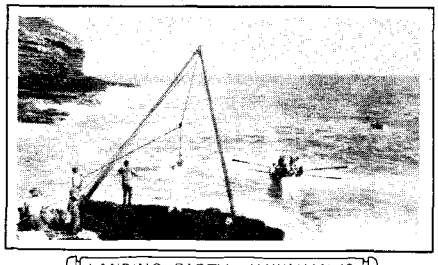


EDDYSTONE ROCK

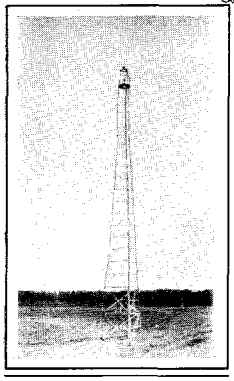
CAMP-SITE AT NEEDLE ROCK, CALIF.
PARTY OF CHAS. PIERCE - 1929



COAST LINE IN VICINITY
OF NEEDLE ROCK, CALIF.

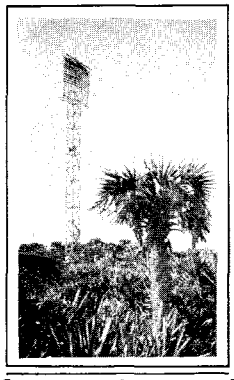


LANDING PARTY - HAWAIIAN IS.
GUIDE 1928



156 FOOT STEEL TOWER
PARTY OF H.W. HEMPLE, LA. 1929

MANGROVE SHORELINE - INDIAN RIVER, FLORIDA
RANGER - 1929



HYDROGRAPHIC SIGNAL
RANGER, 1930

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DEPARTMENT OF COMMERCE

OFFICE OF THE DIRECTOR

U. S. COAST AND GEODETIC SURVEY

WASHINGTON

My dear Commander Borden:

I have read the June Bulletin of the Association of Field Engineers from cover to cover, and am very much pleased with it. I know that the motive of the Executive Committee in getting it out was to promote the best interests of the Service, and am sure it can be made a very useful medium toward that end.

We are justly proud of the Survey, of its more than a century of useful service, but we must never think of it as being so good today that it cannot be made better tomorrow. For the moment we begin to do that we will begin to go backward. Rather I feel that we should always think of the Service as a living, growing thing, and should make a constant effort to develop new and better ways of carrying on our work and to give more and better service with the facilities at our disposal.

The progress by which that result can be attained is of two kinds: First, there is the infrequent development of some new and revolutionary idea or method, the Fathometer or R.A.R. for example; and second, constant minor improvements in our methods and processes, no one of which may be of outstanding importance, yet which in the aggregate become impressive. These two things are both important; neither could meet our requirements without the other.

I am quite sure that the majority of our engineers feel as I do in this matter, but they are scattered to the four corners of the earth, so that a concentration of effort toward the solution of any one problem becomes a difficult matter. Here it seems to me is where the Bulletin can help — by furnishing a medium for informal, unofficial discussion of problems or descriptions of new methods which some Chief of Party has found advantageous but which have not yet been so thoroughly tested as to justify a recommendation for official approval.

I know it was things of this sort which the Executive Committee had in mind in preparing this first issue of the Bulletin. I am not merely in sympathy with it, but anxious that it be continued, and I want you to feel that if in future there is any way in which I can contribute to its success, I shall be only too glad to do so.

Sincerely yours,

R S Patton

Director

BULLETIN SUGGESTIONS

I.

The ideas embodied in paragraph 2, page 1, of the June, 1930, bulletin are good and are in line with my ideas for fulfilling a long-felt need. I make the suggestion that the bulletin have certain "departments", or "pages" if you will, which shall have a certain title that will encourage the writing in for publication certain ideas, methods, etc., which are outside the scope of the various manuals and yet are of valuable use to the Service.

As a start I suggest the following "departments":

"Wrinkles in Field Work"
"Questions and Answers"
"Undeveloped Ideas"
"Can You Equal It?"

"Wrinkles in Field Work" - In this department would be published all fully developed ways, means and ideas for the various phases of field work which are new but workable, which are old but not included in the manuals or which are not officially recognized as good practice but which must be resorted to in times of difficulty.

"Questions and Answers" - In this department would be published any question or problem which the officer propounding it wished to submit to the field force as a whole. It would bring the collective experience and knowledge of the whole service to aid in finding the answer.

"Undeveloped Ideas" - In this department would be published the germ of an idea which an officer might have on anything in connection with our work, but which had not been completely worked out in practice. It, also, would bring the collective experience and knowledge of the whole service to aid in making the idea workable or in disproving its feasibility. Many of the ideas might already have been tried out and discarded as worthless.

"Can You Equal It?" - In this department would be published any personal boast, which would be of general interest to the service, and the officers in general would be urged to disprove it, if possible.

K. T. Adams.

(It will be noted that lieutenant-Commander Adams[1] suggestions have been followed in preparing this issue of the bulletin).

II.

Taking this one (June bulletin) as an example, imagine the considerable amount of constructive ideas and even well-worked out plans which have been evolved by the various officers through the years that are hidden in letters and reports in the files.

Assuming that the many articles published by our officers from time to time in technical journals are educational, we have heretofore been educating personnel outside our own service far more than our own, because few of these articles reach our far-scattered personnel, while all of them read our bulletin. It would, therefore, appear quite worth while if it could be printed and sent out along the lines of this last one and carry many brief instructive articles that now find their way into outside journals.

I am wondering if we have not now grown to a size to support a service journal along the lines of some of the other commissioned services, a journal that would be subscribed to by both officers and members of the crew.

G. T. Rude.

III.

I know there is a lot of work attached to bringing such a veritable magazine into existence and I hope you secure suitable encouragement and assistance. Sometimes it is even harder to keep such a thing going than to bring out the first edition. I certainly wish you the best of luck all the way.

My hobbies have about been confined to uniform ship organization and improved hydrographic launches. Probably something along the latter line would furnish promising material for the bulletins. As Captain Maher maintains, the most important hydrography is inside the ten-fathom curve, the province of launches rather than ships. While Captain Lukens and I were on the west coast I think we fitted up some ideal hydrographic launches and special reports of the same are in the office.

H. A. Cotton.

(The report on hydrographic launches to which Lieutenant-Commander Cotton refers will be included in a future bulletin).

IV.

I suggest including photographs of various phases of field work in the bulletin.

H. C. Rowse

THE GEORGES BANK PR0JECT

Ships LYDONIA and OCEANOGRAPHER
Season, 1930.

The necessity for more adequately charting Georges Bank as an aid to both the shipping and fishing industries is indicated clearly in the extracts below. It should be of interest to our engineers to know that practically all of about forty masters of transatlantic liners who contributed opinions and suggestions bearing on this project reported it to be their regular custom to take soundings when approaching and crossing the bank. Approximately fifty per cent reported the employment of some form of echo sounding while several reported they hoped to be equipped to use this method in the near future.

Master, S. S. MAJESTIC.

"When westbound on sea track, my practice is to commence sounding on approaching Georges Bank when bound to New York and to run a line of soundings to Nantucket Light Vessel in both clear or doubtful weather. It is essential that good reliable soundings should be available. I would suggest, therefore, an accurate survey of Georges Bank covering the line of approach from the eastward by the various Atlantic lane routes, in fact, the whole of the bank as being very necessary for safe navigation in a vicinity where so much fog prevails."

Master, S. S. ST. LOUIS.

"My experience has shown me when making Georges Shoal that tidal currents are very irregular and therefore I would be much obliged to you if you could improve the knowledge of the tidal currents in that region."

Master, S. S. SCYTHIA.

"I think it most desirable that an accurate survey of Georges Bank should be made, as soundings are the only reliable check on a ship's position when making land during fog or poor visibility."

Portland Trawling Company, Groton, Connecticut.

"In view of the necessity of accurate information as to depths of water and nature of bottom on the fishing grounds, I believe it would be of great help to the fishing industry if your Department could make a new survey of Georges Bank and vicinity without undue delay."

Master, S. S. BERGENSFJORD.

"Soundings, whether by hand or echo, across all depth curves are a most important factor towards safe navigation, particularly so in the North Atlantic where poor visibility almost is the rule. But the curves should be correct, which, unfortunately, is not always the case.

Atlantic and Pacific Fish Company, Boston, Mass.

"We would very much appreciate your cooperation in having a new survey of the fishing grounds made. We feel that, in view of the amount of money invested in fishing trawlers, it is a matter of vital importance that this be done at an early date."

Master, S. S. UNITED STATES.

"I consider it of the greatest importance to have an accurate and up-to-date delineation of the depth curves in the above mentioned area." (Georges Bank) "Thick weather and fogs are very frequent in this area and shipmasters therefore, to a very large extent, have to use soundings in carrying out a safe navigation."

Kelvin & Wilfred O. White Company, Boston, Mass.

"Inasmuch as the fishing industry is a vital part of the New England life, proper action should be taken in the way of a new survey of Georges and other shoals."

Master, S. S. PENNLAND.

"More reliable soundings between Halifax and Nantucket would be of great assistance, in view of the prevalence of fogs, of the currents, and of the few opportunities of taking observations."

Master, S. S. ACCUITANIA.

"From my experience with soundings and depth curves approaching Nantucket L. V., it would appear that there is great need for a resurvey of Georges Bank and its vicinity."

Master, S. S. AUSONIA.

"It would be an improvement in making a land-fall if a new survey could determine the depth curves from 100 to 50, and to the 20 fathom lines."

Bay State Fishing Company, Boston, Mass.

"This company operates a fleet of twenty steam trawlers which fish in the vicinity of Georges and LaHave Banks. The captains of these trawlers depend largely upon the sounding load to determine the proper location for the best fishing. One of our trawlers is equipped with a fathometer and the captain of this vessel has found some very different soundings than those indicated on the chart. We feel that a new survey of this area would greatly aid our captains in determining their positions and would be of further value in locating "spots" which might produce larger quantities of fish."

There are included in this issue of the bulletin reports on some of the methods and instruments employed on this project and it is expected that others will be forthcoming after the smooth sheets have been plotted and the data are tabulated and studied.

A special effort was made by the parties on the LYD0NIA and OCEANOGRAPHER to obtain comprehensive data relating to such phases

of field work as (1) the limitations of R.A.R. as regards temperature and depth of water, degree and abruptness of slope, character of the bottom, state of sea, current, shielding of shoals, as well as the relation of these conditions and features to the velocity of sound; (2) the accuracy with which a main control buoy can be located astronomically; (3) the accuracy with which R.A.R. triangulation, to serve as primary control for detailed hydrography, can be extended over an extensive offshore bank, the practicable length of the sides and a practical method of adjusting the scheme; (4) the accuracy of sun azimuths and the weight to be applied to them in a R.A.R. scheme of triangulation; (5)the accuracy of the Chernikeeff electric log as compared with ordinary taffrail logs; (6) the value of radio compass bearings for survey work, and (7) the practicability of making tidal and magnetic observations on an offsshore bank by the vessel serving as a hydrophone station.

Of outstanding importance was the knowledge obtained that radio acoustic ranging can be used in this region to the same extent that it can be used on the Pacific Coast, on the same type of survey.

The question naturally arose as to what velocity of sound to accept for R.A.R. work,since the method ordinarily used on the Pacific Coast for obtaining such values can not be employed on an offshore bank of this nature where water conditions differ so materially from those inshore.

Attempts were made to compare R.A.R. distances with actual distances as measured with piano wire run out over two registering sheaves. While the method appeared entirely practicable in so far as measuring the base was concerned, the velocity values obtained at different periods were rather inconsistent. This was probably due to the inability to relate accurately the hydrophone to one end of the measured base and the bomb explosion to the other end.

In a study made by Mr. A. L. Shalowitz, Cartographic Engineer, of the velocities of sound used on the various west coast projects, a remarkable agreement in practically all of the cases tried was found between the experimental values obtained by the field parties and corresponding theoretical values based on bottom temperatures and salinities. With this knowledge, an experimental value obtained by the LYDONIA and OCEANOGRAPHER in Massachusetts Bay was then compared with the theoretical value, computed in the same way and, as a close agreement was found, it was decided to employ theoretical velocities based on bottom temperatures and salinities for the season's work on Georges Bank.

An accompanying plate shows the portion of the survey completed during the past season and the main control scheme employed. A second plate shows the boat sheet position and outline of a rather remarkable submarine valley found along the southeast edge of the bank. No indication of this feature can be found on existing charts despite the fact that it has an average width of over two miles and cuts back into the shelf for a distance of seven miles.

Charting this valley will furnish the navigator with a valuable submarine landmark since it lies in, and is approximately normal to, the principal west bound transatlantic steamship lane between Europe

and the United States. It is ideally oriented with respect to the general trend of the Continental Shelf for fixing position from lines of soundings taken by vessels traversing any section of it. It should prove especially helpful since it lies in a locality where west bound vessels are particularly desirous of obtaining accurate positions. Astronomical observations in this vicinity are often impossible due to the prevalence of cloudy or foggy weather, while dependable radio bearings are often prevented by static.

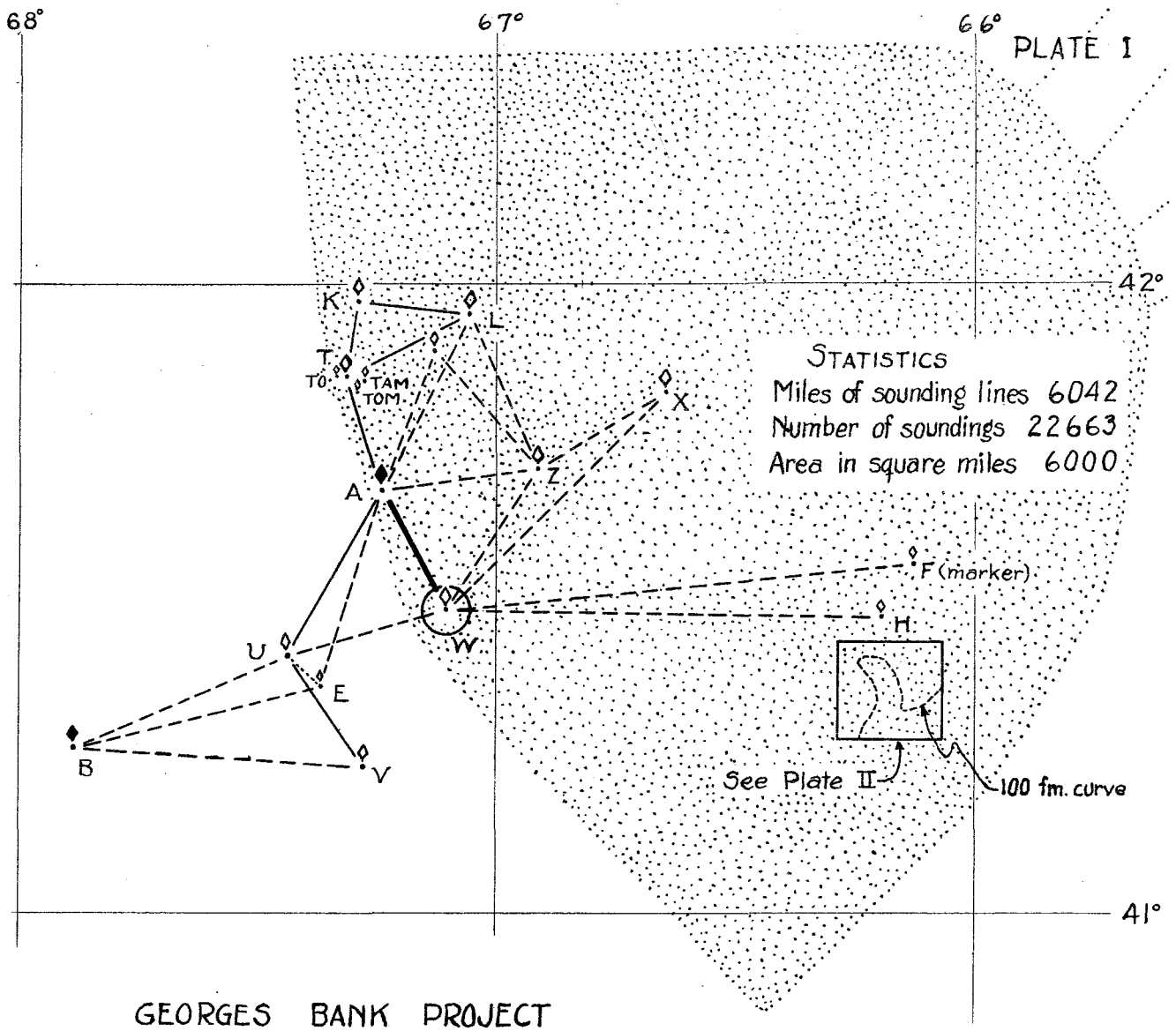
Although lying 170 miles cast of the New England coast, it is safe to say that the smooth sheet location of the valley will not be in error in excess of one-half mile. The main control buoy "W" upon which its position primarily depends was anchored on the axis of Georges Bank approximately 40 miles distant from the valley. This buoy was located by a series of astronomical observations extending over several days and made under favorable observing conditions. The results of the observations at this buoy are given in an article by Lieutenant-Commander G. D. Cowie appearing in this issue of the bulletin. The positions of the soundings which determined the outline of the valley depend for distance on R.A.R. from the main control buoy and for azimuth on adjusted dead reckoning loops using current allowances based on observations made at the hydrophone station while the lines were being run. Additional development was controlled by a buoy planted just to the northward of the valley.

The currents in the locality of the control buoys are of the rotary type and, while having considerable strength, are remarkably regular. The maximum flood and ebb currents set in a general NNW, SSE direction and occur from 2 to 3 and from 8 to 9 hours, respectively, after slack water at Pollock Kip Channel. The employment of a floating hydrophone station on this project offered an excellent opportunity to obtain extensive current observations.

The U. S. Lighthouse Service cooperated on the project by planting three nun buoys along the axis of the bank ("A", "B" and "C"). These are to be considered as reference buoys and will serve to hold control throughout the period of the survey.

References to the Above Project in this Issue.

Star Sight Positions - G. D. Gowie and K. T. Adams
Transmission of Sound Through Sea Water - H. G. Dorsey
The Chernikeeff Electric Log - E. L. Peacock
Calibration of Radio Direction Finder - F. L. Peacock
Data for Studying Velocity of Sound - A. L. Shalowitz
Georges Bank's Valley of Mystery - E. G. Fassett
Big Business Gomes to the Trawler - Earl Hamson



GEORGES BANK PROJECT

SHOWING MAIN CONTROL AND AREA SURVEYED

SHIPS
LYDONIA
&
OCEANOGRAPHER

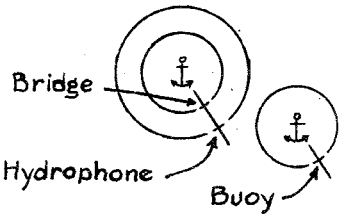
SEASON 1930

Same scale as Chart No. 1000

LEGEND

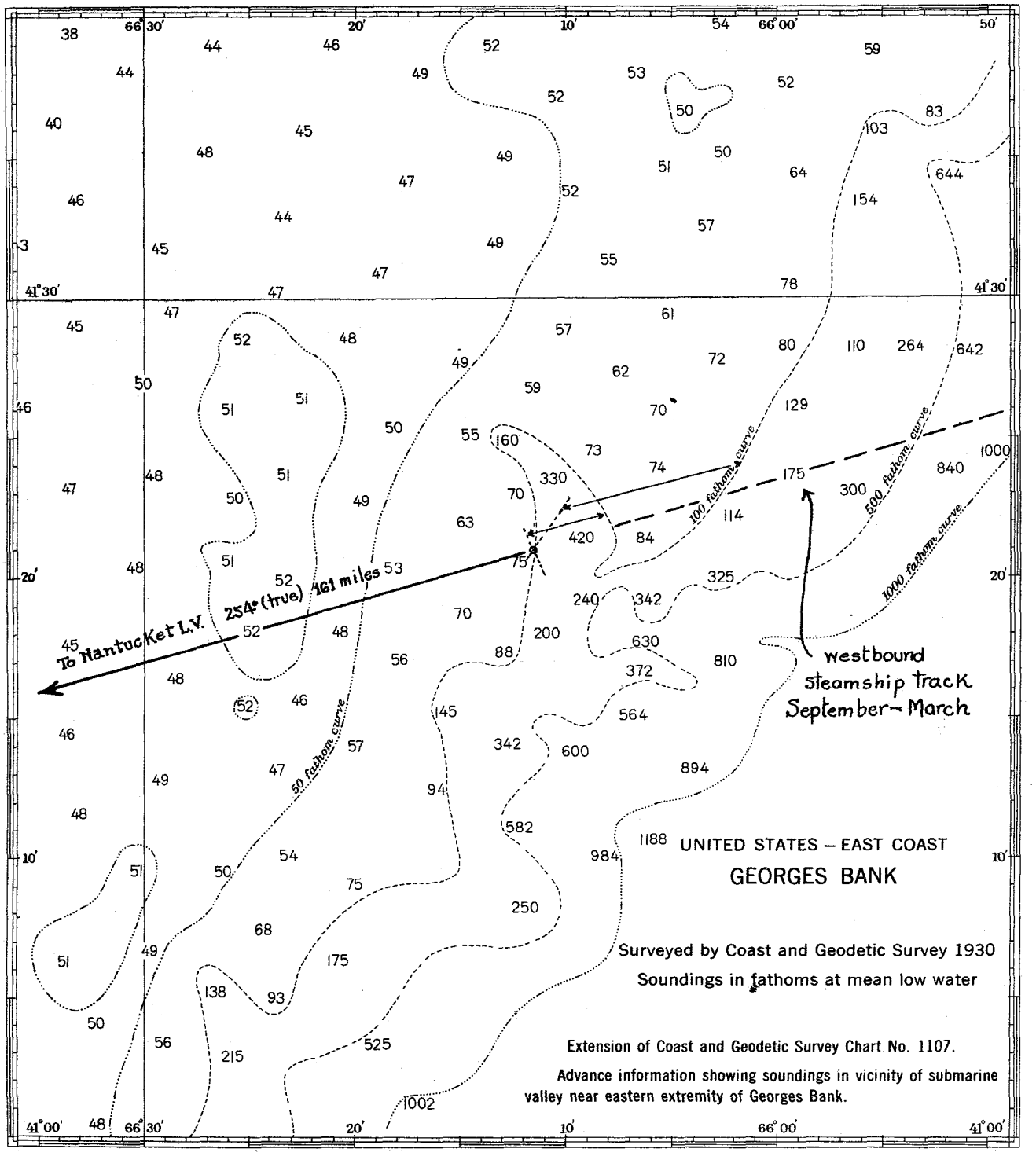
- Permanent Buoys
- Temporary Survey Buoys
- Strong Astronomic Location
- Base Line
- Bomb Distance and Sun Azimuth
- Bomb Distance Only
- Velocity Test Line

Relationship between bridge of station ship, hydrophone and buoy



Relative positions at 16:00 hrs. (4:00 P.M.) August 27, 1930.
Current setting 146° – 2.4 Knots.

(R-86)



Without reducing the speed of his vessel, it is now possible for the navigator to have a continuous record of the depths over which he is passing. If the chart shows the configuration of the bottom accurately and in sufficient detail, these records can be used in fixing the position of his ship even under conditions which render other methods of no avail. On the other hand, if the chart does not portray a true contour map of the bottom, the position of his ship becomes uncertain. This uncertainty means greater precautions, slower voyages, delayed arrivals and increased operating expenses. It can readily be understood then why echo sounding has accelerated the demand not only for more accurate and more detailed surveys, but also for the extension seaward of such surveys.

(R-84)

HYDROGRAPHY - NAVIGATION

STAR SIGHT POSITIONS

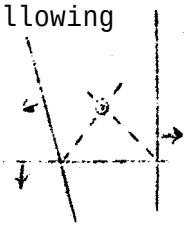
Lieut. Gomdr. K. T. Adams, U. S. C. & G. Survey

(Memoranda of certain methods used and conclusions arrived at on this class of work in the Hawaiian Islands)

1. To arrive at the most probable ship's position for any number of stars taken as nearly as possible in the different quadrants, the method used in the Hawaiian Islands was as follows: All stars were rated by the observer at the time of observation (see paragraph 1-D). After computation, each officer plotted his lines of position on cross section paper on a scale of generally one nautical mile to the large square, sometimes one mile to two squares. These sights were then run up to a central time, because they were always taken underway. They were marked with the name and direction of star and with the officer's rating. A cursory study was then made as to which was the best way to graphically resolve the total sights (averaging about seven) into a more or less rectangular (very seldom a triangular) figure. This figure was generally a rectangle with its sides roughly north and south and east and west (see paragraph 2-B). This was attained by taking the angular mean of two or more lines of position from stars in approximately the same direction. In doing this, the rating of the sight was taken into consideration. After the rectangular figure was arrived at, the mean of the north and south lines was taken and the east and west lines, the ship's position being at the intersection of the two. In this latter case the rating of the sights can not be taken into consideration. This was done with the dividers and not by actually drawing in the lines. This method applied to a few figures will be found later.

(A) In my opinion a mathematical solution is not warranted. Considerable thought and study was put on it by the writer and I am reasonably sure a method can be evolved, but I am also reasonably sure that the accuracy obtained by the sights does not warrant any such accuracy of finding the most probable position.

(B) I do not believe that the system of bisictrices can be fised to any advantage with more than a few stars, and even then, only when they are well placed for its use. In the following figure of three stars bisectrices can be used, but an equally correct result could be more quickly obtained by taking the dividers and finding a point equidistant from each side.



(C) In using the method described above for finding the ship's position, in my opinion, it should be limited to stars taken by one officer, with one sextant, on one evening. Stars taken by different officers, stars taken with different sextants, stars taken on different evenings should not be combined. Neither should sun sights be combined

with star sights, and care should be taken in combining bright stars (such as Venus and Jupiter) with ordinary stars (see paragraph 5). The figure theory, of course, is based on symmetrical errors of observation and conditions must be as nearly as possible similar for all stars in all directions.

(D) The observer at the, time of observation should rate his sights according to his judgment of how good they are. This is a relative rating for each officer. Four ratings, excellent, good, fair and poor, were used by me. It does not matter if one officer's "excellent" is equivalent to another officer's "good". The rating depends, on many things and is more a feeling of the value of the sight than anything else. A few of the variable factors that enter into this rating are:

1. Whether the wind is blowing in his eyes or not. This would depend on the direction of the star whether he was facing toward or away from the wind.

2. Amount of roll and pitch of the vessel.

3. How fast the star is rising or falling.

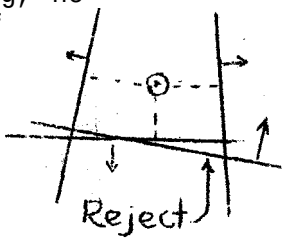
4. How clear the horizon is in that direction, i.e.,in the evening a star in the west is better than in the east due to the lighter horizon. Sometimes the horizon is more hazy in one direction than the other.

5. How small and definite the star is, sometimes with poor mirrors and extraordinarily bright stars (such as planets) the star will look fussy or elongated or have rays extending in one direc--on from it.

6. How long after sunset or before sunrise.

This rating enters into the determination of the ship's position in two ways and does not enter into the determination a third way. As explained above, when the angular mean of two lines of positions from stars in the same general direction is taken, then the rating is used and with the following approximate weights: Excellent, 4½; good, 3, fair, 2; poor, 1. After the figure is resolved, no ratings are used thereafter in determining the ship's position. This may sound erroneous, because given four stars, North, excellent; South, fair; East, good; and West, Poor, the north and south stars would get equal weight and the east and west would get equal weight. Here much depends on judgment; after considerable observing each officer with the same sextant will find that he has a normal figure to which his stars always resolve. This figure is always about the same size and shape. Therefore, when he gets an abnormal figure he should study the ratings of the stars to see if the use of a weak star has distorted his figure. For instance, if the officer's normal figure is a rectangle with the

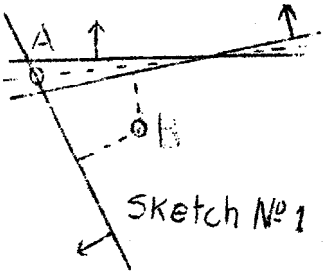
ship's position one mile may from each star, and on some occasion he resolved his figure into the following, he should examine the north or south line to find if either depended on one weak sight and, in this case, probably reject that sight and use the other three lines of position as shown. The justification of this would be apparent on comparison with the figures and positions obtained by other officers.



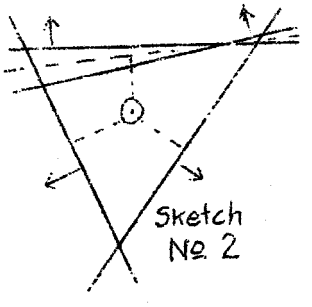
Lastly, the ratings enter into the determination of the final adopted ship's position as determined by a comparison of the different positions obtained by the various officers. If one officer's position depends on seven sights, two of which are excellent, three good and two fair, it obviously should be given more weight than that of an officer who had only four stars, one of which was good and the rest only fair. This comparison between figures and ship's position of the various officers often results in the finding of an error in the computations or in the rejection of one sight altogether to make the officer's figure approach normal, if all of his other sights agree fairly well but that one sight has made his position disagree with the positions of the others.

(2) The following sketches show my method as applied to some suggested figures:

In sketch #1, assuming all ratings equal, I would take the angular mean of the two north stars; this mean is shown by the broken line. Then, if I knew nothing about my normal figure, I should place the ship's position at A. However, if my normal figure was a rectangle in which the ship's position was about one mile away from the stars observed, I would plot the ship's position at B with perpendiculars one mile long, to the broken north line and the west south west line. This situation should be avoided at all cost; even the poorest observation east or south would be valuable. If this observation gave approximately the normal figure, all right; if it did not give a normal figure, it should probably not be considered and one is then no worse off than if he had not taken it. It is surprising what apparently poor observations turn out to be just as good as the good ones. (See paragraph l-F).



In sketch #2, which is really similar to #1 with the addition of an east south east star, I would follow a similar procedure, taking an angular mean between the two north stars and using that mean with the other two lines of position would form a triangular figure, the ship's position being equidistant from the three sides.



In the above sketches and in sketch #3, which is a copy of a set of actual sights taken on Georges Bank by Lieutenant-Commander G. D. Cowie, all stars are assumed as being of equal rating. In fact, this seldom, if ever, is the actual case. In sketches #4 and #5 are given two examples of actual observations with full explanation of the use of my system.

(F) Further, in regard to rating stars, I believe in the ratings but they must always be used with intelligence. It takes many months of observing to become skilled, but after that, what appear at the time to be very poor observations generally turn out to be equally good with the good ones. For instance, in the tropics dawn and dusk are very short, and star sights must be taken very rapidly to obtain enough while there is a good horizon. It therefore often happens that the last or first star is taken with quite a dark horizon. To test how reliable such sights were, several times after completing all my sights, I deliberately waited until the horizon was very dark, much darker than was considered possible, and took a sight on a star in the same direction as one previously observed. The horizon would be so dark I was in some doubt about it, but that star,would almost always check very closely with the one previously taken. with binocular sextants a much darker horizon can be used. Great care should be observed against rejecting poor sights. Such sights taken by an experienced observer are usually all right. Generally an error can be found in the computing or perhaps it is another star. One evening, after my star chart was in use, we observed Dubhe. This did not look quite correct when computed. It was not out much, only perhaps a mile, but all the other stars checked well. Using my star chart, I found that Dubhe and B Ursa Majoris were almost exactly the same altitude. And thus found, we had really taken B Urse Majoris. I then remembered several cases the previous season where Dubhe had not worked out well, and in going over them with the star chart, I found in each case that B Ursa Majoris had been the star used, although it was thought at the time that we were observing on Dubhe.

2. It is very unusual for an observer to get stars which intersect in a point. An experienced observer, with the same sextant, usually obtains a certain figure with all of the stars' lines of position either away from or towards the stars. My normal figure was with the lines of position always between the star and the true position, average distances about three-fourths of a mile, and although the distance varied with the I.C., the shape of the figure rarely did. The length east and west was generally about fifty per cent greater than the width north and south. During one trip I used another officer's sextant and my figure became almost nothing; my stars intersected almost in a point. Another officer always obtained a figure opposite mine with the lines of position on the opposite side of the ship's position from the star. And yet this officer and myself checked on the average of probably not more than one-third of a mile in our location of the ship. We would be taking Polaris simultaneously and sometimes our angles would differ by two minutes after correcting for the I.C., and yet after all sights were computed and the figures drawn, we would check on the ship's position.

(A) There are various reasons for this large figure, among which are the following:

1. Incorrect index correction.
2. Sextant's limb not true.
3. Abnormal refraction.
4. Officer's personal equation.
5. Amount of waves and sea.
6. Incorrect height of eye.

Another possibility is an incorrect I.C. due to the fact that officers generally do not read a sextant the same at night as in the daytime. On this vessel we read sextants by a flashlight held so the light came in sideways and no matter how close the vernier was to the limb, that caused a slight parallax. An I.C. taken at the same time the stars were taken could never be checked by officers here during daylight.

The height of eye on a ship changes after she has been away from port a short while. I found that our H.I. changed very rapidly the first week out and then more slowly after that. We went out fully, loaded and were down by the head, which was corrected as quickly as possible to obtain a more normal trim. A four foot change from 20' to 24' H.I. makes a difference of 25" in the dip.

(B) Probably the best theoretical figure is one in which there are four stars bearing exactly N E, N W, S W, and S E. These stars are all changing in altitude at the same rate, and if the observer could get used to that rate and no other, I am sure that better results would be obtained. However, this is impracticable because, even if stars were spaced to suit, an observer can not resist taking Polaris. Everyone always wants to take Polaris, and there is no doubt that for a single star, Polaris gives probably better results than any other, but it does not combine especially well with other stars which change altitude fast. Anyhow, I could never resist taking it and I am assuming that other observers can not. The usual procedure is to consider all other stars with reference to Polaris (i.e., we assume we are going to take Polaris, then we see what star will be most nearly south, what one most nearly west and what one most nearly east). The result is that instead of observing four stars with an average rate of change of altitude, but all of nearly the same rate, we observe two which change altitude the fastest in the heavens and two which change the slowest. I recommend the S E, N E, N W, S W figure to anyone with the will power to avoid Polaris.

However, assuming the weakness of human nature, almost everyone will get a N, E, S and W figure and the difference in the rate of rise and fall of the stars accounts for the fact that the figure may be longer east and west than north and south, or vice versa. This is not necessarily a bad figure; it may be just as good as a more nearly square figure.

3. A question has been raised as to why one observer should get results consistently a mile and a half away from the others, always about the same distance and direction and yet that observer's stars by themselves appearing rather good. If the direction is east or west, I believe I know the answer. If it is north or south, I have nothing to suggest except poor observing. I have encountered the same situation several times where the ship's position obtained by one observer differed from that obtained by the other two consistently by three-quarters of a mile to a mile in an east or west direction. This same condition would exist morning and evening for several days and perhaps for an entire trip. In one case it was my sights which differed from the other two observers' sights. After a great deal of worry, study and investigation, I finally came to the conclusion that it was due to an observing lag or personal error on the east and west stars which change so rapidly in altitude. For example, if the observer always comes west of the other two, it means that his angles on the east stars are too small and on the west stars too large. This, of course, can be caused by the natural lag of the observer, but more probably it is due to the following fact: Especially if the altitude of the star is rather large, it is necessary to swing the sextant back and forth in a small arc. The usual procedure is to set an east star below the horizon and swing back and forth until the star makes contact with the horizon and then mark, and vice versa with a west star. Now, with rapidly changing east and west stars the arcs must be very small and the swing very rapid or by the time the observer decides he has contact he will really be past contact.

Somewhat more difficult to explain is when one observer comes east of the other two. This could be explained by a lag in the recording of the time, but I eliminated that by interchanging recorders and time-pieces. My remaining conclusion was that, in his eagerness to mark quick enough, he would mark too quickly.

If the officer who has these results does not take any stars for a few weeks, you are apt to discover that the situation has disappeared and then later a similar situation will appear in another officer's observations.

4. It has been my experience that no noticeable errors are introduced by the observations on low altitude stars, while quite noticeable errors are introduced by the observations on high altitude stars, especially east and west stars, and very noticeably so by inexperienced observers. I know that all treatises on star observations or on refraction warn against low altitude stars, but I have not found it so and have had my observations verified by several people to whom I have talked who have dealt more or less scientifically with star sights. I will grant, however, that there is probably less chance of abnormal refraction in the tropics than in other zones. I have taken stars as low as five degrees in altitude and could find nothing wrong with them. I am inclined to make the lower limit perhaps eight to ten degrees.

On the other hand, it must follow that the less the altitude the more accurate the perpendicularity of the observation. The arc of swing is of very small radius, the sextant needs be moved in a very short arc and can be swung back and forth very fast, thus very much decreasing the chance of the star being on the horizon at the outer end of the swing. With high altitude stars, however, the radius of the arc is large, the arc is flat, the sextant has to be rotated farther and can not be brought back and forth across the proper point for contact nearly so often. There is therefore a much greater chance of the star being on the horizon while the sextant is not perpendicular. This is one of the greatest faults of inexperienced observers. An inexperienced observer can take a low altitude star almost as accurately as an experienced observer but he can not take a high altitude star nearly so well.

The more nearly north and south the star is the less the above applies. With Polaris, for instance, one has all the time in the world to get proper perpendicularity. I would therefore be inclined to lower the lower limit on all stars and lower the upper limit on east and west stars, to some such limit as 8° to 30° for east and west stars with the preference at 15°, and to 8° to 45° for north and south stars with the preference at 15° to 30°.

I object very strongly to much higher altitudes; even with the sun, I am inclined to doubt the advisability of sights over fifty or sixty degrees unless it might be a meridian altitude.

5. As previously stated, I do not like to combine bright stars with moderately faint ones. The usual method of overcoming this is in the evening to observe the brightest star first and the faintest last, and in the morning vice versa. By this I do not mean to infer that observations on bright stars are not so accurate. I believe just the opposite. If only two stars are available and nothing is known about the observer's normal figure, if the only two stars are very bright ones, the intersection of those will be closer to the true position than the intersection of two faint ones. What I do mean is that it is not advisable to take Venus, for instance, in the east against a faint star in the west. In my own observations Venus would always come inside of the rectangle formed by all the stars. In other words, Venus was closer to the true position of the ship than the others. Try as much as possible to have all stars of about the same brilliancy. Avoid combining the moon with other stars.

6. Avoid the smokestack. The heat from the stack causes great errors of refraction. An observation on a star just over the smoke is liable to be in error as much as five minutes of arc. It seems to create more of an error when the star is above the smoke than when it is in the smoke. Take every precaution possible to keep the wind out of your eyes. Get a clear view for your observation; do not observe a sight through the rigging, close to the mast, smokestack or stanchions. Your sense of perpendicularity is disturbed by these. If possible, get where you see nothing except the sea.

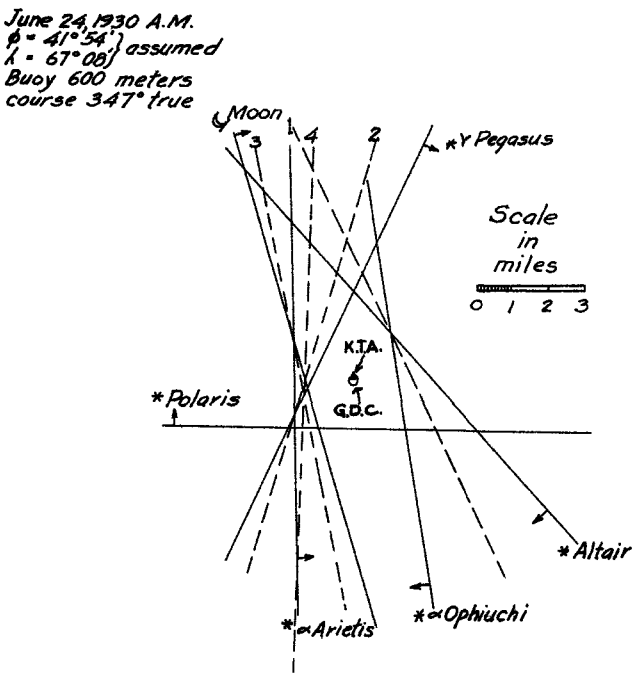
7. Make much use of the "Hate of Altitude Change" table. This table will tell you more about the relative worth of various officers' sights and more about the relative worth of each sight of an evening's observations than can be told in any other way. One observation, as computed ahead from the preceding by the "rate of altitude change" table, should rarely be out more than fifteen seconds of arc.

8. I advise the use of a stop watch. My recorder always used a stop watch, which was compared with the chronometer before and after each set of observations.

LINES OF POSITION.
(With reference to Lieutenant L. P. Raynor's article in the June bulletin).

The Sumner Bisectrix is applicable only in the more simple problems of position finding by stars. Necessarily, the Hydrographic Manual showed only simple examples to explain the method and reasoning as more complex figures would have only confused the reader. But, let Lieutenant Raynor try to find the position of the ship, given a series of some seven or eight stars, which, of necessity, are not symmetrically placed. He will find the Sumner Bisectrix system most confusing.

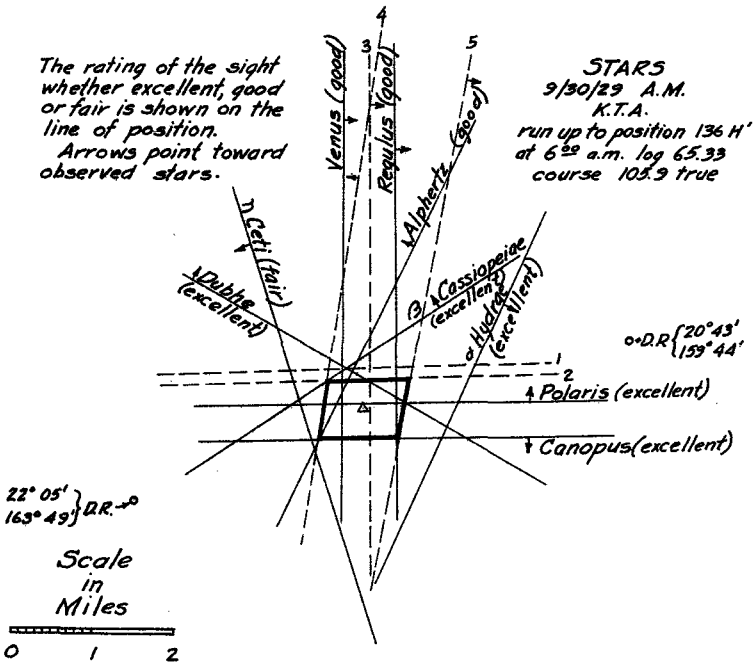
SKETCH #3



Explanation –

Sketch shows a copy of a set of actual sights furnished by Lt. Comdr. Cowie, taken from the ship Lydonia on Georges Bank, June 24, 1930. In this case I would take the angular mean of the western stars Altair and Alpha Ophiuchi (broken line #1). This would form the eastern side of the figure. Polaris would form the southern side of the figure. I would then take the mean of the moon and Alpha Arietis, giving the moon a weight of 2 and Alpha Arietis a weight of 1 (broken line #3). Then take the mean of γ Pegasus and Alpha Arietis, using Alpha Arietis a second time giving γ Pegusus a weight of 2 and α Arietis a weight of 1 (broken line #2). I would then take the angular mean of broken line #2 and #3 which would give broken line #4. This would give all three eastern stars equal weight (although I do not approve of this (see paragraph #5)) and broken line #4 would be the western side of the figure. Then with the dividers find a point equidistant from broken line #4 and #1 and Polaris, shown by a small Δ as the ships position and very close to that adopted by Lieut. Comdr. Cowie who used the Sumner Bisectrix method as follows: "Combinations of groups of 3 stars were used to determine the Sumner Bisectrices. No group having two stars in it with flat intersections were used, i.e. Arietis and Moon, α Arietis and γ Pegasus, Altair and α Ophiuchi, were not grouped. All other combinations considered, a total of eight groups of 3 stars each. The mean point from the loci of the Sumner Bisectrices then gave value as shown. Horizon good."

SKETCH #4



Explanation –

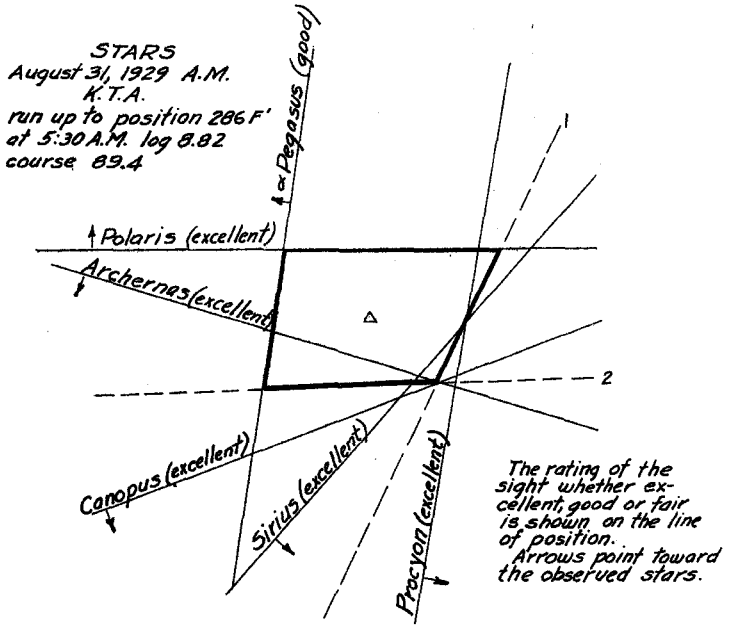
A perfect example of a position easily, quickly and accurately arrived at from a great number of stars of various ratings. There are nine stars. These quickly resolve into 3 north stars, 1 south star, 2 west stars and 3 east stars. Dubhe and β Cassiopeiae are first used, taking the angular mean as they are both excellent (broken line #1). The mean of broken line #1 and Polaris is taken, using weights of 2 to 1. This gives broken line #2, the north side of the figure. Canopus is the south side. η Ceti and Alpheratz are next used with the weights of 2 to 3 resulting in broken line #4. This is the west side of the figure. Next use Venus and Regulus taking the angular mean as both are good, getting broken line #3. Next take the angular mean of broken line #3 and α Hydrae with weights of 6 to 4½ or 4 to 3. This gives broken line #5 the east side of the figure.

The figure has been outlined in heavy ink. Place ships position equidistant between north and south sides and equidistant between east and west sides, using dividers. Position shown by Δ.

Note that distance between east and west sides is about 50% greater than distance between north and south sides and that all stars except Venus are in the same direction from the chosen position.

(R 58)

SKETCH #5

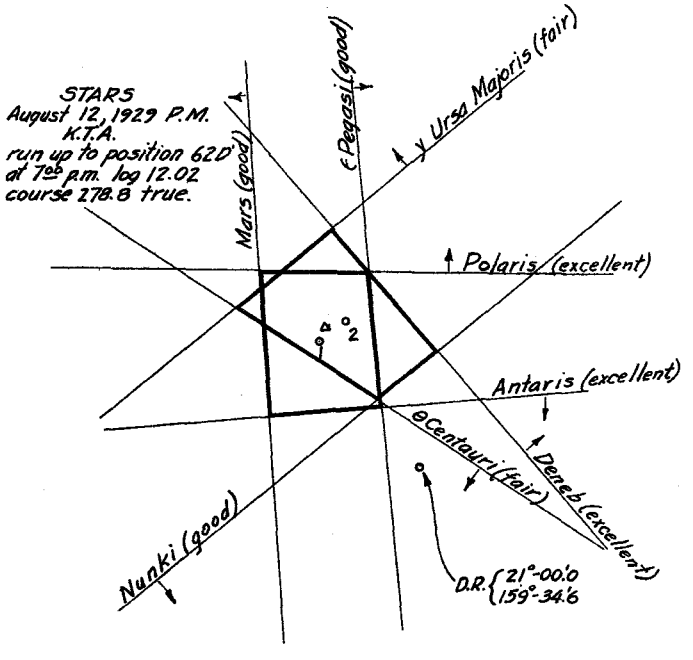


Explanation -
A perfect example of a position derived from a figure stronger on the east and south sides than on the north and west.
Procyon and Sirius (both excellent) are averaged to obtain broken line #1 the east side of the figure. Canopus and Archernar are averaged to obtain broken line #2 the south side of the figure. Polaris forms the north and α Pegasus the west.
According to weights the south side would be twice as strong as the north and the east three times as strong as the west but these weights cannot be used after the figure is arrived at. Futhermore Polaris is rarely wrong.
The figure has been outlined in heavy ink with the ships position shown as Δ arrived at as before.
Again note that the figure is about 50% wider east and west than it is north and south. If this were not approximately true, we would suspect α Pegasus.

Scale in miles

0 1 2

SKETCH #6



The rating of the sight whether excellent, good or fair is shown on the line of position.
Arrows point toward observed stars.

Explanation —
This is a replica of actual sights in which there happened to be exactly eight stars, four of which formed a almost perfect North and South figure and four of which formed a very excellent N.E. and S.W. figure. As a matter of interest this has been resolved into two figures, shown in heavy outline, the north and south figure formed by Polaris, Autaris, Mars and ε Pegasis, two of which are excellent and two good. The N.E.-S.W. figure formed by Nunki, γ Ursa Majoris, Deneb and θ Centauri, one of which is excellent, one good and two fair. The center of the north and south figure is shown at O_1 and the center of the N.E.-S.W. figure at O_2. It will be noted that these two positions are only 0.41 naut. miles apart. The actual position used is shown by a Δ. How this was derived has not been shown to avoid confusion but the greater weight of the north and south figure is seen as well as the lesser weight of the two fair stars.

(R 59)

HYDROGRAPHY - NAVIGATION

NOTES FOR STAR OBSERVATIONS

Lieut. Comdr. G. D. Cowie, U. S. C. & G. Survey

(Conclusions arrived at on this class of work on Georges Bank, 1930, with comments on the previous article of Lieut. Comdr. K. T. Adams)

By observing stars around the horizon a closed figure is obtained and several possible sources of error are eliminated.

(1) Wrong height of eye does not affect the mean position, as all lines of position are either toward or away from the celestial object by exactly the same distance. (A single observation, however, will be in error.)

(2) Incorrect index error of sextant will have no effect.

(3) The more nearly all stars are observed of the same altitude, the less will be the errors due to refraction, mirror error and arc error. All of these errors would be eliminated if all the stars were of the same altitude.

Using star observations only, better theoretical results are obtained than by using sun sights.

(1) Because refraction conditions are probably the same during the hour, or half-hour, that star observations are made.

(3) The colored shade-glasses are not used.

In sun sights, morning, noon and afternoon, there is greater possibility of change in refraction and the very probable error caused by the colored glasses.

The writer uses the Sumner bisectrix method — somewhat simplified -- of finding the mean position from star observations. This method eliminates constant errors only but not accidental errors.

If all the possible Sumner bisectrices are drawn when five or more stars are observed, there are so many possible points that selecting the true position becomes considerably involved. This difficulty may be avoided, if an even number of stars are observed, by drawing the bisectrices of the pairs, and from the figure of error evolved, determining the position by estimation. Four stars give two lines and a point. Six stars three lines and a triangle, the center of which is taken as the assumed point, light stars give four lines and a rectangle, the center of which is used as the point.

If an odd number are observed, two lines observed in approximately the same direction may be combined and used as one, thus re-

ducing to the proposition in the foregoing paragraph, or one line may be used with each of two other lines and two bisectrices determined. The latter method may be objectionable, since one line is used twice while all others are used but once; however, if the bisectrices give a small figure of error, but little error is introduced by this method.

Examples are shown on the attached plate of several actual cases observed.

The writer is somewhat opposed to the idea of weighting the observations, as the weighting depends entirely on the opinion of the observer. As mentioned in the article by Lieut. Comdr. Adams, a star observed when the horizon was dark gave a line opposition about the same as the line determined from the same star observed with a bright horizon. Yet the weights assigned to the two observations would probably be very different.

The writer has found that his lines of positions when horizon was distinct generally were about 0.8 to 1.2 miles away from the mean position. A symmetrical grouping about this point was considered to indicate good observations. Unsymmetrical lines were considered doubtful, and in some cases a line could be rejected because it was much greater or less than the average intercept.

A measure of the accuracy of a result may be obtained by finding out how much the mean position is changed by comparing it with the position obtained when one unsymmetrical line is not considered.

For example, in the sample given by Lieut. Comdr. Adams, when eight stars were observed giving two rectangles, should star Centauri be left out of the grouping, the seven remaining stars group closely to the point determined as the center of north and south square — or .15 to .20 of a mile from the position resulting from the eight lines.

In sketch #3 accompanying the article of Lieut. Comdr. Adams, I do not approve of weights 2 for the moon and l for *L* Arietis. I would rather reverse them if taking much stock in weights. The moon blurs out the horizon at night more than the stars do and probably gives a poorer contact with horizon. The moon observed in daytime may be a different story, but brings in the difficulty of possible changes in refraction from day to night.

The writer is inclined to believe that the accepted position from one set of four stars under good conditions will probably be correct within one-half mile. Very experienced observers may have an error of not more than one-quarter mils.

There follow the results of a series of sights (four or more stars in each set) taken at anchor near the main control buoy "W" under fair horizon conditions by three observers using different sextants. All sights are thrown to the buoy anchor.

OBSERVATIONS AT MAIN CONTROL BUOY "W"
GEORGES BANK - SEASON OF 1930
SHIP LYDONIA
G. D. Cowie, Commanding

Date 1930	Time A.M.-P.M.	Observer	Latitude ° '	v	v^2	Longitude ° '	v	v^2
7-15	P.M.	G.D.C.	41 29.40	+.07	.0049	67 06.00	-.36	.1296
7-15	P.M.	L.S.H.	29.16	+.31	.0961	05.52	+.12	.0144
7-15	P.M.	W.M.S.	29.36	+.11	.0121	05.41	+.23	.0529
7-16	A.M.	G.D.C.	29.05	+.42	.1764	06.10	-.46	.2116
7-16	P.M.	G.D.C.	28.85	+.62	.3844	05.70	-.06	.0036
8-7	P.M.	G.D.C.	* 29.85	-.38	.1444	05.50	+.14	.0196
8-7	P.M.	L.S.H.	* 29.94	-.47	.2209	05.81	-.17	.0289
8-7	P.M.	W.M.S.	* 30.06	-.59	.3481	05.50	+.14	.0196
8-11	A.M.	G.D.C.	29.20	+.27	.0729	05.50	+.14	.0196
8-11	A.M.	L.S.H.	29.53	-.06	.0036	05.22	+.42	.1764
8-11	A.M.	W.M.S.	29.86	-.39	.1521	05.89	-.25	.0625
8-12	A.M.	G.D.C.	29.60	-.13	.0169	05.50	+.14	.0196
8-12	A.M.	W.M.S.	29.28	+.19	.0361	06.33	-.69	.4761
8-12	P.M.	W.M.S.	29.36	+.11	.0121	04.89	+.75	.5625
8-13	P.M.	L.S.H.	29.23	+.24	.0576	05.57	+.07	.0049
9-4	P.M.	G.D.C.	29.70	-.23	.0529	05.45	+.19	.0361
9-5	A.M.	G.D.C.	29.45	+.02	.0004	05.30	+.34	.1156
9-5	P.M.	W.M.S.	29.65	-.18	.0324	06.37	-.73	.5329
Mean (n = 18 sets)			41 29.47		1.8243	67 05.64		2.4864

*Note that the highest values of the latitude were obtained by all observers on the same day, indicating abnormal refraction or else a false horizon.

Probable error of the result = 0:052 = 96 meters.

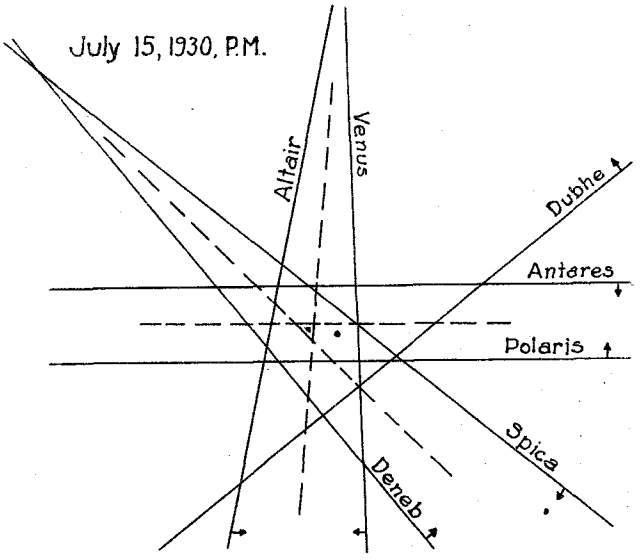
Probable error of a single set = 0:221 = 409 meters.

Probable error of the result = 0:061 = 85 meters.

Probable error of a single set = 0:258 = 359 meters.

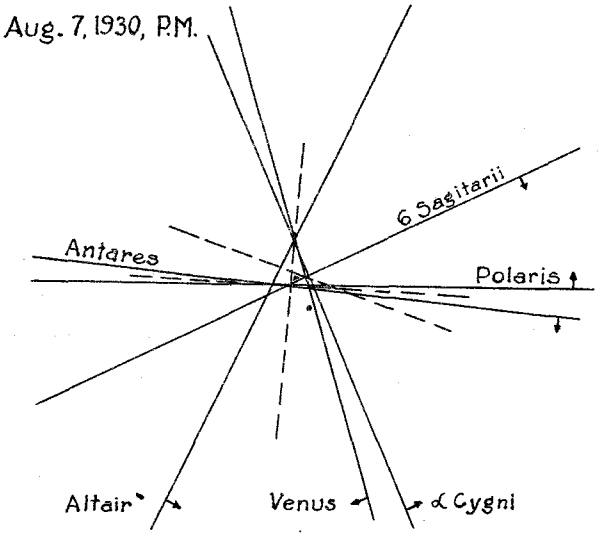
MEAN VALUES FOR DIFFERENT OBSERVERS

Observer	Number of sets	Latitude	Longitude
G. D. Gowie	8	41° 29239	67° 05263
L. S. Hubbard	4	41° 29246	67° 05253
W. M. Scaife	6	41° 29260	67° 05273



Positions:	Assumed	Accepted	Anchor, buoy "W"
φ	41° 29.0	41° 29.1	41° 29.4
λ	67° 05.0	67° 05.9	67° 06.0

Buoy "W" bears 326° true, distant 390 meters, scope 165 meters. Ship's head 10° true.
Horizon good, except dark on Dubhe, could be rejected on account of being unsymmetrical.

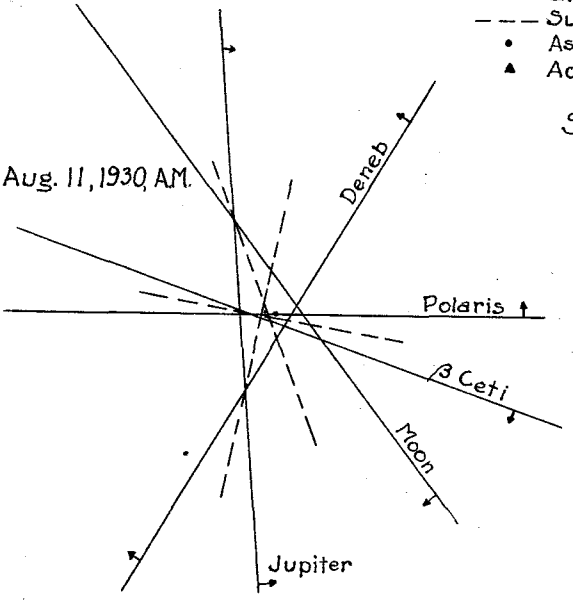


Positions:	Assumed	Accepted	Anchor, Buoy "W"
φ	41° 29.3	41° 30.0	41° 29.85
λ	67° 05.6	67° 06.0	67° 05.5

Buoy "W" bears 112° true dist. 615 meters, scope 165 meters. Ships head 109° true.
Altair was considered to be well observed. However if it were rejected, the position would be moved to the east southeast about 0.4 mile.

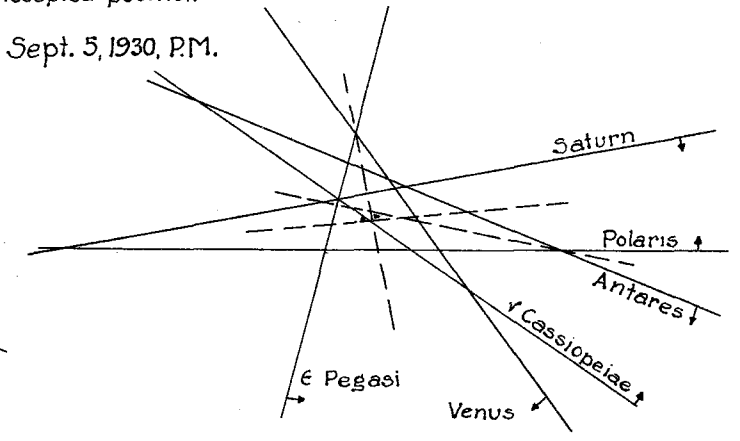
LEGEND
—— Line of position
– – – Sumner Bisectrix
• Assumed position
▲ Accepted position

SCALE
0 1 2 3
MILES



Positions:	Assumed	Accepted	Anchor, Buoy "W"
φ	41° 29.3	41° 29.3	41° 29.2
λ	67° 05.6	67° 05.9	67° 05.5

Buoy "W" bears 118° true, distant 601 meters, scope 165 meters. Ship's head 360° true
Unsymmetrical observations:-
β Ceti towards instead of away from, Polaris at center.



Positions:	Assumed	Accepted	Anchor, Buoy "W"
φ	41° 29.5	41° 29.6	41° 29.45
λ	67° 05.8	67° 05.4	67° 05.3

Buoy "W" bears 182° true, distant 330 meters, scope 165 meters. Ship's head 72° true.
Case of unsymmetrical observations:-
Horizons for γ Cassiopeiae and Antares were not good, Antares was retained because it was symmetrical, but γ Cassiopeiae was rejected because it was unsymmetrical. In this set, rejecting γ Cassiopeiae changed the position but slightly.

Examples of astronomical observations for position.
GEORGES BANK, Season of 1930
U.S.C. & G.S.S. LYDONIA, Lieut. Comdr. G.D.Cowie, Comdg.
(h-88)

GEORGES BANKS VALLEY OF MYSTERY

Hole Nine Miles Long in the Ocean Floor an Aid to Navigation — How It Came There Matter of Conjecture — Discovered During Summer's Work of the Coast Survey -- Former Morgan Yacht and Consort Have Charted Many Miles off the New England Coast — The Tale of the Sea as Told in Echoing Sounds

By Frederick G. Fassett
Boston Evening Transcript

Out where deep water begins at the southeastern border of Georges Bank the summer's work of the Coast and Geodetic Survey has revealed a freak in the ocean bottom that should prove a valuable aid to navigation. It will tell its story to the mariner as plainly as the flashing beams of the lighthouse. It is a sign-board on the ocean floor to be read as clearly as the sign-board which tells the motorist where he is as he travels along the concrete highway.

The significance of the discovery of this mysterious valley may be better understood by the landsman when he is told that vessels from Europe bound for New York, as they approach the coast, follow along the southern edge of Georges Bank as their course is laid to that busy corner of ocean highways which is marked by the Nantucket lightship. In thick weather, the landfall is indicated by soundings when the ship reaches the eastern or southern border of the bank.

Georges is not far from Cape Cod and Nantucket at its western extremity and extends eastward to a region of deep water about south of the western coast of Nova Scotia. The bank is about 180 miles in length. Inside the line which marks the deepening of the water to 100 fathoms — the one-hundred-fathom contour as it is professionally described — there is an area of from 12,000 to 15,000 square miles, with about 3,000 miles of comparatively shallow water. The area of Massachusetts is about 8,000 square miles. The comparison gives some idea of the extent of the banks as a fishing ground for vessels out of Boston and other New England ports.

THREE HUNDRED FATHOMS DEEP.

The ocean floor drops rapidly beyond the limits of the bank. On the chart there is shown first a fifty-fathom line. It marks the deepening of the water to 300 feet. Beyond, for much of the distance only five or six miles away is the line which marks depth of 100 fathoms. And thence, in the open sea to the south and east of the bank, it is ten miles or less to the line which shows where the distance from the surface to the bottom is 1,000 fathoms, or more than a mile.

The new-found depression in the bottom of the sea when outlined in pencil on an existing chart looks like an indentation in the

hundred-fathom line. It is more than that for its depth is three times one hundred. It is about nine miles long and two or three miles wide. The deep water extends from what may be called the ocean end of it nearly to the other extremity. This coastward end is in about latitude forty-one degrees and twenty-seven minutes and about longitude sixty-six degrees and fifteen minutes. The valley extends from that point in a general south-southeast direction.

On each side of it are depths of fifty and sixty fathoms or thereabouts. The master mariner whose apparatus shows soundings of such depths broken by a drop of 300 fathoms may know that he has passed this submarine sign-board, which, of course, will be indicated by the readings on future charts. He will have one more valuable aid in ascertaining his position when clouds and storm obscure the sun and stars or when the fog settling over the waters does likewise.

WAT CAUSED IT.

Such valleys in the ocean floor are sometimes easily explained as the ancient beds of rivers as they existed in those far off geological epochs when the coastline was where now is the open ocean. There are many such cases on the Pacific Coast. On this side of the continent the ancient bed of the Hudson River is so to be traced far seaward from its present mouth. But this little valley cutting into the bottom of Georges Bank is not so easily accounted for. To that extent, at least, it is a valley of mystery.

To the uninitiated it may seem also a mystery that this depression in the ocean floor was not sooner discovered. But there is really nothing very mysterious in the fact that it has heretofore been unsuspected, as far as the officers of the Coast Survey are aware. The charts of Georges Bank were made from data obtained by vessels that moved back and forth across it making soundings as they went. The soundings were thus in lines several miles apart. The existing charts would seem to show that one of the lines was just to the west of the valley and another just to the east. In other words, the surveying vessel may have gone north not quite near enough to drop a sounding line into the three-hundred fathom depression, and coming south have missed it again in similar fashion.

WHY THE PRESENT SURVEY.

In recent years great advances have been made in the art of mapping the bottom of the sea. Instruments are available which make it practicable to take many soundings where but one was taken before. The position of the surveying vessel may be definitely fixed by devices that were unknown to a past generation of cartographers. At the same time, the modern appliances for measuring ocean depths as used on modern vessels reveal the deficiencies of existing charts. They prompt the resurveying of ocean areas, and they give it an accuracy of detail that was lacking in by-gone surveys.

Such are the conditions that prompt work of untold value to fishing and shipping interests in bringing ocean charts into keeping with the resources of modern science. In this case, the Boston Field Station of the Coast and Geodetic Survey, last winter investigated the need of a survey on Georges Bank, and especially the section where the first year's survey should start, from the standpoint of the local fishing industry both here and in Gloucester. At the same time the New York Field Station investigated it from the standpoint of transatlantic shipping interests. Both interests appeared to believe that a resurvey of the eastern end of the banks would be of most value to them, and this portion was undertaken this year.

The project calls for a complete survey within the one-hundred fathom contour with sufficient work outside to make it possible to trace the wandering course of the line with exactness. The work will be continued to the westward during following summers until at the end of two or three years the entire bank has been covered. When this season's work came to a close at the end of September, it had covered practically all the area between a line some miles to the west of longitude sixty-seven degrees and the eastern extremity of the bank.

A CORSAIR'S BENEVOLENT MISSION.

Two Coast Survey vessels were employed in the work which came within the jurisdiction of the New England district of the service, in charge of Commander Robert F. Luce. One of the two vessels, the Oceanographer, commanded by Lieutenant-Commander Fred L. Peacock, is the former yacht Corsair, which was given to the Government by J. P. Morgan when he built the latest Morgan yacht to bear the name. The other vessel is the Lydonia, commanded by Lieutenant-Commander George D. Cowie. On both craft were appliances of the new order in such work.

Included in the equipment was the fathometer used to ascertain the varying depths of the water, the fathometer being that instrument which measures the time that it takes a sound from an electric or mechanical oscillator on the vessel's hull to go to the bottom of the sea and send back an impulse to be received by a sensitive hydrophone and recorded on a dial on board the vessel. Soundings may be made at half-second intervals with the vessel running at full speed, resulting in an almost perfect contour of the ocean's bottom along the line of the vessel's course.

But the surveying ship must know where she is at all times, and in this case, as sound in the other is made to tell the depth of the sea, so it may be called upon to reveal the distance of a point upon its surface from a known and fixed point. Here comes into play the TNT which in the days of war was thought of only as an agent of destruction. Small bombs of it exploded under water cause the sound waves which actuate delicate instruments on board two vessels, one at anchor at a known position. Its distance from the other is shown by the length of time used by the sound in its travels through the water.

Combined with bearings obtained visually and by radio compass the echo method of ascertaining distance is a mighty advance from the methods employed before it was known. It is described as radio acoustic ranging, was developed by the Coast Survey about six years ago and has been extensively used on the Pacific Coast.

A REGI0N OF TUMBLED HILLS.

The mysterious valley was not the only interesting discovery concerning the bottom of the sea on and near Georges Bank. In an area of about twenty square miles it was discovered that where it had been supposed the depth of the water did not greatly vary there were many hills beneath the surface. To mention one example, fourteen fathoms were found at a point almost within a stone's throw of a depth of twenty-six. These variations suggested that were the waters to recede about one hundred feet there would be an area in which small islands would emerge from the surface much as they do in Boston Harbor. It might also be said that here was suggestion of a subaqueous surface much like that where generations of New England farmers have struggled to get a living from stony hilltops in regions far above the waters.

What has been done off the New England coast during the season which began in June last is intended to form part of work which will result in a complete resurvey of the Atlantic Coast. It is work which introduces to public notice a branch of the Government service which gets little publicity. Its undertakings do not attract a crowd. There are no crowds one hundred or two hundred miles off shore where the survey vessels move back and forth. Their officers and crews are not often seen on shore during their busy seasons, and somewhere it is always the busy season. Visits to port are made for supplies, of course, but the day's work is done out on the waters. In this case, there were eleven days when the ships were on location, to borrow a term from Hollywood, and three days when fuel, food and water and other supplies were obtained at the Navy Yard. But seamen know the value of the work. All who go down into the sea in ships share in the benefit of this constant labor in discovering the lay of the land under the waters off the thousands of miles of American coastline.

HYDROGRAPHY

THE TRANSMISSION OF SOUND THROUGH SEA WATER

Herbert Grove Dorsey
Senior Electrical Engineer, U.S. C. and G. S.

Since more and more is said and written on how sound goes from the bomb to the hydrophone in R.A.R. work, it seems well to state to all the Coast Survey officers my own theory of it. This theory has been held for many years and has been told to several of our officers, including a discussion with Dr. Jerry Service while he was still with us. I do not believe Dr. Service's theory is necessary to explain any of the phenomena of sound in water, nor did his professors at the Ohio State University, as is made evident in his paper printed in The Journal of the Franklin Institute, December, 1928, page 788.

My belief is that the sound from an exploding bomb such as we use in R.A.R. spreads out equally in all directions, just as would occur when a firecracker explodes in aid air. Of course there is the difference that in water the velocity is greater and the conductivity is greater; a given amount of energy travels farther and faster. If any obstruction is encountered there will be reflection or absorption, or both, part being reflected and part absorbed. The conductivity of the path of water has been decreased by the obstruction. From the explosion a single compressional wave starts out followed by a single rarefaction wave, having the same sound as an explosion in air — bang, pop, boom, or whatever else is your favorite word to describe a single sound before it has had suffered reflections or refractions or other distortion. No doubt all of you have been near enough a flash of lightning to hear just one loud report, no mutterings or rumblings such as you do hear when farther away. Listening to bombs and detonators on the LYDONIA this summer with a new type of magnetophone and good quality amplifier, when near, they all sounded "just as you would expect an explosion", as quoted by one of the officers. When farther away, 40 to 60 miles, the sound was more prolonged.

Now in warm water sound travels faster than in cold water, and I believe that at the greater velocity, the energy is used up quicker so that it does not travel as well in warm water as it does in cold water, and, consequently, will not travel as far. In this belief I may stand alone so far, but I had my first evidence in the winter of 1918-1919 while associated with John Hayes Hammond, Jr. In the cold, clear water at the entrance of Gloucester Harbor, certain apparatus gave a certain deflection of 5,000 yards and when moved to the warm water of Hampton Roads, the same deflection was obtained at 2,000 yards, nor could this distance be extended without further refinement in the receiving apparatus.

In the cold Alaskan waters in the summer of 1927, improvised apparatus enabled me to get readable deflections to 40 miles and I predicted R.A.R. would work well; you all know that it does. In the Sulu Sea, nearly similar improvised apparatus brought in the first

bomb, a few miles distant and no more. While shoals may have vitiated this test, the results seemed so similar to many days on the Carolina coast that I believe it was due to warm water.

A year ago preliminary tests with the LYDONIA and ECHO, off the Maryland coast gave promising results for R.A.R. using floating hydrophone stations, the hydrophones being located where the water was about SO fathoms deep. I then stated that I would not promise it to work well in the warmer Florida waters, and such proved to be the case in early spring, 1930, when it was as difficult to get a distance of 20 miles as it was to get 60 miles off the Maryland coast.

During the past summer, in the cool waters on Georges Bank, quart bombs of TNT gave good automatic returns at 60 miles, the longest distance tried, and many records were made as far as 18 miles with detonators. These distances are comparable with those on the west coast so that I still believe that cold water has greater conductivity or less resistance than warm. This may be tested by laboratory experiment and I hope to try it some time.

Continuing then on this hypothesis, there being no doubt that the velocity in warm water is greater, it is easy to see that that part of the sound which is near the surface will travel faster than that which has traveled downward. Remember that I am picturing it as if the sound were traveling like a cloud of dust, filling the space as it goes forward. If a large obstruction is near, such as a battleship, there will be a sound shadow on the other side of it, but if it is farther away, the shadow will be less sharp. This I have actually observed in Hampton Roads. The same is true in air, only sound bends around corners much easier than it does in water so that the sound shadows in air are less sharply defined than in water.

For R.A.R. work we are more concerned with capes and shoals than battleships. The Commander of the GUIDE or PIONEER, I forget which, reported that Tillamook Rock made no shadow. If you think of a body of water as a conductor of sound, it is easy to see that in general we have a conductor which is broad horizontally and narrow in the vertical direction. Any obstruction such as a shoal will decrease the area of cross-section of the conductor and it will be more difficult for the sound to get through. A cape will be worse, for we seldom have a cape without shoal water, so you have a double decrease in the cross-section of the conductive area.

If the sound starts in a conductor of small cross-sectional area and goes towards one of greater cross-section it will travel easier than from what we may call a large conductor to a smaller one. In the first case, the conductor by spreading out carries more of the sound with it, while in the converse, more and more of the sound is absorbed by the inclined surface of the bottom. Experiments between the ECHO and LYDONIA showed that bomb sounds went from inshore depths of 6 fathoms outwards to 20 fathoms easier than in the reverse direction.

Although sounds in water can not bend around corners as easily as in air, it should not be thought that they do not bend at all; otherwise the cases already mentioned of the battleship and Tillamook Rock would not be possible. In spreading out, that part of the sound which passes through the warm water will travel faster and that which travels through cold water will be retarded, but more energy will be carried by the cold water. It is probable that the hydrophone is acted upon by a composite bundle of energy, the individual parts of which have come through almost the entire cross-section of water. Now if the sound has come by way of all the layers of water, its velocity will evidently be that of the average velocity throughout the cross-sectional area which we are considering, and that, I believe, is the very velocity which we determine when we measure it for R.A.R., either by visual fixes or any other method such as by a wire.

If this idea had been considered by Mr. Service, I see no reason for formulating his theory of multiple reflections, because he says, page 787 of the article mentioned that the measured velocity agreed with the calculated velocity when computed for the average cross-section, using, of course, the proper values of temperature, salinity pressure, etc., and that was the reason he got up his reflection theory. How if we consider his reflection theory a moment, I believe it could be shown that possibly the velocity and surely the conductivity would necessarily be some function of the bottom for different bottoms certainly have different reflective properties . In my experience, the flat steel bottom of a ship is the best reflector, and I would put a flat rock bottom next, but I have never found any flat rock bottoms; they are usually broken up, so the best I have found is what we label "soft mud". Apparently this presents a smooth flat compact surface to a sound wave which is nearly a perfect reflector. Anyway the soft mud bottoms along the Maine coast are much better reflectors than the hard sand of the Carolina coast as evidenced by multiple echoes with the Fathometer. Of course, sea grass would be the poorest reflecting bottom and broken coral is not good.

Now the velocity being greater in warm water than cold, and the warm water being usually on top, means that if we consider a line perpendicular to the line of travel or wave front, it will be bent over so as to point towards the bottom. This effect is called the temperature gradient effect and has been so called by the Submarine Signal Corporation for upwards of fifteen years. During that time it has been their uniform experience that submarine signals are heard farther in winter than in summer, due to the cold water, and also that signals are heard farther in clear water than in muddy water.

In visualizing what takes place at the hydrophone and ensuing apparatus at the R.A.R. station and the chronograph itself at the receiving station, we must remember that energy of a certain value must be received at both stations before a mark is made on the tape. Taking concrete examples, on the Pacific coast where a plate circuit relay is used with the hydrophone amplifier, it may require a current deflection of two milliamperes to operate this relay and on the

LYDONIA last summer it required not more than 0.1 milliampere to operate the thyratron which transmitted the signal. If these are the minimum values to produce operation, increasingly greater amounts will operate the relay faster although it will make no change on the thyratron which operates in about a millionth of a second, being thermionic motion instead of mass motion.

Now if the distance between bomb and hydrophone is great, the sound reaching the latter having traveled through different velocity paths will not be one single impulse like an explosion, but will be a rumbling sound, the first part of which may be less loud than the last part and it may be the last part only which has sufficient energy to operate the transmitter. The difference in velocity between top and deep bottom layers for a distance of 50 miles may be as much as one second. It is not conceivable to me that sound is going to be whimsical and go on top for one bomb and on the bottom for another bomb even if there are intervening valleys or shoals. I believe it will take the course of best conductivity each time and if we get different results they are most likely due to our measuring apparatus. It seems evident that the minimum amount of energy necessary to operate the transmitted signal will have come via the best conductor for that energy which we might call an integration of velocity and energy over the entire distance. This necessarily brings in the measuring apparatus as well as purely theoretical considerations. It may be that in one case the theoretical velocity along the bottom will agree with experimental results, or some intermediate layer. Surely it will never agree along the surface because of temperature gradient and also because the bombs are always fired at some depth below the surface.

It may be possible that some of the sound may go into rock strata at the bottom and be carried through long distances by the rock formation and then reach the hydrophone. While I say it may be possible, I believe it is improbable in most cases because we seldom encounter solid bare rock bottoms and, if so, they would reflect most of the sound, and where rock bottoms are covered by a layer of sand or mud the latter would act as an absorbing cover to prevent the sound from reaching the rock.

Since this article was started I find that Mr. Shalowitz has begun a study of measured velocities in R.A.R. on the west coast as compared with the theoretical velocities of different horizontal lines of water along the vertical plane through the bomb and hydrophone.

His studies indicate that for twenty-four separate records distributed over four years and much area, Mr. Service's theory of multiple reflection is entirely untenable or at least unnecessary. Mr. Shalowitz's comparisons show that the measured velocity corresponds with calculated bottom temperature velocities to within 1.4 meters per second for the average of the twenty-four independent measurements mentioned. In other words, from these comparisons it would appear as

though the sound went to the bottom, traveled along the bottom and reached the hydrophone in that manner rather than by any reflection method. The average depth between bomb and hydrophone was about 60 fathoms and one of the distances was more than 60 miles, so it is evident that the sound was not traveling in a straight line and was unaffected by the curvature of the earth.

I believe these comparisons tend to favor my idea of "the integral of the velocity and energy". If by spreading out, the minimum necessary energy path is along the bottom for a given type of apparatus, well and good, and we may reason from one set of data to another in that vicinity, but it may be unwise to say that such a method will be applicable on the Atlantic coast with different apparatus. Unfortunately, we obtained no velocity measurements on Georges Bank which I believe are accurate enough to be worth considering in such discussions and hope that we may get better measurements in the future.

While Mr. Shalowitz's studies show that the sound appears to travel along the bottom when the average depths between bomb and hydrophone are about 60 fathoms, he finds that a comparison made when a bomb was fired where the depth was 2,000 fathoms shows the measured velocity to be 1479 meters, whereas the bottom velocity would be 1501 meters. However, taking a path through a depth of about 300 fathoms, the velocity would be 1477 fathoms which would be in keeping with my "velocity energy integral" idea.

Even if we never know all the whys and hows of the path of sound, if we put in the bomb record all the data available we may eventually have sufficient to know the exact equivalent method of travel.

The determinations of velocity of sound from explosions by the British in the English Channel as reported in Proceedings of the Royal Society, volume 103, A 1923, show very great care in making their measurements at neap tide slack water to avoid water currents, the use of several hydrophones approximately in a line, and the firing of a series of bombs by a destroyer steaming in a line at right angles to that of the hydrophones so that the times could be taken from pairs of hydrophones exactly in line with the explosion. Times were measured to thousandths of a second on an oscillograph record. One set of tests was made in September with average temperature of 17° and in February with temperatures of 6° and 7°. They were extremely careful to get the temperature measurements at the time of the tests and took an average of the bottom midway and six feet below the surface to represent the temperature at that position and they found that "the vertical temperature gradient was generally negligible". "Owing to the lack of homogeneity of the surface layers, temperature observations were not made at depths less than six feet".

They fired bombs of 18½ pounds of gun cotton at depths of 10 feet, 40 feet and 108 feet and 300 pounds of gun cotton at 50 feet. The distances were roughly 4, 8 and 11 miles between hydrophones and a visual average of the depths by inspection of their chart would be 7 to 20 fathoms.

There conclusions were that no certain differences in velocity were observed between explosions of detonators and other size charges up to 300 pounds. No difference was detectable through the different depths of explosions or the different depths of water between hydrophones (which was slight).

Their final values are:

(a) V = 4955.5 (±1) feet per second at 16.9°c (±0.1°) and salinity 55 parts per thousand.
(b) V = 4836 (±2) feet per second at 6° (±0.l) salinity 35.1
(c) V = 4847 (±1.5) feet per second at 7° salinity 35.2

The salinity coefficient is 3 to 4 feet per second per part per thousand.

The coefficient of adiabatic compressibility of sea water at 16.95°c and 35 o/oo is calculated to be C = 42.7441 0.02×10^{-6}.

Mr. Service gives in his paper his own velocity comparisons for (a), (b) and (c) as follows:

(a)	1510.4	meters,	Heck	&	Service	1514	meters
(b)	1474.0	"	"	"	"	1474	"
(c)	1477.3	"	"	"	"	1478	"

I don't know why there is such a difference for the warm water test, but the other two show very close agreement and I wish to point out that the timing device in the two methods do not involve mass motion such as used in a chronograph nor any relays at all. Notice that the British results are based on the assumption that sound has passed through the entire cross-section of water excepting 6 feet which would be in agreement with my idea of the method of transmission. That is, in the "velocity energy integral" the energy factor would be negligible and the average velocity would agree with the measured value.

Before closing, just a few words about the velocity of sound as a function of intensity of the signal. I never did believe that a loud sound could travel faster than a weak one. After a careful study of Threlfall and Adair's experiments in 1889 in Australia, where they obtained velocities of 2,000 meters per second, I believe the contacts on their timing devices chattered on strong signals and thereby sent a pulsating current to the magnets instead of a steady current at the beginning of the records and, consequently, the markers did not always function properly. Their distances were only about 500 feet and the receivers were submerged drums with soft rubber heads which sent a compressional wave of air to a second rubber diaphragm actuating contacts. The records show pulsations of about 100 per second and some faint marks which they observed and which they thought might be due to echoes are, I believe, simply the beginnings of true records. I have studied a chart of the region in which their work was done to see what echoes might have done to the results, and while I can not calculate

from their records what I believe would give regular sound velocities, I believe it was simply a beautiful piece of experimental work with erroneous results.

The Fathometer when used in depths of say 10 fathoms will indicate shallower depths for a strong signal than it will for a weak one, and at first thought you might say that the velocity of the stronger signal is greater than for the weak, but luckily for us it is not. The Fathometer will indicate exactly similar results if you vary the intensity of the signal received by the amplifier by just changing the hydrophone rheostat. In the equation "force equals mass times acceleration", the acceleration is directly proportional to the force and this appears true in electrical circuits as well as in mass motion, so that if a strong signal reaches the amplifier, the red light appears quicker than it will for a weak signal. This effect is scarcely noticeable with the 412 type of Fathometer, for the energy of the blow from the striker is so great and so constant, compared with the energy from the oscillator used with the 312 type, that in shallow depths where we are sure the depth is not changing we get only a constant flash. I believe we might notice the effect in depths of about a hundred fathoms.

It has been observed, particularly by Lieutenant-Commander Swainson, that the depths as figured by bombs are less than those indicated by the Fathometer or sonic depth finder, but I feel quite positive that this is due entirely to the quicker response of the time measuring apparatus to the much stronger bomb signal than to the oscillator signal. And when you stop to consider if the velocity were really greater for strong signals than for weak signals then all the beautiful velocity tables of Heck and Service would be in error, for surely the sound of the oscillator is much weaker when it passes through 2,000 fathoms of water than through 100 fathoms, and I doubt if either of the authors care to reconsider their measurements and calculations.

During the summer's work on Georges Bank, I obtained two records where half a pint of TNT and a detonator were fired within a few seconds of each other.

The records were:

No. 1,	detonator,	deflec.	2 ma,	time	20.17 sec.
No. 2,	½ pint TNT	"	10 "	"	20.17 sec.

The two were dropped simultaneously and the detonator fired just three seconds before the half pint. In second record:

No. 1,	half pint,	deflec.	10 ma,	time	20.22 sec.
No. 2,	detonator,	"	1 "	"	20.33 "

Again the two were dropped together and the half pint fired just seven seconds before the detonator.

The difference of 0.01 second in the latter record is no greater than the claimed accuracy of measuring the tape and these two records would be sufficient proof to me that the two sounds travel with the same velocity.

At that time I had not read the British article in which they found no difference between detonators and 300 pounds of TNT so far as velocity is concerned, so I think that with all the evidence we are justified in saying the velocity is the same for all size bombs, from detonators to cast iron. If, when listening on the ear phones, there is indication that sound gets there before the relay works, it only means that the sound has spread out and taken a composite path in getting from thither to thence.

BIG BUSINESS IS BOARDING THE TRAWLERS

Condensed from The World's Work (August, 1930), Earl Hanson

Forty-nine modern power trawlers were built around Boston last year. The days of dory fishing, which thrilled us as youngsters and called for heroes born and bred to the sea, are definitely over. Machinery is beginning to take the place of man power, partly because of the economies involved and partly for scientific reasons. Take the matter of pitchforking the product. It is hard to convince an old salt that this traditional method of handling fish is open to question; but when the freezing-plant bacteriologist, whose job it is to count the bacteria on his company's output and to keep that count at a minimum, finds that every pitchfolk hole in a fish is a likely source of infection, his word carries weight.

Much development work will have to be done before a trawler of exactly the right size and speed is built. Most trawlers at present in use are 150 feet long. Why? Because that is the time-honored size. The new trawlers being built are smaller and faster. These boats, spending less time in mere transport than slow boats, can spend more time actually fishing, can make more trips to the banks per year, can land fresher cargoes.

The trawler steams out to the banks, tosses its net overboard, and drags it along the bottom for from 30 minutes to an hour. The net is then hauled in, emptied of its contents, and thrown back into the water for another fill. Meantime the crew, knee-deep in writhing, gasping fish, is busy sorting, cutting, and gutting anywhere up to 6,000 pounds of catch and passing it to the hold, where it is packed in ice. The deck must be cleared before the trawl comes up again.

The radio has proved invaluable in making a big-business proposition out of fishing. Gone are the days when captains went to sea and used their own judgment about the proper time to turn home. Now they send daily reports to headquarters by radio, giving their positions and catches -- and turn back when ordered.

In the shore office sits the production manager, with a chart in front of him, on which pins mark the locations of ships in his fleet and figures indicate their contents. He watches the market and orders ships home as he needs them. Not always does he try to anticipate the period of highest price. If his company is engaged in the quick-freezing business as well as in catching, its plant can freeze fish when the price is low and sell when the market is more favorable. At high-price periods it does better by throwing its cargoes directly on the fresh-fish market.

Fish have a habit of suddenly leaving a spot where they may have been plentiful for years. Nobody knows why they leave, where they go, or when they may be expected back. The trawlers go blindly in search

of them, burning hundreds of tons of coal, paying many hundreds in wages. Alarmists raise their hands in holy horror over the depletion of our marine foods.

Eventually biologists will establish definite relationships between marine life and ocean conditions — currents, temperatures, depths, locations of bottom springs, and so on. Scientists have found that cod and haddock and other food fish seem to have a habit of staying in water of certain depths and between certain ranges of temperature. British trawler captains out of Grimsby and Hull have long made use of the sonic depth finder and the thermometer as the "divining rods" of the fisherman. American captains are slowly beginning to see the value of these instruments, though, with the deep-rooted conservatism of their calling, most of them look with suspicion on new-fangled ideas.

One large company is gradually overcoming this suspicion by sending its captains, one after another, to England. These men, sailing as observers on the Hill and Grimsby boats, have an opportunity to see active and effective use made of strange devices; they return with minds more receptive to scientific innovations.

Let every trawler captain once learn to use the thermometer and the depth finder and to report his readings to the home office, together with catch and position, and the accumulation of a vast amount of scientific data will go hand in hand with the commercial game of harvesting. But even this is not enough. One company, which for the past year has been placing scientific observers on its boats, is now planning to send out one ship fitted purely for research, equipped with laboratories, able to linger wherever necessary and to investigate "spots" commercial vessels can not visit because of the cost involved and the risk of catching nothing.

In the fisheries as well as in other industries, big business has at last realized the importance of endowing research in what seems to be abstract knowledge. And research so endowed to fill the needs of commerce never fails to produce economic results.

CALIBRATION OF RADIO DIRECTION FINDER, MODEL ER 1485 B
U.S.C. & G. S.S. OCEANOGRAPHER, F.L. PEACOCK, COMDG.
GEORGES BANK, PROJECT No. 63, 1930

The Radio Direction Finder on the OCEANOGRAPHER was calibrated three times during the field season on Georges Bank, i.e., at the beginning of the field season, in mid-season and near the close of field work.

There is shown below the curves of the three calibrations and also tabulated corrections to observed readings as determined by each calibration.

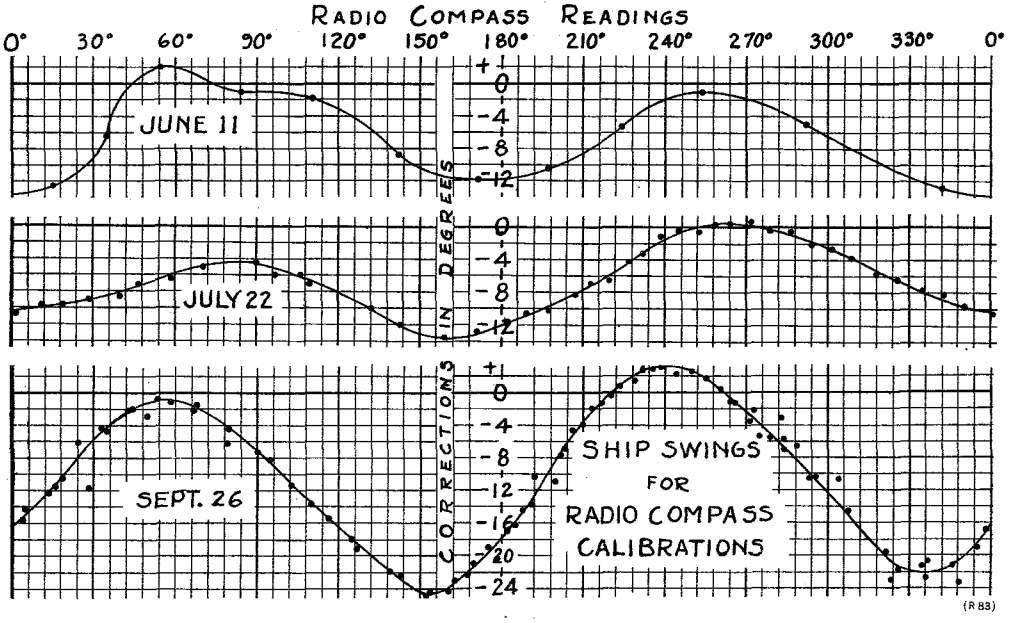
A scrutiny of the three curves in conjunction indicates that:-

1. The probable error of an observation under favorable conditions with sharp minimum obtainable is less than one degree.
2. A better location for the instrument on the OCEANOGRAPHER should be searched for.
3. The bonding of the standing rigging was not effective throughout the season.
4. The Radio Direction Finder should have been calibrated more frequently.

From the foregoing it appears that the apparent unreliability of radio bearings observed with this instrument during the 1930 field season was due largely to deflections caused by changes in the radio character of the metal of the vessel. A further study to keep these changes a minimum, and more frequent calibrations, may make the Radio Direction Finder a valuable adjunct to surveying equipment.

CORRECTIONS TO RADIO COMPASS READINGS
FROM CALIBRATIONS ON DATES SHOWN

RADIO COMPASS	JUNE 11	JULY 22	SEPT. 26	RADIO COMPASS	JUNE 11	JULY 22	SEPT. 26	RADIO COMPASS	JUNE 11	JULY 22	SEPT. 26
0°	-13.4°	-10.5°	-15.8°	120°	-3.7°	-8.3°	-16.7°	240°	-2.1°	-1.3°	+2.9°
10	-12.9	-9.8	-13.5	130	-6.2	-9.8	-19.6	250	-1.1	+0.2	+2.3
20	-11.4	-9.3	-10.0	140	-8.5	-11.4	-22.3	260	-1.0	+0.7	+0.3
30	-8.9	-8.7	-6.0	150	-10.3	-12.8	-24.5	270	-1.8	+0.5	-2.3
40	-3.0	-7.8	-2.8	160	-11.4	-13.3	-24.0	280	-3.0	-0.2	-5.0
50	+1.6	-7.0	-1.3	170	-12.0	-12.8	-21.1	290	-4.6	-1.2	-8.1
60	+2.2	-6.2	-1.2	180	-12.0	-12.0	-17.7	300	-6.3	-2.5	-11.5
70	+1.5	-5.2	-2.5	190	-11.5	-11.0	-13.7	310	-8.0	-4.1	-15.2
80	-0.2	-4.8	-4.9	200	-10.0	-9.7	-8.5	320	-9.7	-5.6	-18.8
90	-1.6	-4.7	-7.5	210	-8.1	-7.8	-3.7	330	-11.4	-7.0	-21.4
100	-1.8	-5.5	-10.5	220	-5.9	-5.6	-0.2	340	-12.8	-8.2	-22.2
110	-2.0	-6.8	-13.6	230	-3.7	-3.5	+2.0	350	-13.4	-9.5	-20.6



THE INTERNATIONAL GEODETIC AND GEOPHYSICAL UNION MEETINGS
STOCKHOLM, SWEDEN - 1930

Captain N. H. Heck, U. S. C. and G. Survey

Attendance at International Scientific meetings has been a part of Coast and Geodetic Survey procedure for many years. The International Geodetic and Geophysical Union meetings and those of the organizations out of which it grew have been attended by Messrs. Tittman, Hayford, Winston, Davidson, Bowie and Heck; the International Geographic Congress by Colonel Jones; the International Hydrographic Bureau by Messrs. Graves, Watkins and Parker, and the Pan Pacific Science Congress by Messrs. Bowie, Watkins, Heck and Colbert.

I have been asked to tell something about these meetings, and this seems especially desirable because some of the field engineers who have not done so are going to have to take up this duty. This could scarcely be avoided, even if we wished, since representation by the Coast and Geodetic Survey is expected, desired and would probably be demanded if it were not forthcoming. The international scientific standing of this Bureau is very high, and its scientific attitude toward all of its work is recognized.

My recent trip to Sweden took two months from the time I left Washington till my return. I took some leave en route and also visited a number of institutions. While on leave I took in the Passion Play at Oberammergau, which is distinctly worth while whether considered from a religious or a purely dramatic viewpoint. The German Museum at Munich should be visited by everyone who has the opportunity since it is the most complete and interesting display of every branch of science to be found anywhere. Ships are shown from the dugout to the modern line. A model submarine, so complete that the propellor turns, is on exhibition with complete explanations. These are only a few samples.

I visited the Central Seismological Bureau at Strasbourg and appreciated the effect of the World War on international activity, since with the fall of the franc the funds available have been so little that it is dependent on the French government and the volunteer work of members of the faculty of the University of Strasbourg for functioning. I mention this because these international activities are directly related to our work in seismology. If they take care of certain features of the work, more time is left to us for studying practical problems bearing directly on the problem of safeguarding cities against earthquake damage.

At Potsdam I saw a gravity apparatus which is still in the experimental stage, but which it is hoped will make gravity observations of the required accuracy in much less time than at present. No pendulums are used.

At Stockholm and later at Copenhagen, I saw the new magnetic instruments which have been developed in Denmark. They are intermediate

in size between the Adie and Eschenhagen types used at our observatories. I also saw the type of building somewhat between an observatory and an observing tent which is proposed to be used in the magnetic observation of the proposed polar year 1932-33. The International Commission on the polar year has suggested special magnetic observations at Fairbanks, Alaska, as an appropriate contribution by our Bureau.

The meeting at Stockholm was very interesting. Like Venice, the city is surrounded by islands and transportation may be either by water or by land. The meeting was held in the "riksdaghusset", or house of parliament, which gave very ample space. The section of geodesy, the largest in numbers, of which Dr. Bowie is chairman, had one of the legislative chambers assigned to it.

In the general meeting the important business was the new statutes, since the old convention expires in 1932. It is expected that the Germans, who were excluded in the organization of the Union in 1922, will soon return and this was made a probability by the acceptance of the invitation sent to certain Germans to come to Stockholm as guests.

I gave principal attention to seismology since the sudden death of the chairman, Professor H. H. Turner, of Oxford University, following a cerebral hemorrhage, left comparatively few persons present whose native tongue is English. A number of problems in which this Bureau is concerned were studied and advance made in their solution. The reports prepared for the three-year period, 1927-30, S. P. 167 and 168, were well received, and Professor Turer, before his death, expressed strong appreciation of the great advances in seismology in the United States.

As an indication that war-time feelings are dying out, Dr. Rothe, secretary of the section, successor to a German as head of the International Seismological Bureau at Strasbourg, France, gave a memorial address to Dr. Wiechert, a German seismologist, who died since the last meeting. Dr. Angenheister, a German guest, replied in German, and the whole will be published in a scientific magazine in German which is published in Austria.

I had my troubles keeping up with the part of the program given in French, understanding about eighty per cent but missing many fine points. It is necessary to be something of a linguist at these meetings.

It must not be thought that these meetings are all work and no play. Entertainment is ample and very interesting. There was a reception at the palace with the Crown Prince and Princess receiving. I recognized them at once as I was on the platform when they unveiled the monument to Ericson in Washington several years ago. The Prince was able to speak to nearly every delegation in its own language. He is a remarkable all-around man and very popular.

There were receptions, dinners and operas, visits of inspection and excursions. I visited the Swedish Hydrographic Office where they have a number of interesting devices, including a three-arm protractor with raised center so that a sounding may be written in without removing the protractor. They recognize the danger of index errors in protractors so have a copper plate with angles correctly marked and have a regular routine for testing them. They issue an index chart showing years of surveys so that the mariner can. appraise the survey of the area in which he is interested.

The language difficulty is always present even with many people speaking English, and the mistakes are often amusing. I was visiting Upsala, the seat of a great university, also of a great cathedral. We were being taken through the cathedral and seeing the tombs of ancient heroes when a man came up to our guide and said something. I said "I believe I understand him. He is going to show us something of unusual interest". He took us through a passage, opened a door and we were outside. I heard some remarks about my knowledge of Swedish. Hot far from Upsala were three of the famous mounds under which lie buried the Norse chiefs as well as the men and horses, killed to accompany them.

The great Swedish Institution is the Smoregasbord, a glorified hors d'ouvres. Anywhere else this first course, which may be of fifteen different kinds, would be a full meal.

There were about twenty Americans all told and they functioned very well. The acquaintance with the delegates, who are the best in their line from every part of Europe, is a great privilege. I was able recently to count up 100 persons whom I could definitely place with name, appearance and work, so it is seen that the opportunities for getting acquainted are ample if followed up.

Since my return I have discussed with members of divisions some of the things that I observed and quite a number of them will be helpful. Also several questions were definitely settled in a way to fix our future procedure.

HYDROGRAPHY

GAS ENGINE DRIVEN SOUNDING MACHINE
(Report on Motorcycle Engine for Taking in Sounding Wire on Launch Hydrographic Work)

Lieut. Comdr. E. W. EiCkelberg, U. S. C. & G. Survey

Summary of report:

1. Mechanically satisfactory in every way.

2. Speed of hauling in - excellent - equal to or better than steam sounding machines.

3. Flexibility good; operator has to be alert.

4. Noise level - altogether too high to insure the proper recording of soundings and angles.

5. Recommendations:- Noise level must be reduced which would mean using water cooled engines as in case of enclosed gas engine electric light plants.

The gas engine sounding machine furnished this vessel for extensive trials has been texted in all depths of water. As far as mechanical features go, the instrument was found very satisfactory. Only two changes were made. She control from handle to carburetor was changed from wire to brass rod. The wire did not work satisfactorily although it seemed to be more delicate in answering changes. The rigid control seemed to suit the operators better. The gas tank continually became unsoldered from its outflow with loss of pressure and gas; a gravity flow was arranged instead and this was quite satisfactory.

On account of excessive vibration the machine has to be mounted very rigidly. At first it was merely bolted to the deck of the launch rather light decking and the vibration was too great. Long bolts were then carried through to the lower main deck beams and these bolts were passed through flanged pipes so that they would be rigid both in tension and compression. This mounting was very satisfactory, although there was still plenty of vibration as evidenced on the plotting table.

It was found advisable to go over the machine at the close of every day and set up on nuts and set screws wherever needed.

When received, the machine was in low gear, and in order to increase the speed of hauling in and to decrease motor speed, the gear was shifted to intermediate. That made the hauling in at an excellent speed - better than the ship's sounding machine. But it requires a quick hand and alert mind to keep from running the lead into the sheave.

There was no difficulty from overheating, although it was feared there might be in hotter climates as this sort of engine gets its air from a speed of about 50-60 miles per hour over a road at maximum load.

The noises produced are excessive - so bad in fact that the recorder could not get the angles as they were called unless he could also see the lips of the observers. This noise is due largely to the chain drives and gears. Last year it was thought due principally to the exhaust, but before going north this year, a maximum silencer muffler, 1¼" Model "P", was purchased and this was very efficient in stopping exhaust noises. The noise now comes from the machine itself. It is impractical to house this machine due to air being necessary for cooling purposes.

Engine and drum base are now separate and I believe it would be advisable to incorporate them into one base.

At the top of the drum for sounding wire is a bolt which holds the drum standards in position. This bolt is so close to the top of the drum that the wire rubs against it when paying out and hauling in. The only alternative is to move the machine forward or tilt it upward. The former requires too much room and the latter does not look good. This bolt keeps the wire from jumping the reel and if made an inverted "U" shape it could still serve the same purpose and decrease the deck room necessary for the machine.

In hauling in on deep soundings, the operators claim they have to exert considerable pressure on lever in order to keep the drum from slipping. This would indicate too small a friction surface.

I believe that by the use of two cylinder water cooled engines of about 6-8 H.P. the machine could be jecketed and so enclosed as to decrease the noises considerably and with the use of two cylinders also cut down on the vibration.

The use of this machine was one day accompanied by what might have proven a rather serious accident. The launch was sounding in a fairly strong wind and when running before the wind the exhaust gases blew into the launch cabin. By noon two of the party were so sick they could eat no lunch and by night they were all sick. One officer was sent to the doctor for medical attention and was given absolute rest for three days. Carbon monoxide gas apparently affects the brain, as the Doctor claimed it was essential not to do any kind of work which required mental effort. Water cooled engines with the cooling water going out with exhaust gases greatly decreases this tendency of gases rising. There is never any difficulty from the main engine exhaust.

The cabin on this launch is open at both ends and there was plenty of opportunity for circulation of air. I believe also that the condition could be remedied by extending the sounding engine exhaust under water.

GEODESY - TRIANGULATION

REFRACTION

Commander C. L. Garner, U. S. C. & G. Survey

As an example of vertical refraction common to semi-prairie lands in Southern Texas, the following actual experience at a station on the Rio Grande Arc of Triangulation is cited:

On the line between Stations Towne and Peters, about thirty miles southeast of Del Rio, Texas, it was noticed, in the afternoon previous to the first night's observations at Station Towne, that a ridge about midway between the two stations obscured Station Peters from view at that time. However, it was hoped that the light of Station Peters would become visible soon after sundown, which is a frequent experience on triangulation parties, as the abnormal refraction following sunset usually tends to lift the horizon. At about the expected time the light on Station Peters was visible and observations were begun in the usual manner, observing on this station along with the others. When the work was about half finished, it became quite obvious that the refraction was decreasing and that Station Peters would soon be lost to view. For that reason, the observations on all stations were suspended except between the initial and Station Peters, which made it possible to observe this single direction in a minimum of time. With this method, the full number of directions on Station Peters was obtained, after which the light soon disappeared from view and later could not be seen sufficiently to give the light keeper at Peters the usual "finish" signal.

When Station Peters was occupied, it was assumed that the same process, but in the reverse order, would be possible at that station. On the first night's occupation of Station Peters, however, the light was not discernible and it was definitely known that the light keeper was on Station Towne, as he was communicated to through other stations. It was assumed that normal refraction was not obtained on this particular night and it would be necessary to wait a second night, when certainly the normal refraction would be experienced and it would be possible to observe the line. The second night gave no better results. On the following day, therefore, the signalman was dispatched to Station Towne and elevated the light at that station by fifteen feet over its previous height, but no observations were possible that night. The light keeper was a reliable one and in every case he was communicated to through, other light keepers, so it was known that his light was properly posted. So on the fourth day the instrument at Station Peters was elevated fifteen feet, and the following night the observations on Station Towne were just barely possible, due to the grazing line. To sum up, it was necessary to elevate the entire line fifteen feet in order to make observations at Station Peters, whereas, at Station Towne, observations were made from the original height of the stations.

A case of severe horizontal refraction was experienced in 1922 in making observations on the Pasadena Base Net, used in determining the length of a line of sight, to be used by Dr. A. A. Michelson in the determination of the velocity of light. The station involved was East Base, where during the first observations the weather was constantly the same. A light warm southwest breeze during the day, accompanied by thick haze and light fog, was followed at night by a very cool land breeze from the north which came over the San Gabriel mountain range. The direction of the wind was normal to the lines affected.

About one-half mile west of East Base Station was a broad dry stream bed covered with masses of large exposed boulders, which absorbed a large amount of heat during the day. This was so noticeable that, when driving over the road which crossed this stream bed almost paralleling the lines of sight under discussion, the hot air from the rocks was easily felt. When closures had been made on all triangles, it was discovered that all triangles were well within the limit required of one-half second closing error, except those which involved East Base and those stations directly west of it. The lines of sight passed not more than forty or fifty feet above the stream bed in question. The triangle closures were in the neighborhood of seven seconds, and after repeated observations at East Base and the other stations, it was impossible to reduce them as long as the same weather conditions continued. The closures indicated the bending of the line in the direction of the wind by the cold night air current blowing down the stream bed radiating heat. East Base was elevated some seventy-five feet over its former height and observations were made as soon as the direction of the wind changed and the closures obtained were satisfactory. This discrepancy in triangle closures is the largest of its kind experienced by the writer.

Atmospheric conditions during the unusually hot spell this past summer caused trouble on all three triangulation parties working in the Middle West due to refraction. Lieutenant Hemple reports that on the Nebraska arc, lateral refraction on the side lines along the Platte River valley caused discrepancies in directions, which, on reobservation under different atmospheric conditions, were changed by as much as six seconds. The Platte River Valley in the region where this party operated is about eighteen miles wide with a table-land on either side about 200 feet higher than the valley floor. The triangulation stations were on the table-land at the edge of the valley. The lines on which the large differences developed were in each case those between stations on the same side of the valley. In other words, the lines were close to the ground for nearly their entire length while the other lines were, due to the valley, elevated considerably above the ground. The lines were in all cases clear, with four-foot stands at some of the stations. On the nights the original observations were made, hot winds blew from the southwest. Reobservations, which changed the directions, were made with the winds blowing from the north and northeast.

HYDROGRAPHY - ECHO SOUNDINGS

(With reference to Lieutenant Burmister's
article in the June Bulletin)
Lieut. Comdr. K. T, Adams, U. S. C. & G. Survey

Observations on the limitations of the Fathometer in detecting sudden shoals, as reported by Lieutenant Burmister, are fully corroborated by my experience, which experience with the Fathometer as a surveying instrument I believe to be as long as any other officer in the Service. To give but one experience, the Ship GUIDE was surveying at French Frigate Shoal, west of the Hawaiian Islands, in a shoal area less than twenty fathoms. Most of this area was of necessity surveyed by hand lead, being loss than fifteen fathoms. Most of it had been surveyed. One afternoon, after completing a day's work, the GUIDE was proceeding to anchorage a few miles beyond the already surveyed area. The Fathometer was being operated by an experienced officer as a navigational safeguard, the ship being in about fourteen fathoms. I was on the wing of the bridge and suddenly saw a shoal. I rushed to the telegraph, but too late to stop in time and the GUIDE drifted over the shoal, which had about three and one-half fathoms on it. I immediately asked the officer at the Fathometer if he would have gotten indications of the shoal if I had not seen it. He said, "Well, I doubt it. There was one flash at eight or nine and perhaps several at three or four, then one at eight or nine and the Fathometer resumed sounding at fourteen fathoms." Of course, the three or four fathom soundings would be taken as the initial and eight fathom sounding as strays.

I give the above as corroboration with what has previously been written on the subject. However, it is only fair to quote both sides of the question. Therefore, how many shoals have been discovered by the use of the Fathometer which would remain undiscovered by the use of hand lead or wire soundings? A good many, I should judge. The following is an example:

An R.A.R. station had been established at Destruction Island with the hydrophone anchored out clear of all previously charted shoal spots. The area outside had been surveyed by hand lead, being a uniform depth of fourteen to fifteen fathoms. This hydrophone did not work satisfactorily. One day, I lowered a launch to investigate the hydrophone; the GUIDE was drifting just outside the hydrophone and I was on the bridge to see that she did not drift too close. The Fathometer was running, as usual, as a navigational precaution. I strolled over to the Fathometer and it did not seem to be functioning properly. It was jumping from nine or ten fathoms to fourteen and back again. I tried to get a better adjustment and could not, so I sang out to the Quartermaster to throw over the hand lead. "Nine fathoms" he shouted. Unfortunately, in my haste to get the ship away from there, I did not get a sextant fix, but I knew very closely my position.

Some time afterward at the beginning of a day's work I ran a hand lead split (the original work was spaced one-sixth of a mile) between the two hand lead lines where I thought the shoal was. No indication! That evening, returning to Destruction Island, I ran another hand lead line at dead slow speed (30 R.P.M.) over the same place, but this time I also ran the Fathometer and had an officer with his eyes glued to it. All the hand lead soundings were around fourteen fathoms. Suddenly the officer sang out, "Shoal". I stopped and backed and the next hand lead sounding was fourteen fathoms. By maneuvering we got over the shoal and found the least depth. But, I assure you, this shoal would have gone undiscovered but for the Fathometer. Incidently, of course, that shoal was what was interfering with the hydrophone.

HYDROGRAPHY

CORRECTING INCLINED SEXTANT ANGLES

George R. Shelton

(With Grateful Acknowledgment to Dr. O. S. Adams)

The method of correcting inclined sextant angles given on page 86 of Special Publication No. 143 is incorrect when applied to angles measured between two objects neither of which is in the same plane as the observer.

After discussing the matter with Dr. O. S. Adams it was concluded that the following formula is the correct one to use in the above mentioned case: Let Vc = the horizontal angle, Vo = the inclined angle between the two objects, and h_1 and h_2 = the angles of elevation of the two objects; the formula is:

$\text{Cos Vc} = \dfrac{\text{Cos Vo} - \text{Sin } h_1 \text{ Sin } h_2}{\text{Cos } h_1 \text{ Cos } h_2}$, which is a fundamental formula of spherical trigonometry involving oblique spherical triangles. To facilitate computation by logarithms the formula is converted into the following form: Let $s = \dfrac{\text{Vo}+h_1+h_2}{2}$ and converting to functions of half angles the formula becomes $\text{Cos } \frac{1}{2}\text{Vc} = \sqrt{\text{Sec } h_1 \text{ Sec } h_2 \text{ Cos s Cos (s-Vo)}}$. Using the form given in Bowditch, paragraph 361, regarding azimuths, the computations may be performed with the minimum of effort. The form is as follows:

Vo --------	
h_1 --------	Sec --------
h_2 --------	Sec --------
2)	
s --------	Cos --------
s-Vo-------	Cos --------
	2)
$\frac{1}{2}$Vc -------	Cos --------
Vc -------	

TABLE
FOR
REDUCTION TO CENTER

==========

HOW TO COMPOTE ECCENTRIC REDUCTIONS BY USE OF TABLE

Pick out the number in the proper Distance Column corresponding to Angle "a", using Column No. 1 if distance is in Statute Miles, or Column No. 2 if distance is in Kilometers. Multiply this number by the Eccentric Distance, "d", expressed in millimeters, and divide by the length of the line, "s", in Statute Miles or Kilometers, computed, or scaled from an accurate map. The result is the Eccentric Reduction "c", expressed in seconds, the sign being plus if Angle "a" is less than 180 degrees, and minus if greater than 180 degrees, as shown at the top of the columns for Angle "a".

Example: a = 214° 20'; d = 0.150 meter, (= 150 mms.); s = 8.2 statute miles. Then reduction $c = -\frac{0.0723 \times 150}{8.2} = -1.32''$

ANGLE "a" (Plus) Degrees		ANGLE "a" (Minus) Degrees		DISTANCE COLUMNS* No.1, for Statute Miles	DISTANCE COLUMNS* No.2, for Kilometers	ANGLE "a" (Plus) Degrees		ANGLE "a" (Minus) Degrees		DISTANCE COLUMNS* No.1, for Statute Miles	DISTANCE COLUMNS* No.2, for Kilometers
0	180	180	360	0.00000	0.00000	45	135	225	315	0.09062	0.14586
1	179	181	359	.00224	.00360	46	134	226	314	.09219	.14839
2	178	182	358	.00447	.00720	47	133	227	313	.09373	.15086
3	177	183	357	.00671	.01080	48	132	228	312	.09524	.15329
4	176	184	356	.00894	.01439	49	131	229	311	.09672	.15568
5	175	185	355	.01117	.01798	50	130	230	310	.09818	.15802
6	174	186	354	.01340	.02156	51	129	231	309	.09960	.16031
7	173	187	353	.01562	.02514	52	128	232	308	.10099	.16255
8	172	188	352	.01784	.02871	53	127	233	307	.10235	.16474
9	171	189	351	.02005	.03227	54	126	234	306	.10368	.16688
10	170	190	350	.02225	.03582	55	125	235	305	.10498	.16897
11	169	191	349	.02445	.03936	56	124	236	304	.10625	.17101
12	168	192	348	.02665	.04289	57	123	237	303	.10748	.17300
13	167	193	347	.02883	.04640	58	122	238	302	.10869	.17494
14	166	194	346	.03100	.04990	59	121	239	301	.10985	.17682
15	165	195	345	.03317	.05339	60	120	240	300	.11099	.17864
16	164	196	344	.03533	.05686	61	119	241	299	.11209	.18042
17	163	197	343	.03747	.06031	62	118	242	298	.11316	.18213
18	162	198	342	.03960	.06374	63	117	243	297	.11419	.18380
19	161	199	341	.04173	.06716	64	116	244	296	.11519	.18540
20	160	200	340	.04383	.07055	65	115	245	295	.11615	.18695
21	159	201	339	.04593	.07392	66	114	246	294	.11708	.18845
22	158	202	338	.04801	.07727	67	113	247	293	.11797	.18988
23	157	203	337	.05008	.08060	68	112	248	292	.11883	.19126
24	156	204	336	.05213	.08390	69	111	249	291	.11965	.19258
25	155	205	335	.05416	.08718	70	110	250	290	.12043	.19384
26	154	206	334	.05618	.09043	71	109	251	289	.12118	.19504
27	153	207	333	.05818	.09365	72	108	252	288	.12189	.19618
28	152	208	332	.06017	.09684	73	107	253	287	.12256	.19727
29	151	209	331	.06213	.10001	74	106	254	286	.12320	.19829
30	150	210	330	.06408	.10314	75	105	255	285	.12379	.19925
31	149	211	329	.06601	.10624	76	104	256	284	.12435	.20015
32	148	212	328	.06791	.10931	77	103	257	283	.12488	.20099
33	147	213	327	.06980	.11235	78	102	258	282	.12536	.20177
34	146	214	326	.07167	.11535	79	101	259	281	.12581	.20249
35	145	215	325	.07351	.11832	80	100	260	280	.12621	.20315
36	144	216	324	.07533	.12125	81	99	261	279	.12658	.20374
37	143	217	323	.07713	.12414	82	98	262	278	.12691	.20427
38	142	218	322	.07890	.12700	83	97	263	277	.12721	.20474
39	141	219	321	.08065	.12982	84	96	264	276	.12746	.20515
40	140	220	320	.08238	.13259	85	95	265	275	.12767	.20549
41	139	221	319	.08408	.13533	86	94	266	274	.12785	.20578
42	138	222	318	.08576	.13803	87	93	267	273	.12798	.20600
43	137	223	317	.08741	.14068	88	92	268	272	.12808	.20615
44	136	224	316	.08903	.14329	89	91	269	271	.12814	.20625
45	135	225	315	.09062	.14586	90	90	270	270	.12816	.20628

* Note: When d is large, and s comparatively small, the numbers in the Distance Columns should be used to 5 decimal places.

Interpolation is necessary when Angle a is given to minutes.

Devised by Chas. M, Thomas, H.&G. Eng'r.
U. S. Coast & Geodetic Survey.

THE CHERNIKEEFF ELECTRIC LOG

Lieut. Comdr. F.. L. Peacock, U. S. C. & G. Survey.

A Chernikeeff Electric Log was installed on the OCEANOGRAPHER on July 20, 1930, and since that date has recorded 7915 nautical miles.

In operation, it has thus far proven quite satisfactory although, in the installation on the OCEANOGRAPHER, it has not met all the claims of the makers.

The following advantages of this log over a log towed from the taffrail may be enumerated:

1. The ease with which frequent readings can be obtained.

2. More positive connection between impellor and recorder:

(a) It is difficult to so govern a towed log that the impellor turns will not accumulate and wane in the log line.

(b) In the case of a towed log a certain number of turns are normally lost through friction and it is difficult to maintain this friction loss a constant due to unequal lubrication. When the recorder of a towed log is freshly oiled, less than the normal friction loss occurs and if the next oiling is delayed unduly, the friction loss becomes greater than normal. It is my belief that the lubrication of the Chernikeeff Log, with weekly attention, remains practically uniform.

3. The Chernikeeff Log is less subject to fouling from waste thrown over the ship's side. It is also more quickly and easily cleared if fouled than is a towed log.

4. The recording of the Chernikeeff Log is more positive on decided changes of course, it being forward of the influence of the ship's wake.

5. The greatest advantage, however, in my opinion, is its non-interference with the maneuverability of the vessel. The towed log is always a source of much concern and annoyance in this respect. Several times during the past season, while on sounding line in dense fog in the steamer track with another vessel sounding her fog signal well forward of the beam, it seemed imperative to get in the taffrail logs against the possibility that the OCEANOGRAPHER would have to back her engines to avoid collision. On such occasions, the Chernikeeff Log maintained the dead reckoning and prevented loss of position.

The Chernikeeff Log is also advantageous in close traffic congested waters in thick weather where the use of a towed log would be impracticable.

6. It is practicable to use the Chernikeeff Log to measure currents with a vessel at anchor although it is my belief that the log would have to be specially rated for this purpose.

It is my present opinion that, should the Chernikeeff Log continue its satisfactory performance and stand up under long continued use without undue wear and tear or the necessity for frequent repair, in the case of a Survey vessel executing offshore hydrography more or less continuously and largely dependent on dead reckoning, it would be in the interest of economy and efficiency to equip her with two or three Chernikeeff Logs and obviate any need for using towed logs. Beside considerations already mentioned, the saving in personnel would be a big advantage. In precise dead reckoning operations, the personnel who read the logs must be dependable and accurate or confusion results. With the installation suggested all log recorders could be constantly under the eye of a competent person who could enter their readings in a record book without undue interference with other important duties. This would free the personnel customarily employed in chasing aft each time log readings are required and render them available for other duty.

The accuracy of the Chernikeeff Log will be further discussed in my season's report after all the data now available have been assembled and studied.

It is suggested that in any future installations of this log on Coast Survey vessels maximum attention be paid to providing that the log seat truly fore and aft and that there be no waste discharge forward of the log.

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Note: The log referred to in Lieut. Gomdr. F. L. Peacock's report consists of a log propeller supported in bearings in a member which projects approximately one foot outside the hull through a gate valve attached to the bottom plating of the vessel in such a manner that it can be withdrawn into a pipe casing attached to the valve and then removed from the casing after closing the valve.

The indicating motion is a separate mechanism located on the navigating bridge or pilot house and actuated by electric impulses caused by the periodic opening and closing of a contact by the propeller mechanism so that the distance run is indicated, in the case of the OCEANOGRAPHER'S installation every .025 mile, but in the new installations on the LYDONIA and HYDROGRAPHER, it will be indicated every .010 mile.

The mechanism by which the revolution of the propeller causes the contact to make and break the electric circuit is free of any friction duo to packing glands for watertightness so that the slip is practically negligible.

HYDROGRAPHY - NATIVATION

ELECTRIFICATION OF SHIP'S PATENT LOG

Lieut. Gomdr. S. W. Eickelberg, U. S. C. & G. Survey.

(This is a result of experimentation on the LIDONIA and EXPLORER. Although not tried out for any great length of time, it has been found quite satisfactory. The principal advantage is that it furnished readings at any time at the plotting table)

Materials Necessary: - The principal item is a Western Electric Message Counter, No. 5L. This can be secured at a cost of five dollars. The other items are materials which are usually on board, including battery current of 25½ volts.

Construction: - (Bliss Log)Remove the hand indicating tenths and put in its place a wheel of silver or special spark resisting metal, with ten points. One of the points was painted black to use for visual readings. Solder same to shaft. Secure an insulated brush so as to make contact with these points as they rotate. When log is in place protect it from weather by some means. A canvas hood was used on the EXPLORER and proved sufficient in very rainy weather.

Construction: - (Negus Log) In this log the gear wheel and brush are placed in the interior. This leaves the tenths pointer in place for visual reading. On the LYDONIA a fifty tooth wheel was tried, but this wheel was hand made and quite irregular. If fiftieths or hundredths of a mile are desired, I would suggest using a special commutator of that many segments with the brush riding on the commutator. Every time a contact is made, the electrical counter changes the last digit by one so that if there are ten contacts, the reading of the counter gives tenths of a mile, etc.

Wiring: - See Figure 2. The wiring is a simple D.C. circuit. A condenser and inductance are placed across the contacts to prevent sparking and radio noises.

The voltage required is 25½ volts and if the battery is allowed to fall below this the counter stops working. On the LYDONIA an ordinary "B" battery was used, and on the EXPLORER part of the ship's storage batteries was used.

The counter is small (see full size drawing Tig. 1) and portable. There is only one precaution in that it has to be mounted fore and aft and not too near the compass. Heavy rolling will operate the counter if mounted thwartship, but experience in crossing Straits of San Juan show that heavy pitching does not operate the relay.

An alternate circuit is also shown using the ship's D. C. supply.

Advantages: - Where the ship's log is mounted aft this log has its greatest advantage as it gives readings at any time on the chart table, without any question of the accuracy, and, if questioned, can be readily checked. If more than one counter is desired, it can be placed in parallel and mounted at the desired second or third location.

For determining velocity at any instant, prepare a table of time distance intervals and then, with a stop watch, determine the time between two successive clicks of the counter. Enter table with this value and read velocity.

Although not tested out in connection with a chronograph, this is a simple matter and could be worked out for D. R, work with a permanent record in addition to the recorded values.

Fig. 1

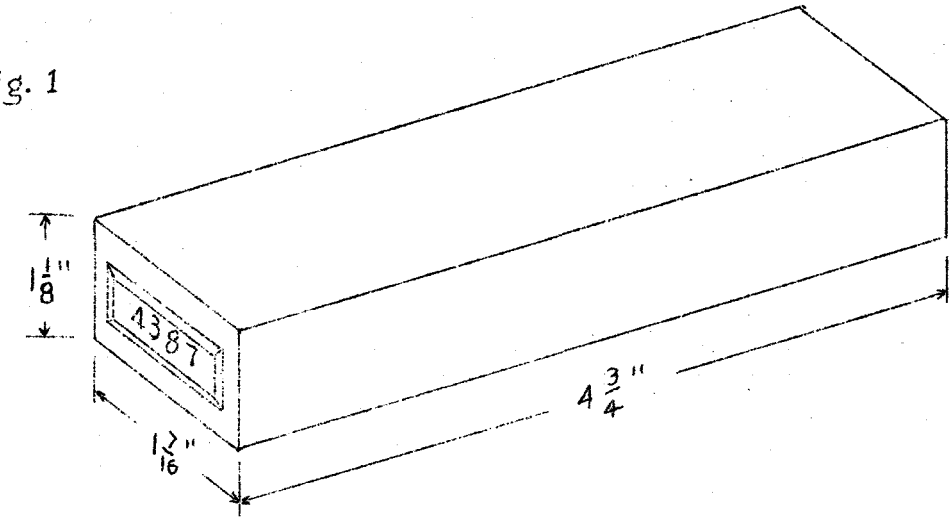
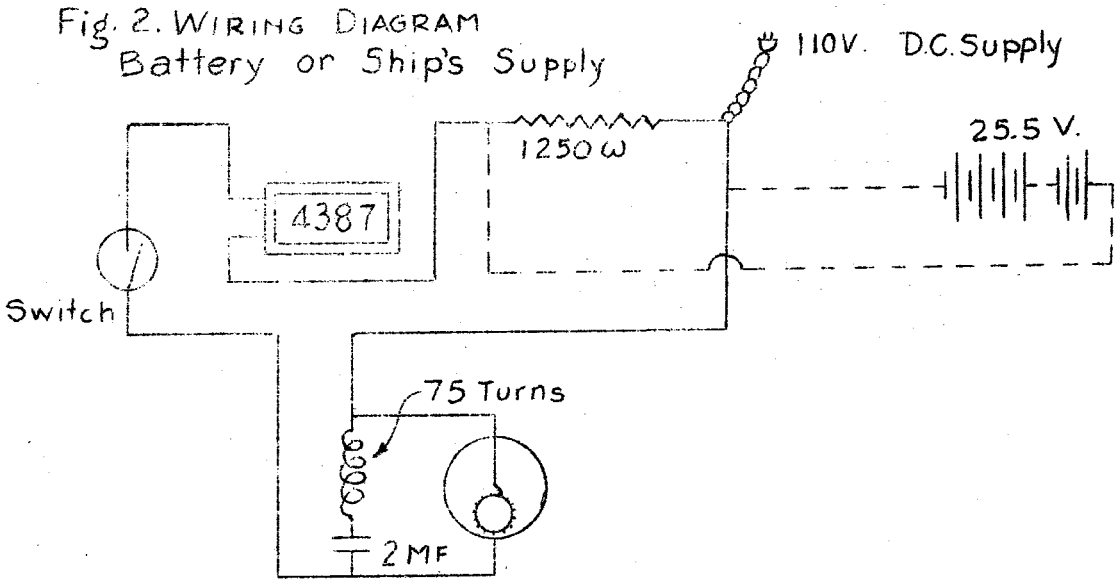


Fig. 2. WIRING DIAGRAM



MAKING AND DETONATING R.A.R. BOMBS ON GEORGES BANK

Ensign, J. C. Tribble, Jr., U. S. C. & G. Survey

(Mr. Tribble has given us the benefit of his season's experience as bombing officer. His report shows commendable interest and intelligent study. His emphasis on matters of safety is well placed. Both he and the Chief of Party realize that without doubt all the information he has set forth has been heretofore uncovered by the experience of others. It was, however, not well known to the members of the party on the OCEANOGRAPHER and it is hoped that this report, if combined with other knowledge on the subject and made available, may prove helpful to other personnel new to this phase of Coast Survey work.) Lieut. Gomdr. F. L. Peacock.

The following report is a record of the methods used aboard the Ship OCEANOGRAPHER in making and detonating bombs while engaged in making a hydrographic survey of Georges Bank, Project No. 63, 1930:

The purpose of this report is to make known anything new in the efficiency and safety of bombing that may not have been previously discovered.

THE CONTAINER:- The containers used in making up the bombs were ordinary cylindrical tin cans, of half pint, pint and quart sizes, with friction covers. These proved to be quite satisfactory, were light and easily handled, with an average cost of three cents a can.

WEIGHTING THE CONTAINER:- To weight the container, Portland cement, iron slugs and pig lead were tried. The cement required too much of the container's volume for satisfactory results, utilizing about five times the volume of lead in giving the same weight. Iron slugs proved very unsatisfactory; they formed an uneven mass in the container and there was danger of the detonator striking a sharp edge while being inserted into the container. Pig lead proved most satisfactory, forming a smooth base and giving adequate weight required for sinking the bomb and at the same time utilizing a minimum of the container's volume.

In weighting the containers, they were first placed in a shallow pan of water and molten pig lead poured into each container, using about one pound for the half pint containers, one and three-quarters pounds for the pint containers and two and one-third pounds for the quart containers. These weights caused the bombs to sink about three and one-half feet per second. A number of containers were weighted in this manner and put aside for future use, keeping several days' supply on hand at all times.

THE EXPLOSIVE:- Flake T.N.T. and granulated T.N.T. were used with test favoring the granulated T.N.T. The flake T.N.T. proved

very unsatisfactory, failing in a number of cases to explode because of the fact that it could not be closely packed into the container and did not make close contact with the detonator. Another objection was that the sound of a bomb made up of flake T.N.T. did not carry as far as one made up of granulated T.N.T. Even considering the difference in cost, it is believed that granulated T.N.T. proved the most economical since more "duds" resulted from the use of two hundred pounds of flake T.N.T. than from one thousand pounds of granulated T.N.T.

FILLING THE CONTAINERS:- The experience of the season indicated that to secure positive detonation and good carrying power the T.N.T. should be a compact mass around the detonator. This desired condition was impossible to obtain with the flake T.N. T., but easily accomplished with the granulated T.N.T. by pressing the T.N.T. into the container with the heel of the hand until full.

The covers for the containers were punched from the inside out, which gave a frayed edge on the upper side of the cover. The cover was then placed evenly on the container, and by placing one foot on the cover, it was pressed down into place. This secured the cover tightly without any pounding or jarring of the bomb and without disturbing the frayed edge.

A supply of the containers of the several sizes were filled in this manner and stored in a specially constructed zinc lined box containing trays, subdivided by one-quarter inch brass rods, spaced so as to form pockets to fit the various size containers.

THE DETONATOR:- Number "8" blasting caps were used almost exclusively. Number "6" blasting caps were tried but proved to be very unsatisfactory, failing in a number of cases to detonate the bomb, especially when using flake T.N.T. as the explosive.

THB FUSE;- A slow burning fuse manufactured for use in wet work and sold in one hundred foot rolls was used. The fuse was kept at a warm temperature to keep it dry and to prevent any breaks in the fuse due to handling in cold weather.

The fuses used were cut ten to twelve inches in length; this gave sufficient fuse to allow about three inches to burn before throwing the bomb overboard and then allowed the bomb to sink to an adequate depth before the explosion occurred.

CRIMPING THE DETONATOR:- There were two important considerations taken into account in securing the fuse in the detonator, namely, that the end of the fuse make contact with the fulminate of mercury in the detonator and that the detonator be crimped about the fuse in such a manner as to insure a water-tight connection.

In inserting the fuse into the detonator contact with the fulminate of mercury was insured by pressing the fuse and detonator lightly together and holding them in this manner while crimping the open end of the detonator around the fuse. The open end of the detonator was crimped three times, beginning about three-eights of an inch away from the open end and with each successive crimp nearer the open end of the detonator. This insured a water-tight connection without the use of collodian or other sealing compound.

INSERTING THE DETONATOR INTO THE BOMB:- The detonators were kept well away from the T.N.T. and only inserted into the bomb when the stand-by signal to the bomber was received.

Before inserting the detonator into the bomb, a small rounded stock of hard-wood was forced down into the T.N.T. to form a clear passage for the detonator. The detonator was then pressed well into the body of the T.N.T. and the frayed edges of the container's cover pressed together, holding the fuse and detonator in place. In pressing the frayed edges together care was taken not to puncture the fuse, thereby causing a "dud" through the entrance of water into the fuse.

LIGHTING THE BOMB:- The fuse was ignited from an electric heating unit. This insured instant ignition of the fuse and made it possible to time the burning of the fuse to the second.

The fuse was lighted about fifteen seconds before the bomb was to be thrown overboard. This allowed about three inches of the fuse to burn before coming into contact with the water, insuring its continuous burning thereafter.

To eliminate any danger in holding the bomb after the fuse was lighted, the fuse was pressed lightly between the thumb and fore finger, following the flame by its heat as it burned along the fuse.

FUSE INTERVAL:- It has already been stated that about three inches of the fuse were allowed to burn before throwing the bomb overboard and that this required about fifteen seconds. To secure the proper fuse interval, between the time the bomb was thrown overboard and the explosion occurred, so as to insure the sinking of the bomb to an adequate depth and that it would explode well away from the ship, it was necessary to take into account the fact that the fuse burned more rapidly under water than in air due to increased pressure. Experimentation has demonstrated that nine inches of fuse burn twelve seconds faster at a depth of five fathoms of sea water than in air and experience in the field indicated that the same length of fuse at a depth of ten fathoms would burn in two-thirds of the burning time in air.

FEASIBILITY OF BOMBING ON TIME:- It was very desirable that the bomb go over the ship's side at a definite time interval. As the organization of the work was perfected, this result was accomplished

by having the bomber's watch coincide with other time pieces being used in connection with the hydrography.

"DUDS" ARE EXPENSIVE:- The cost of a bomb using granulated T.N.T. as the explosive was about sixty per cent more than a similar bomb with flake T.N.T. as the explosive. However, in spite of the added cost, it proved to be the most economical bomb, since "duds" were less frequent. The cost of one "dud" was quite often more than a dozen bombs. For instance, in "bombing in buoys" it required from nine to twelve minutes to bring the ship around and come alongside the buoy. Here every "dud" took just that much time from the ship and her entire complement.

WATERTIGHTNSSS OF CONTAINER NOT ESSENTIAL:- It was found by experimentation that a watertight container was not essential to successfully detonate a bomb. This was proved conclusively by detonating T.N.T. that had been thoroughly mixed with water. The results did not differ from those in which the T.N.T. was dry.

THE SEASON'S RESULTS:- During the season on Georges Bank more than fifteen hundred bombs were thrown overboard with only fifty "duds", and most of the "duds" came during the earlier part of the season when flake T.N.T. was being used as the explosive but collodian was used to insure a watertight connection between the fuse and the detonator and soap was used to close the opening in the cover of the container.

During the latter part of the season the use of collodian and soap was dispensed with, but more of the fuse was allowed to burn before throwing the bomb overboard. It is believed that this adequate sealing of the burned end of the fuse before throwing the bomb overboard was the most effective of the several details of technique developed during the season to reduce the percentage of "duds". The records show that from September 15 to 29 a total of 296 bombs were thrown overboard with only one "dud", which is believed to be a record.

SUMMARY OF IMPORTANT POINTS.

1. Use pig lead to weight the container.
2. Use grade "A" granulated T.N.T.
3. Use number "8" detonators.
4. Have the T.N.T. well packed into the container.
5. Be sure that the fuse makes contact with the fulminate of mercury in the detonator.
6. Have the detonator well imbedded into the body of the T.N.T.
7. Gut the fuse long enough to allow about three inches to burn before throwing the bomb overboard.

WRINKLES IN FIELD WORK

I. HYDROGRAPHIC RECORDING

K. T. Adams

For putting soundings on ship boat sheets, there are two usual practices. One of these is to ink the soundings at night after all work is done for the day. This usually entails overtime work on the part of someone and is hard on the eyes, which a Coast Survey officer should cherish. The second method is to have the recorder look back in the record and read them to the officer plotting. This leads to errors; the recorder forgets to watch his time and misses taking soundings and positions at the correct time.

For two years it has been the practice on the GUIDE to make carbon copies of the soundings. This is done by using a narrow strip of carbon and copy paper just wide enough to take a carbon of the "position numbers", "the time" and "the soundings". These are clipped to each page just before starting to record on a new page. On completion of the page the carbon copy is given to the officer plotting and whenever convenient for him, he enters the soundings on the boat sheet.

II. IMPROVED METHOD OF TRANSFERING SHORELINE, ETC.

A. M. Sobieralski.

In transferring shoreline, etc., from a tracing, carbon paper smears the drawing. English Vermillion dry pigment spread on the back of the tracing or on an intermediate sheet of thin paper will give excellent results. Lines will be transferred sharply and can be erased easily. The process is simpler and better than the common practice of blackening the tracing with a soft pencil. The materials are obtainable at any paint store. (Schedule of Supplies: Item 8610-g-5, Dry Pigment, Vermilion, English).

III. CENTERING TRIPOD HEAD

H. W. Hemple

In centering the aluminum instrument tripod head on the inner steel tower, using the new type of collimator which is operated from the ground, a strip of celluloid about 3/32 inch thick and six inches square is used. This has concentric rings drawn on it at distances a centimeter apart from the center. The center is also distinctly marked. The outer ring on the celluloid is the same diameter as the hole in the aluminum tripod head. In practice, this strip of celluloid is placed on the aluminum plate so that the outer ring is in juxtaposition with the hole, and holding it in this relative position, the whole is moved as a unit until it is centered, and then the aluminum tripod plate is secured. The hole in the center of the lamp-plate for the signal lamp, on the outer tower, can be seen thru the transparent celluloid, and its position transferred thereon, where its distance and direction can be measured.

IV. STEEL PLATE SUPPORT FOR SIGNAL LAMP

H. W. Hemple

In place of the wooden board for the lamp on the outer tripod of the steel tower, Lieut. P. A. Smith is using a steel plate about 15 inches in diameter and 1/4 inch thick. This is placed on top of the angle iron, while underneath the angle irons at each of the three corners of the triangular top are placed strips of steel about 8 inches long, 1½ inches wide, and 1/4 inch thick. Machine bolts are used to connect the plate and strips, and by bringing up on these bolts, the plate is rigidly clamped to the tripod top. A hole in the center of the plate serves to bolt the signal lamp to it. Holes spaced at intervals around the edge of the plate permit of great leeway in centering. On the instrument tripod two aluminum tripod heads are used, one above, the other underneath the angle iron top. These are clamped together using machine bolts and give a very rigid setting for the instrument.

V. RIGID CONTROL FOR THE SURVEY OF AN OFFSHORE BANK.

From Reports of O. W. Swainson

Work on Raita Bank was finished on July 11. This Bank is twenty-one miles long and nine miles wide. There are twenty fathoms over most of the area and a ten-fathom reef along the southeast edge. The control was by means of fixed positions on floating signals spaced three to four miles apart. The southern buoy was located by six sets of star fixes. The positions of the other buoys relative to this one were determined by R.A.R. distances between them and by sun azimuths. The velocity of sound used was that determined by measurements between two buoys located off Laysan Island, by triangulation from a base line on Laysan Island, and by measurement between two buoys cut in by plane table off Maro Reef from a plane table base line. The two determinations of velocity agreed within one meter per second.

Star fixes were also taken by two officers at the northern buoy. This fix agreed within two tenths of a mile of that as carried from the southern buoy.

Note: Raita Bank lies approximately 100 miles northwest of Gardner Pinnacle and 125 miles east of Laysan Island and somewhat more than half way along the chain of shoals, reefs and islets that extent westward from the main group of the Hawaiian Islands to Midway Island, a distance of over 2,000 miles. The present program calls for a survey of the entire chain, well over fifty per cent of which has been completed during the last three seasons. The floating hydrophone station equipment was mounted in a whaleboat. (See Wrinkle No. XIII)

VI. LIGHTS ON NAVIGATING SEXTANTS.
(Names withheld by request)

Although a light on a navigating sextant had never been used by me, I had considered it at various times and thought it quite feasible. I had always read my sextant by a flashlight. However, I suggested to a fellow officer that he try it by putting a small battery in the handle of the sextant, and I recently received the following letter from him:

"Your suggestion about the lights in the sextants is sure the stuff. I had them rigged up two days out and they have worked fine ever since. I got hold of some 'pencil' batteries and made new handles for the sextants, each with two holes bored to take a pair of batteries. . A small spring switch, operated by the little finger on the hand holding the sextant, lights a very small bulb back of the ground glass over the vernier. The result is excellent. We would be sunk without them now. Thanks for the idea."

VII. FATHOMETER OPERATION
A TRICK OF THE TRADE
K. T. Adams.

Every trade has its own tricks and here is one I discovered accidentally which can be used to advantage on the GUIDE'S Fathometer. I do not know whether it can be worked on other Fathometers without a slight change, but I am sure that the change could be simply made and that it would pay to make it.

I noticed that our Fathometer, when on "red light fast speed", occasionally sent out a long signal. This bothered me for some time until I discovered that it was caused by not having the gear shift turned firmly enough. From this point, I discovered that by turning the gear shift slowly toward the "white light slow speed" method, the long dash would come in continuously, although on fast speed.

Of course, this condition is not supposed to exist, but I find it of great advantage in the deeper soundings. On this vessel we use the "short signal fast speed" up to 100 fathoms and then slip the gear shift gently back until the long dash comes in and then we use the "long signal fast speed" up to four hundred fathoms quite successfully.

VIII. WIRE DRAG TESTER
From Monthly Report of B. H. Rigg
Wire Drag Surveys in Long Island Sound, 1930.

During the month a new method for testing the drag depth was developed by H. E. Finnegan. The regular tester, a piece of one-half inch round iron rod six feet in length, is coated with white lead and cup grease. The tester is suspended in the water in front of the drag

at a depth equal to that at which the drag is set plus one or two feet. The man making the test suspends the testing line so that an even foot mark is at the surface of the water. When the drag passes the tester, the ground wire scrapes the coating of white lead and grease, leaving a definite mark. The distance from the top of the mark to the bottom of the rod is measured and subtracted from the suspended depth of the tester, giving the drag depth. By this method the drag depth may be determined very easily to within one-half a foot, and possibly to a tenth of a foot, depending on the condition of the sea and upon the accuracy with which the man making the test holds the foot mark at the surface of the water.

IX. POINTING WITH INSTRUMENT OUT OF FOCUS

H. W. Hemple.

On first-order triangulation using signal lamps, the appearance of the light sighted on is sometimes of such a character as to make it difficult to pick out a definite center. Under such conditions the experiment was tried on the Mississippi River triangulation of throwing the telescope out of focus. This causes the light to take a pronounced umbra-like appearance with a definite center. By centering on this umbra, then placing the telescope in focus and using this center, observations were obtained which closed the triangles satisfactorily. Lieut. Smith this past summer carried this a step further in a case where a triangle closure of four seconds was encountered. Indications pointed to trouble on one line. He observed sixteen positions with the telescope out of focus on the two lines in the triangle, at the station at which was obviously the trouble. The resulting values closed the triangle within less than two seconds.

X. USE OF A THEODOLITE AS A TELESCOPIC PELORUS.

From Descriptive Report on Sheet H-5012.

K. T. Adams.

Bearings were taken with a four-inch theodolite mounted on the bridge and oriented while the ship was in port. As a rule, "series bearings" were taken, i.e., as many as eight or ten bearings were taken as rapidly as possible and the mean compass bearing computed. These were started at a predetermined time before the position and continued for the same length of time after a position. (Hawaiian Islands)

XI. ONE WAY TO BUILD A TALL SIGNAL

From Season's Report of Chas. Pierce

There were three flags placed in trees, but the outstanding one of the three was on the timbered ridge just south of Jackass Gulch. The flag was placed in a redwood tree 200 feet high, about seven feet in diameter at the base. On order to get into this redwood, a fir 100 feet high was felled into the redwood and cleats nailed up the fir for over 100 feet to a point where the redwood could be climbed.

The topmost branches were left on this redwood and the lower branches cleared to below the tree line. The trunk of the redwood was dressed with black and white cloth and crossed targets nailed just below the top of the tree. This tree showed conspicuously from all directions with the top branches making certain of identification. All pointings were made on the slim trunk of the redwood. (Northern Coast of California).

XII. SEXTANT ILLUMINATION

O. W. Swainson

For the past six months, sextants equipped with illumination for the graduated arcs have been used aboard this vessel and the illuminating device has proved to be very satisfactory. This pertains, of course, to the sextants which have been used in observing star sights for astronomic fixes and which formerly required the use of a flashlight and an extra man while reading angles. By equipping sextants with these devices, they have been made much more convenient for the observer to use, the necessity of an extra man has been eliminated and the confusion on the bridge caused by having it too crowded has been lessened.

To so equip the sextant, the handle was removed and hollowed out so that a small Eveready flashlight battery No. 706 could be fitted neatly inside. A flashlight bulb with shade was then attached to the movable arm in such a position as to properly illuminate the vernier. The battery and bulb were then connected by a wire which was made fast along the movable arm so that it moved freely with the arm. The contact was placed on the metal part of the handle where it is not necessary to move the hand to illuminate the arc. This work was done aboard ship and the weight of the sextant was not increased enough to be noticed.

XIII. LAUNCH HYDROPHONE STATION

O. W. Swainson

(See Wrinkles in Field Work No. V)

The transmitter is a Hartley oscillator directly connected to the antenna. It uses a 75 watt tube. The plate current is furnished by a 350-750 volt dynamotor run by 12 to 24 volts of storage battery.

The receiver is three tube regenerative, with range of 80 to 150 meters.

The amplifier is same as used at a shore station.

The above set could be built very compactly by using the same amplifier for both the receiver and bomb impulse. We did not attempt to make the set small, as there is plenty of room in the launch.

When the astronomic party was ashore at Laysan Island, Mr. Heaton maintained communication with the ship by means of a small portable transmitter described in the July, 1929, issue of Radio News. It uses a 171 A tube with 135 volt B battery. With this set we worked with voice up to a distance of 30 miles. The wave length is 85 meters.

XIV. MEASURING STRONG CURRENTS IN COMPARITIVELY DEEP WATER.

F. S. Borden.

For making a lunar month of current observations in San Bernardino Strait, P. I., in a depth of 55 fathoms (rocky bottom) and a current at times reaching seven knots, special anchor gear and a mooring buoy had been provided. This never was entirely satisfactory, and when the vessel had to leave the station temporarily for fuel, it was found on returning that the mooring buoy had disappeared -- probably towed under and crushed. As the time consumed in running for and procuring additional special equipment would have ruined the series, the ship was anchored with one of her bower anchors, using one shot of chain at the anchor and approximately 100 fathoms of six-inch Manila line.

When the current attained a velocity of about three knots and the line began to show evidences of parting, the engines were turned slow ahead to relieve the strain. By gradually increasing and decreasing the revolutions as the current increased and decreased and maintaining a resultant strain equivalent to that caused by a three-knot current, it was found that the ship could stay on station and obtain very satisfactory observations.

The series was completed without the loss of any of the ship equipment and without the anchor having dragged except on the last day of the series when, with the maximum current of the month at hand and a fouled anchor, the strain on the bight of the line alone was great enough to drag the anchor slightly, oven though the ship held up its end.

Using the engines had no effect on the accuracy of the observations provided they were not made immediately after increasing or decreasing the revolutions of the engine and before the forces acting on the vessel had become balanced.

It might be interesting to know that during the series the engines turned over the equivalent of 350 miles with the ship at anchor and the steering wheel secured "amidships", that at times of maximum current the engines were turning as high as 64 r.p.m., that during the series the flood current passing the station traveled 1537 miles and the ebb current 560 miles. The duration of the flood current was 489.3 hours (70.3%), whereas that of the ebb was only 206.7 hours (29.7%). A general explanation of the type of currents experienced is given in the Pacific Coast Current Tables under Predictions for San Bernandino Strait.

THE TRAINING SECTION

Lieut. L. G. Wilder, U. S. C. & G. Survey.

(For the information of those who are not familiar with the activities of the Training Section, the following has been furnished by Lieutenant Wilder)

The Training Section was transferred to the Ship OCEANOGRAPHER as an independent unit last March. The opportunity to give practical training aboard one of our larger surveying ships has proved to be excellent. The aims have been to give as much practical training, combined with what theoretical work is thought desirable, in the subjects or activities with which newly appointed officers are most unfamiliar, and knowledge of which is necessary in order that they may take their places as junior officers on board our ships engaged in combined operations. This amounts to an attempt to turn out a capable junior ship's survey officer. The training in those subjects required to make a good ship's officer is stressed rather than training in survey methods, as newly appointed officers have received at college a grounding in the survey work. The course has required about four months. An extended course to include those activities of the Bureau not undertaken by parties assigned to ships engaged in combined operations was originally planned but has not, as yet, been undertaken.

The following form is that used in submitting the report covering the training of each officer completing the course. The form is self-explanatory, but a number of statements might be seasonable. The practical experience gained varies considerably with the occupation of the Ship OCEANOGRAPHER'S party, An attempt has been made in the "Report of Occupation" to denote specifically the time devoted to each separate subject. There is, of course, much overlapping of subjects, as for example, subject 1 is practiced during the entire course; subject 2b is practiced under subject 3; 2k under 2g, etc. Some of the time devoted to separate subjects may be misleading, as for example, subjects 2a and 2b, which, if precisely tabulated, would include some time tabulated under subject 3.

In further explanation of the thoroughness of the instruction, under subject 3c a grounding is given in the code to develop a speed in sending or receiving of five to seven words per minute; subject 3d covers actual performance of the duties of quartermasters at sea; subject 3e covers the duties of junior watch officer while engaged in R.A.R. hydrography as well as in running to and from port; subject 5d (), Months Accounts, is to be initiated soon; under subject 6 every effort has been made to obtain practical experience; subjects 8, 9 and 10 depend to a large extent upon the activities of the ship's party.

Practical experience in the training of officers has averaged from 60 to 70 per cent for the officers who have completed the course.

REPORTS OF OCCUPATION IN THE TRAINING SECTION

COAST AND GEODETIC SURVEY

NAME _____

PERIOD OF INSTRUCTION From _____ to _____

DATE OF COMPLETION OF COURSE OF INSTRUCTION _____

Note: Time devoted to different subjects is tabulated in days, assuming an 8-hour day and a 45-hour week. Actual hours of occupation per day will approximate 10 hours; one to two hours per day are devoted to work which has not been included below, such as writing logs, evening study assignments, etc. A number of subjects of lesser importance have not been tabulated. Practical and theoretical experience are tabulated separately; P - practical, T - theoretical. A chock mark indicates that the subject has been covered.

P T

1. SHIP ETIQUETTE . . . . . .

2. NAVIGATION AND PILOTING

(a) ( ) Dead Reckoning - ( ) lay out Courses - ( ) Middle Lat. & Mercator Sailing . . . . . .

(b) ( ) Charts - ( ) Aids to Navigation - ( ) Coast Pilots - ( ) Light & Buoy Lists - ( ) Notices to Mariners

(c) ( ) Compass, log, lead - ( ) Compass Dev. & Var. ( ) Box the Compass - ( ) Compute Ships Swing . . . . . .

(d) Compass Compensation . . . . . .

(e) Bowditch Epitome . . . . . .

(f) Astronomical Definitions . . . . . .

(g) ( ) Mirc St. Hilairo for Sumner Line - ( ) Azim. of Sun or Star - ( ) Meridian Altitude - ( ) Ex Meridian Altitude - ( ) Time Sight & Long. Factor - ( ) Weems ( ) Star Identification - ( ) Transit of sun or star ( ) Moon Sights - ( ) Duttons Navigation . . . . . .

(k) Miscellaneous ( ) Piloting - ( ) Chronometers ( ) Noon Positions, etc. . . . . .

TOTAL . . . . . .

3. BRIDGE WATCHES

(a) Rules of the Road . . . . . .

(b) International Code Flags . . . . . .

(c) Wireless Code and Blinker . . . . . .

(d) Quartermaster Sea Watches . . . . . .

(e) Junior Watch Officer . . . . . .

(g) Miscellaneous ( ) Beaufort Scale - ( ) Weather and Clouds - ( ) Fog, passing ships - ( ) Emergencies, man overboard - ( ) Handling Telegraph - ( ) Dipping Colors ( ) Lookouts, rounds of the ship - ( ) Night & Morning

P T

Order Books - ( ) Turning over a Watch - ( ) Relieving a Watch - ( ) When to call C. O. -.( ) Steamboat Inspection Service, etc. . . . . .

TOTAL . . . . . .

4. OFFICER OF THE DECK WATCHES

(a) Junior O.D. in port . . . . . .

(b) Quartermaster Watches in port . . . . . .

(d) Miscellaneous ( ) Test Telegraph, whistle and steering gear - ( ) Log Books, smooth and rough - ( ) Q.M. Instructions - ( ) Receiving Supplies - ( ) Mooring Lines - ( ) Rounds of the Ship - ( ) Liberty Book - ( ) Duties of the ship's complement - ( ) Ship Routine ( ) Muster & Inspection - ( ) Holding Mast for Offenses - ( ) Watch and Station Bills - ( ) Making Colors . . . . . .

TOTAL . . . . . .

5. ACCOUNTS AND REPORTS

(a) Purchases ashore . . . . . .

(b) Letter writing . . . . . .

(c) Different Forms . . . . . .

(d) ( ) Months Accounts - ( ) Monthly Journal .....

(f) ( ) Miscellaneous - ( ) Inventories . . . . . .

TOTAL . . . . . .

6. SEAMANSHIP

(a) Nautical Terms and Parts of a Ship . . . . . .

(b) Make a Sea-bag . . . . . .

(c) ( ) Rope, knots & splices - ( ) Make a fender - ( ) Stoppers, straps, etc . . . . . .

(d) Ship Chandlery . . . . . .

(e) Pulling a boat . . . . . .

(f) Sailing a boat . . . . . .

(g) Handling a launch, bells . . . . . .

(h) Marking Leadling . . . . . .

(j) Heaving a Lead . . . . . .

(k) Inspect ( ) Freighter ( ) Passenger Ship ( ) Naval Ship ( ) Sailing Ship . . . . . .

(l) ( ) Inspect Shipyard - ( ) Ship Repairs .....

(m) Wheel and Lookout Watches . . . . . .

(n) Various Duties of Seamen () Hoisting and Lowering boats - ( ) Handling Lines - ( ) Painting and Ship Maintenance, etc. . . . . .

(p) Reisenbergs Seamanship . . . . . .

(q) Knights Seamanship . . . . . .

(s) Miscellaneous ( ) Blocks and Tackles - ( ) Landing in Surf - ( ) Steering & Steering Orders....

TOTAL . . . . . .

7. MISCELLANEOUS P T

(a) Engineroom Watches . . . . . .
(b) Run Gas Engine . . . . . .
(c) Publication No. 23 . . . . . .
(d) Traditions and History . . . . . .
(e) Regulations . . . . . .
(f) W. R. Mess Treasurer . . . . . .
(g)Clothing & Snail Stores . . . . . .
(h) Miscellaneous - ( ) Leadership - ( ) Ship Med. Chest - ( ) Reading - ( ) Other Services . . . . . .
TOTAL . . . . . .

8. HYDROGRAPHY

(a) Use and Adjustment of Sextant . . . . . .
(b) Left Angle . . . . . .
(c) Recording . . . . . .
(d) Fathometer . . . . . .
(e) Smooth Sheets . . . . . .
(f) R.A.R. . . . . .
(g) Hydrographic Manual . . . . . .

(j) Miscellaneous - ( ) Methods of Sounding - ( ) Bottom Characteristics, etc. . . . . .
TOTAL . . . . . .

9. TOPOGRAPHY

(a) Projections . . . . . .
(b) Signal Building . . . . . .
(c) Use of Plane-table . . . . . .
(d) Topographic Manual . . . . . .
(e) Smooth Sheets . . . . . .

(g) Miscellaneous . . . . . .
TOTAL . . . . . .

10. TRIANGULATION

(a) Mark & Describe Stations . . . . . .
(b) Signal Building . . . . . .
(e) Use of Instruments . . . . . .
(d) Triangulation Computation . . . . . .
(e) Triangulation Manual - Sources of Error - Sum Angles . . . . . .
(f) Miscellaneous . . . . . .
TOTAL . . . . . .

11. TIDES AND CURRENTS

(a) Inspect Tide Station . . . . . .
(b) Tide Manual - Tide Tables . . . . . .
(c) Current Manual - Current Tables . . . . . .
(d) Current Observations . . . . . .
TOTAL . . . . . .

12. MAGNETISM & SEISMOLOGY

(a) Declinometer Observations . . . . . .
GRAND TOTAL . . . .

HYDROGRAPHY

NOTES OF BUOY CONTROL FOE OFFSHORE SURVEYS

Lieut. Comdr. K. T. Adams, U. S. C. & G. Survey

I. FOR THE SURVEY OF A L0NG NARROW SHOAL BY THREE POINT FIXES ON BUOYS.

(a) Plant buoys about five nautical miles apart.

(b) Keep buoys as nearly as possible in the middle of the shoal and in a straight line.

(c) Use car-couplers for anchors and counter weights.

(d) With car-coupler anchors use one and one-half times the depth for total length of anchor chain and wire. Use wire a trifle more than the depth and chain a trifle less than one-half the depth. With any other type of anchor use more nearly two times the depth.

(e) Get distance between buoys by a double ship run, streaming two well rated logs from bridge. (See Borden's buoy control method).

(f) For azimuth, get two buoys exactly in range early in morning or late in afternoon. Observe inclined angle from one limb or sun to the two buoys in range, observe vertical angle to sun, mark time. Compute by formulae, paragraph 352 and 361, Bowditch, edition of 1925. I also believe the cosine formulae (Spherical Astronomy) can be used for reduction of the inclined angle to the horizontal.

(g) It is sometimes advisable to measure the azimuth by bearings with ship's compass to use temporarily.

(h) The normal expectancy of visibility from the upper bridge was eight and one-half miles. Buoys standing sixteen to eighteen feet above the water.

(i) Where buoys are not quite so far apart and where two other buoys can be seen from one, it helps, after they are planted, to measure the small horizontal angle between the distant buoys, when you are at the third one with the ship. You must be almost exactly at the buoy.

(j) Too much emphasis can not be put on getting the azimuth correct, as this is what eliminates jumps when you are near the row of buoys.

(k) Two methods of running lines are: First, run all lines parallel to the row of buoys. Second, run all lines perpendicular to and through the row of buoys. Each has its advantages and disadvantages .

(l) If you are going to run parallel lines, then sound when locating the buoys. The parallel sounding lines close to the row of buoys can be run by using three officers and splitting the big angle on a cloud. This gives strong azimuth of the sounding line and weak distance.

(m) In general, all angles were taken from upper bridge and the plotting was done in the pilot house. However, a table was erected on the upper bridge and used in calm weather. The personnel was: One officer at Fathometer, one officer in charge (taking right angle) one officer taking left angle and one recorder. At times the officer at the Fathometer can also record, but it was found that he could not take left angle. At times, two officers taking angles are needed in addition to the officer plotting.

(n) Three point fix work was done on these buoys exactly as on shore objects.

(o) Off the edge of the shoal dead reckoning loops were run from a three-point fix out, across and back to a fix. No sights were used. These loops were usually short. The thing to be emphasized is accurate dead reckoning and steering. Ship must be on final course with logs normal before taking departure fix.

(p) Same record was used for dead reckoning loops, going right from three-point fix work into dead reckoning work.

(q) One thing is important: When locating buoys or when closing dead reckoning loops on a buoy, DO NOT pass too close to the buoy. You may set over a little and foul your log line. This happened to us more than once. In the officer's zeal to get close enough to get an accurate vertical angle, he gets too close and ruins the logs.

(r) Take vertical angles from the horizon down to the water line at the buoy. If angle is less than three degrees, take it from upper bridge. They are not to be relied on at a distance greater than one-third of a mile.

(s) A four-inch theodolite was erected on the upper bridge and used instead of a pelorus. It was much more accurate. Somewhat difficult to use, especially with the buoy abeam.

(t) Making carbon copies of the soundings is a great help. Thus the soundings can be inked in as the work progresses. This is done by using narrow strips of thin paper and narrow strips of carbon just wide enough to catch the position number, the time and the soundings.

(u) For both the vertical angles on this work and the HI on astronomical work, it was found advantageous to measure the height

of the bridge deck above the water (both sides, taking mean) just before leaving port and again just after return to port. After a few trips it was found that this height on the return was always the same for practical purposes. Thereafter on starting a trip an empirical table of HI's was made up for the whole trip and everyone used this (posted in wheelhouse). The bow rises much more rapidly for first week than thereafter.

(v) Test your pelorii in port and get an I. C. for each one.

(w) Recommend a "buoy" log book in which every move made in regard to buoys be logged. Including dates and hour in which each buoy was planted, when runs were made, a short description of buoy, when renewals, etc., are made. This should be on bridge at all times.

(x) Recommend same as above with regard to "logs".

(y) Recommend same as above with regard to "compasses".

II. FOR SURVEY OF A SMALL ISOLATED CIRCULAR SHOAL SPOT AND THE SLOPES OUTSIDE OF IT.

(a) Plant one buoy in or near the center of the shoal.

(b) Locate buoy by astronomical sights, ship at anchor near buoy. Buoy located from ship by a bearing and vertical angle.

(c) Run radial dead reckoning loops away from and towards buoy, closing each loop on a vertical angle and bearing close to buoy.

(d) Take bearings with theodolite as long as buoy is visible (See "Wrinkles in Field Work").

(e) Eliminate as many changes of course as possible.

III. ALL DEAD RECKONING LOOPS.

(a) Accurate dead reckoning depends on many things, as follows: Accurate ship swings, accurate log factors, good steering, good recording, and last, but not least, an officer who is on the job <u>all</u> the time.

(b) Take positions six or seven minutes apart. Read both logs and time accurately.

(c) In making turns, ignore log loss on less than fifteen degree turns; on more than that get time accurately of putting helm over and time on course; then about two or three minutes later, when logs are normal, take a position. For this interval, from the change of course to logs normal, the distance must be computed by time. The logs can not be used.

(d) In taking bearings, a man must read standard compass at the mark, record this as ship's head. Take bearings a few seconds early or late when ship is steady rather than exactly on the position. If more than fifteen seconds late, record it at exact time of mark.

(e) The Officer of the Deck must keep up Abstract, This is generally done by the Junior Officer. Senior Officer must keep dead reckoning plotted. Fathometer officer figures all azimuths. Senior Officer adjusts a loop which has been run while running the next loop.

(f) Always attempt to run actual laid out lines.

(g) Make table of log distances corrected for factor. This can be used much faster than a slide rule.

(h) It helps to know your steering compass well enough to use that rather than the standard compass. Use standard compass for long astronomically controlled dead reckoning, but not for short dead reckoning loops.

(i) Dead reckoning loops can be begun and ended either on a fix (three point) or at a buoy.

(j) Accuracy, Accuracy and More ACCURACY and SPEED are needed on the part of the officers. Vessel running full speed and dead reckoning lines short (say three-quarters of an hour), and perhaps ten or fifteen minutes across the end keeps the officers on the job all the time or they will run too far across the end or get engrossed on the sheet and forget to look for the buoy on approaching it.

(k) When ending a dead reckoning line on a fix, it is almost always necessary to have the best officer available to take angles, or two of them. Generally one officer can find one angle and pass the sextant to another officer to watch that angle while he hunts the other one. When buoys have been out of sight and you are approaching a fix, it is the most difficult part of the work to get that fix soon after all the buoys have become visible.

(l) Great care must be taken in hauling in and putting away log rotators.

(m) Never stop or slow down during a dead reckoning loop, in my opinion, this ruins it. In starting a dead reckoning loop at a buoy always start four or five minutes run back of the buoy, so that logs will be normal when you pass it.

(n) Adjust dead reckoning loops on time and to the bearings if the bearings look reasonable.

COMMENTS ON THE ABOVE
F. S. Bordon

The methods as given above by Lieut. Comdr. Adams were those employed by him on the survey of a large bank in the vicinity of Gardner Pinnacles, T. H., and resulted in an exceptionally well controlled survey. The type of buoy used is shown on an accompanying plate. Comments are made on his notes as follows:

(a) With the clear atmosphere generally experienced in the locality in which he was working and with the two-barrel type buoy employed, the spacing of five miles is no doubt the proper distance. However, in localities where hazy weather is the rule and with the single-barrel type of buoy, three miles has been found to be the most satisfactory spacing.

(b) Employment of the two-barrel type buoy, construction and planting of which apparently entails very little additional time and cost, would probably eliminate the necessity of using the second barrel ordinarily bent to the single barrel type buoy to provide additional buoyancy where strong currents are encountered.

(c) One of the most severe tests on the proper location of a line of signal buoys is to run sounding lines normal to and through the line. Unless the azimuths between adjacent buoys have been well determined and remain fairly constant, considerable jump will be experienced as the sounding vessel passes from the "large angle-small angle fix" on one side of the line of buoys to a similar fix (reversed) on the opposite side. Simultaneous measurements of the inclined angle between an astronomical body and two buoys in range furnishes the data for computing an accurate azimuth between the two buoys. This azimuth will remain fairly constant as the buoys swing with the current provided the buoys arc anchored with approximately the same scope.

(d) In reducing the inclined angle between an astronomical body and two buoys in range, the right spherical triangle formula, $\cos V_c = \frac{\cos V_o}{\cos h}$ (V_c = horizontal or computed angle, V_o = inclined angle and h the altitude), can be employed provided the inclined angle is measured to the point where the range cuts the horizon. If the inclined angle is measured to some point above or below the horizon having a measurable elevation angle, this angle should also be measured and the azimuth obtained by formula given in Bowditch, paragraph 361 (See formula furnished by Liout. G. R. Shelton, page 47).

(e) The Chernikeeff electric log installed on the OCEANOGRAPHER during the past summer was found a great convenience on this class of work. It eliminates the troublesome characteristics of patent logs indicated by Lieut. Comdr. Adams in paragraphs II q, III c, and III m. (See report on page 49).

(f) Some suggestions for further investigation and studies for further development and standardization of "Control for Offshore Shoals and Banks" are given below. It is known that certain of these have already been made, but up to the present time, reports have not become available.

(1) Table or tables showing the strength of sun azimuths for different values of inclined angles and altitudes; also the error in azimuth, resulting both from errors in the measurement of the angles and from the change in the azimuth of the sun. In other words, a table showing when and where sun azimuths can be accurately observed.

(2) The development of a small portable R.A.R. set that can be readily mounted in a whaleboat or launch for use in obtaining comparatively short distances between buoys rather than for obtaining long distances. (See "Wrinkles in Navigation No. V", page 58)

(3) The most practicable method of relating accurately the hydrophone of a floating station to one buoy and the bomb explosion to the second buoy.

(4) Investigations and studios indicated at the top of page 6 in this issue of the bulletin.

Two drum hydrographic floating signal

In 1928 several buoys were built for use at French Frigate Shoal and for use on the shoals in the vicinity of Nihoa Island. It was found that these buoys had a decidedly top-heavy tendency. One was used successfully which was made according to specifications from the Manual but the others laid over almost on their sides. To remedy this it would be necessary to shorten the center pole, which we did not wish to do for reasons of visibility, or to add more weight to the counterweight.

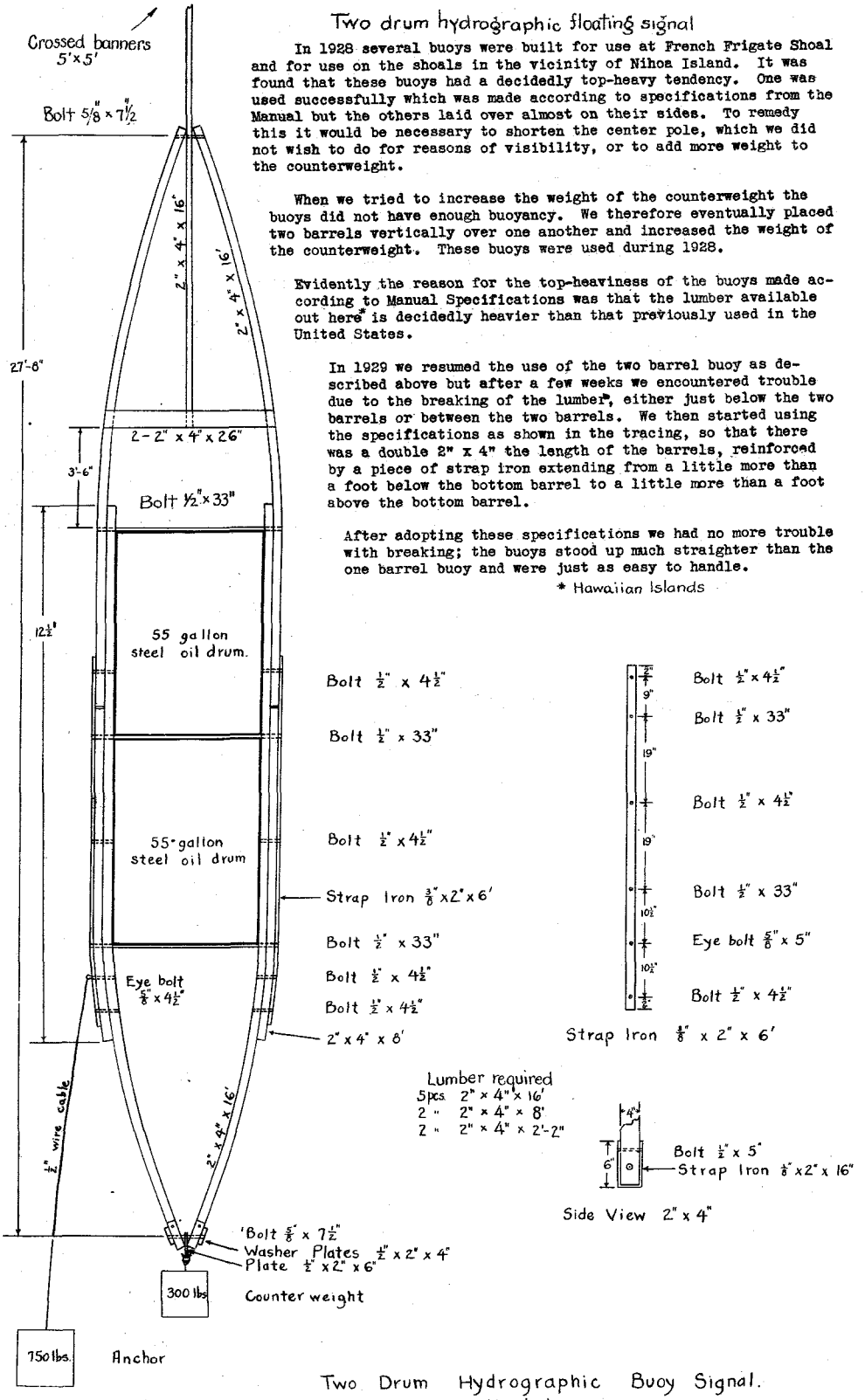
When we tried to increase the weight of the counterweight the buoys did not have enough buoyancy. We therefore eventually placed two barrels vertically over one another and increased the weight of the counterweight. These buoys were used during 1928.

Evidently the reason for the top-heaviness of the buoys made according to Manual Specifications was that the lumber available out here* is decidedly heavier than that previously used in the United States.

In 1929 we resumed the use of the two barrel buoy as described above but after a few weeks we encountered trouble due to the breaking of the lumber, either just below the two barrels or between the two barrels. We then started using the specifications as shown in the tracing, so that there was a double 2" x 4" the length of the barrels, reinforced by a piece of strap iron extending from a little more than a foot below the bottom barrel to a little more than a foot above the bottom barrel.

After adopting these specifications we had no more trouble with breaking; the buoys stood up much straighter than the one barrel buoy and were just as easy to handle.

* Hawaiian Islands



Two Drum Hydrographic Buoy Signal.
Used by
U. S. C. & G. S. S. GUIDE.
K. T. Adams, Commanding.
Hawaiian Waters.
1929.

(R71)

SUGGESTIONS, RECOMMENDATIONS, UNDEVELOPD IDEAS, ETC.

I. TOPOGRAPHIC INSTRUMENTS, EQUIPMENT AND METHODS

Lieut, (j.g.) B. G. Jones

Planetable tripod: The heavy tripod now in use is set convenient for working on a rocky or exposed coast where landings are often difficult and where the area possible for a set-up is often extremely limited. It is suggested that there be furnished for work on rocky coasts a lighter tripod with telescopic legs. On a firm foundation such as the rocky lodges found in most of Alaska, the light tripod would be steady. It would considerably lighten the work of the topographer when traveling over rugged ceast, when landing, or when climbing. The telescopic logs would make it much more convenient for setting up on small ledges where the space is very often extremely limited. With the tripod now in use it was often found impossible to center over important set-up points due to the space required for the spread of the tripod legs. The telescopic tripod legs would also make it possible for the topographer to set the table at a convenient height which in restricted places is not possible with the present tripod.

Alidade: It is suggested that the type of alidade now in use be fitted with a set of peep sights lined in along the upper surface of the telescope barrel and just to the right or left of the stride level. The sights to be so aligned as to give a line of sight parallel to the line of sight through the telescope. The sights to consist of a bead sight on the object end of the telescope and of a circular peep sight of about two millimeters in diameter on the eye piece end of the telescope. Such an arrangement of sights would be useful at any time when doing topography but would be particularly useful in wooded country when obtaining elevations for form lines by vertical angles. When sketching form lines it is very desirable to obtain elevations on the numerous small wooded knolls and humps which show against the background of higher hills. In wooded country it is very difficult to see the tops of such low hills through the talescope though they can be seen with the naked eye. With the sights suggested, such points could be located by intersections and approximate elevations obtained. During the last season, vertical angles were often taken on hills which could not be seen through the telescope by sighting over the top of the stride level. When the same objects could be seen through the telescope from some other station, vertical angles were ,taken by the usual methods. As a rule the two or more elevations obtained chocked within from five to thirty feet. This was done at the time merely as an experiment and is used to illustrate the possible use of the sights suggested. With properly aligned sights, it is thought that very good vertical angles could be obtained.

Sunshades: The sunshades now in use are not large enough in diameter to protect the planetable sheet from even light rain, one corner of the sheet is exposed and the only way to properly protect

the topographic sheet is to take it off the table entirely in even the lightest rain. A larger sunshade could be conveniently used in Alaska where it rains with very little effort and one is liable to be exposed to a number of light showers of short duration within any one or part of one working day.

FORM LINES.

Scale: The present method of sketching the form lines on the regular topographic sheets on scales of 1:20,000 and 1:10,000 has several very inconvenient features. The topographic sheets are laid out primarily to cover the shore line and not to cover the most important mountain ranges. Very often it is possible to sketch only the less important features near the shore while outstanding peaks and ridges which are important landmarks come just off the edge of the sheet. A scale of 1:10,000 and even 1:20,000 spreads the form lines over an area of paper so large that it is necessary to show an amount of detail not consistent with the number of elevations usually obtained. Form lines of an interval of 100 feet also require more detail than is consistent with the number of elevations usually obtained. Since the form lines are usually published on charts of a scale of 1:80,000 or smaller, it is thought that they could be sketched more efficiently and with the required accuracy on a scale of about 1:80,000. One sheet on a scale of 1:80,000 could be laid out especially for form lines and would cover probably all the area surveyed during a season of combined operations. Such a sheet would be laid out to cover all important features and would extend back from the coast far enough to reach the more important ranges so often missed on larger scales. The form lines sketched on a scale of 1:80,000 to an interval of 200 feet would show all detail important to the navigator. More elevations would be obtained per square inch of sheet and the sketching would be both simplified and better controlled. The smaller scale would be much more convenient to work on in the field.

Stream Lines: When sketching form lines, the stream lines should be shown. The stream lines can be sketched on the sheet by noting their relative position with regard to elevations obtained. Once the stream lines are sketched, they form a frame-work around which the ridges and valleys can be sketched. The sheet has a much more complete and natural appearance when the drainage or stream lines are clearly shown.

Elevations on Charts: Elevations on wooded hills are usually taken to the tops of trees and are accurately obtained. The heights of trees are estimated and this estimated height is subtracted from the elevation actually obtained to get the elevation of the ground. The elevation of the ground is given on the chart. The navigator using the chart must make his own estimate of the heights of trees and apply it to the elevation shown on his chart in order to obtain

the elevation of the highest point he can see, namely, the top of the highest tree. Two estimates are therefore applied and the original accuracy obtained, by the surveyor is largely destroyed. The heights of the trees will vary from perhaps twenty or thirty feet to one hundred and twenty-five feet. During the last season whenever a rift in the trees could be seen, a second vertical angle was taken as nearly as possible on the ground and the height of the trees thus computed. However, the ground could seldom be seen and heights of trees obtained in this manner are still only estimates. The only accurate elevation is the elevation obtained by vertical angles on the point actually visible, namely, the top of the highest tree. It is suggested that the elevation of the highest visible point be shown on the chart or that the elevation of the ground be shown and also just above it the estimated height of the trees be shown in parenthesis with a note on the chart explaining how to compute the actual elevation obtained by the surveyor.

II. CONTROL METHOD SUGGESTED ON COVER PAGE OF JUNE (1930) BULLETIN.

I would like to make a suggestion about the method indicated on the cover page of the June bulletin. Inasmuch as sun azimuths are not obtainable under many conditions, it is suggested that an azimuth marker buoy be introduced some three or four miles away from C. The azimuth from C to the ship while sounding can then be obtained by observing the angle at C between the azimuth marker buoy and the ship while sounding; the azimuth from C to the azimuth marker buoy to be obtained from the sun under various conditions of wind and tide.

Comdr. F. B. T. Siems.

In my opinion the employment of a reference azimuth buoy as suggested by Comdr. Siems would constitute a marked improvement in the method suggested. To avoid large corrections to the measured azimuth of the comparatively short line due to the buoy swinging with a scope different from that of the hydrophone station vessel, it would seem that the buoy should be anchored with a scope as nearly equal to that of the station as possible. If we assume that the buoy and vessel are anchored three miles apart and that a difference of 26 fathoms exists between the radius of the vessel's arc and that of the buoy, there could be a correction considerably larger than one degree. Assuming the current the same at the two stations and of sufficient strength to keep thorn both swinging in the same direction, this correction would be reduced to one-half degree, provided the sun azimuth were obtained when the current was setting along the bearing between the vessel and buoy. Knowing the actual scope of the vessel and that of the buoy, a table giving corrections for currents setting in any direction could be prepared and it is unlikely that the bearing furnished the sounding vessel would over be more than a few minutes in error.

The use of an azimuth buoy would fit nicely into the method as regards the coordination of the work performed by the parties on the two vessels. The radio dash, ordinarily sent to the hydrophone station at the time a bomb is dropped, could be used by that station to "mark" the angle between the azimuth buoy and the sounding vessel. The true bearing could undoubtedly be furnished to the sounding vessel by the time the chronograph tape had been scaled and the bomb distance had become available for plotting.

Lieut. Comdr. P. S. Borden,

III. CHARACTER OF THE BOTTOM - NEED OF STANDARDIZATION

L. M. Sobieralski.

In the designation of the character of the bottom, there is need of a classification, particularly for determining the differences between fine and coarse sand, between sand and gravel, gravel and pebbles, etc.

The following extract from a pamphlet by Pehr Olsson-Seffer, Ph.D., entitled "Genesis and Development of Sand Formations on Marine Coasts", may be of some assistance:

	"Diameter of grains in millimeters
"Fine dust or silt	0.02 -- 0.03
Medium dust or silt . . .	0.03 -- 0.05
Coarse dust or silt . . .	0.05 -- 0.1
Finest sand	0.1 -- 0.2
Fine sand	0.2 -- 0.3
Medium sand	0.3 -- 0.5
Coarse sand	0.5 -- 1
Grits	1 -- 2
Gravel	2 -- 4
Coarse gravel	4 -- 6
Pebbles	6 -- 10
Coarse pebbles	10 -- 20
Shingle	20 -- 50
Stones	50 -- 250
Boulders	250 -- Upwards

"The limit of the coarseness of sand grains is here considered as 0.2—0.1 mm. When the grains are finer than 0.05 mm., the soil has lost the physical properties of sand. It does not feel gritty to the fingers, and if it is dropped on a level and hard surface, the grains will not separate but congregate in small heaps. It needs several minutes to sink in water to the bottom of a test tube. When

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"1) The term soil is in this paper used in its broadest technical sense to designate, the loose material constituting the disintegrated superficial layers of the earth's surface.

over 0.05 mm., the soil has, however, more of the characteristics of real sand. It is then gritty, when pulverized between the fingers. If scattered dry, it will separate into grains conspicuous to the naked eye. When mixed with water in the test tube, it sinks rapidly, usually in less than one minute, and it is to a noticeable degree conductive of water. It is difficult in practice to draw the lower limit for sand of a certain coarseness, because the soil is more or less mixed. On account of the difference in specific gravity of the grains, many samples contain grains of different grades."

IV. TOPOGRAPHIC METHODS AND EQUIPMENT.

Extract from a letter from Lieut. Comdr. E. W. Eickelberg.

"Personally, I think there is room for improvement or change in methods and equipment for our topography.. This work is usually left to our younger officers, who are busy learning the methods at first and then are put on other work before they can make much constructive criticism. Especially do I think there is room for improvement in our paper. In that matter, I take the attitude that our methods and scale are wasted on paper which comes and goes like the present material. Smaller sheets mounted on aluminum are a better balance for the methods, scale and accuracy of control which we use. Poor quality of paper entirely annihilates the incentive for careful work of a topographer, and often what is actually good, careful and conscientious work appears otherwise on unequally distorted sheets."

(Why not have, for publication in subsequent bulletins, expressions of opinion and suggestions relative to this important subject from both the officers who have had considerable topographic experience and from the junior officers who are now obtaining this experience?)

V. TEE SPHERANT, AN INSTRUMENT FOR OBSERVING HOUR ANGLE OR LATITUDE DIRECTLY.

Howard B. Easter.

(From "Science" - Paper read at a meeting of the National Academy of Sciences, Pacific Coast)

"The instrument described in this paper and exhibited at the meeting has been under development at the University of California for several years. It breaks the old tradition that a navigator, in order to find his position, must measure an altitude and then solve a spherical triangle. The instrument gives directly either hour angle or latitude. The observed hour angle, combined with the proper Greenwich hour angle from a watch or chronometer, yields the longitude. Usually such latitudes and longitudes are not independent but lie along a Sumner line, as in the case of reduced sextant observations. The advantage lies in the elimination of practically all computation or use of tables. The instrument has the same weight as the average sextant, and with the same amount of practice, is as easily handled. It is called a spherant."

DATA FOR STUDYING THE TRANSMISSION OF SOUND THROUGH SEA WATER.

A. L. Shalowitz, Cartographic Engineer, U. S. C. & G. Survey.

(The report covering the study being made by Mr. A. L. Shalowitz, Cartographic Engineer, on "The Transmission of Sound Through Sea Water" is not available, in its entirety, at this time. He has, however, made a special effort to give us for this issue of the bulletin that portion of it which will be of immediate interest to our field officers. References to his studies have been made in preceding articles. What he here presents clearly shows us what is needed in the way of additional field data as well as the way in which these data should be tabulated, studied and submitted in order to achieve maximum coordination of the efforts of the "field and office" in the solution of this much discussed and perplexing problem. It will be noted that in computing theoretical velocities he has used British Admiralty Tables, H.D. 282, which are particularly well adapted for this purpose.)

Recommendations

It should be quite evident that further experimental work is necessary in the field before any final deductions are made in the office. In the study that has been made so far, approximations and assumptions frequently had to be resorted to. One outstanding fact has been the lack of physical data taken simultaneously with the velocity tests. This is not intended as a criticism for it is fully realized that such data were until now regarded as of secondary importance, since in all our radio acoustic work on the west coast it has been possible to obtain experimental velocity determinations to be used over the entire field of work. Theoretical velocities were unnecessary and the path of the sound wave was unimportant. But if we are to determine the path of the wave actually or empirically, we must have a complete picture of the physical conditions that the sound energy passes through from the bomb to the hydrophone. When a velocity test is made, serial temperatures should be taken simultaneously at the point where the bomb is exploded and at several points along the line from the bomb to each hydrophone. Two or three velocity tests should be made at the same spot in order to eliminate accidental errors. Every precaution should be exercised in accurately determining the distances from bomb to hydrophone. They should either be computed by the three-point method or the points should be plotted on an aluminum plate to avoid errors of distortion. Nor should the salinity data be overlooked. This affects the velocity of sound to the extent of 1 meter per second for every part per thousand, and when it is remembered that in one season on the west coast the salinity varied from 29 to 34 parts per thousand, the effect on the theoretical velocity is at once apparent.

Further data are also required in deep water. If it should finally be established that bottom temperatures are the controlling

factors in the velocity of sound in moderate depths, it will be necessary to determine at what depth the temperature element is overcome by other factors. If there is a depth at which the conductivity of the water ceases to increase, due, perhaps, to the small temperature gradient, the effective sound wave would travel along the layer of practical maximum conductivity. Such depths might be capable of determination in the field, if suitable conditions could be obtained.

Another line of experimental data that is desirable is to determine at what distance from the hydrophone the surface wave ceases to be the effective one and gives way to the bottom wave. It is my belief that if the bottom layer of water is the best conducting medium, it will not be apparent over short distances on account of the increased velocity of the surface wave, but should become increasingly apparent as the distance from the hydrophone increases. This can be established by a series of accurate tests beginning about five miles from shore and extending to a point offshore where the experimental velocity is at considerable variance with the theoretical velocity based on surface temperatures.

And just as important as the collection of the necessary field data is the recording of such data in a usable form. Some standard method should be adopted for submitting such information to the office, as the successful study of sound transmission in general will depend not only upon the completeness of the field data, but upon the availability of the material as well.

And to this end, I suggest that all the data be embodied in a report entitled "Special Report on the Transmission of Sound Through Sea Water" covering the entire season's work. This report should be properly referenced in all the descriptive reports of the various sheets affected to enable the reviewer of a particular sheet to refer to it if necessary. The report should include the following data:

1. A list of the bomb positions where velocity tests were made, giving the date, the sheet number, the position number, the three-point fixes, the time intervals, the scaled distances to the hydrophone stations and the computed velocities.

2. A list of the serial temperatures and salinities taken during the season, giving the dates, the sheet and position numbers.

3. A table of mean temperatures for various depths from bomb to hydrophone as required for the abstract given below.

4. Computations of theoretical velocities (See example below) at each experimental position or group of positions giving the velocity based on surface temperatures, the velocity based on bottom temperatures from bomb to hydrophone, and velocity based on the mean temperature for the entire vertical section from bomb to hydrophone.

Example of Computation of Theoretical Velocity.

Group 14 and 15 X (H. 4969) - Shelikof Strait - July 30, 1929.
To station KVJ - Test in 140 fathoms.
Experimental velocity = 1466.03.

Bottom depths from bomb to hydrophone = (130 fms. for 1/2 distance
(110 " " 1/3 "
(60 " " 1/6 "

Temperature at Surface = 12.1° (From Curve for month)
" " 60 fms. = 6.0° (From Serial temp. July 26)
" " 110 " = 5.3° (" " " " ")
" " 130 " = 5.0° (" Curve for month)

Salinity = 30.5
Velocity at Surface = 1488.9

Bottom Velocity

Velocity at 5.0° = 1465.9) Corrected for
" " 5.3° = 1466.5) salinity and
" " 6.0° = 1467.5) for pressure
at the respective depths

Mean bottom velocity = 1466.4 (Weighted in 3-2-1 ratio)

Mid-Section Velocity

Mean temp. at 60 fms. = 7.9°
" " " 110 " = 6.8°
" " " 130 " = 6.5°
Mean temp. bomb to hyd. = 6.8°
Mean depth bomb to hyd. = 56 fms.
Mean velocity = 1470.7

Summary

Experimental velocity = 1466.03
Surface velocity = 1488.9
Bottom velocity = 1466.4
Mean velocity
(surface to bottom) = 1470.7

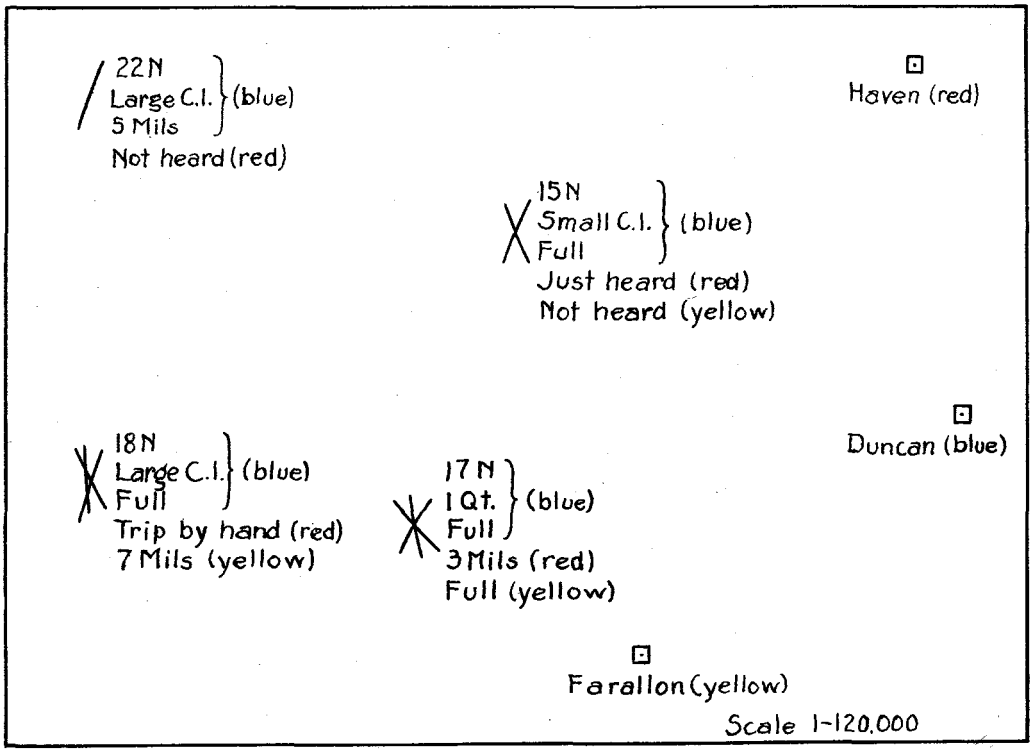
5. An abstract of velocities (see suggested form on the following page) giving the experimental velocity and the theoretical velocities at the surface, bottom and mid-section.

COMPARISON OF VELOCITIES AT VARIOUS DEPTHS
Project No. 60 - R. R. Lukens - Gulf of Alaska - 1928

Sheet and Position Numbers	Experimental velocity (Meters per sec.)	Theoretical Velocities (Based on B.A.Tables 2, 3, and 4) For temperatures from bomb to hydrophone in degrees centigrade			Remarks
		Surface	Bottom	Mean (surf. to bottom)	
Field No.4 (H-4856) Pos. 57-C		12	5.8-6.l-6.7	8.7	To station KGHM Test in 80 fms. Salinity 31
	1469.8	1489.1	1469.7	1478.3	
Pos. 1-V		10	6.0-7.2	8.4	To station KGHM Test in 55 fms. Salinity 30.5
	1467.4	1481.9	1470.5	1477.5	
Field No.6 (H-4969) Pos.14&15-X		12.1	6.0-5.3-5.0	6.8	To station KVJ Test in 140 fms. Salinity 30.5
	1466.03	1488.9	1466.4	1470.7	

In addition to the above, each hydrographic smooth sheet should be accompanied by an overlay tracing showing all the bomb positions and giving at each position information as to the size of the bomb and the milliammeter reading at each hydrophone station. The distance arc at each position and the notations should correspond in color to the color used for the particular hydrophone station.

An example of what is intended is herewith given:



RECORD OF BOMB RETURNS
To accompany sheet No.____

Conclusion

In conclusion, I wish to state that whatever the merits or demerits of the tentatively proposed theory of the path of sound may be, this investigation has served to accomplish the following:

(a) The establishment of a basis for determining a velocity of sound to be used on Georges Bank, without which the work of plotting the smooth sheets would have been deferred for at least another year in the hope that a successful method would be developed for making velocity tests on the bank proper.

(b) The definite disproval of the theory, accepted to some extent, that horizontal transmission of sound in sea water is effected by a surface wave, or a close to the surface wave, being propagated from bomb to hydrophone.

(c) The advancement of considerable evidence that the sound wave that reaches the hydrophone is one that corresponds in velocity to the theoretical velocity that would be obtained by using the mean temperature of the bottom layer of water in a vertical section from bomb to hydrophone.

(d) A proper appreciation of the value and importance of bottom temperatures, particularly in an area where experimental velocity determinations are not practicable.

(e) A basis for further study both in the field and in the office looking toward a solution of the many perplexing problems of sound velocity and sound propagation in sea water.

Further than this, I do not believe we are justified in going at present. The time is not yet ripe for publishing the results to the world. Further corroborating evidence is necessary. More intensive study is desirable. The information obtained should, however, be made available to all parties engaged in R.A.R. work who, through their personal observations and experiences, are, or might be, in a position to throw valuable light on this phase of our work.

The writer will welcome any comments or criticisms from others who have given this matter thought and to whose notice this report may come.

GENERAL AND PERSONAL

From Boston Field Station, R. F. Luce, Inspector.

This office has distributed to date quite a large number of copies of the advance sheet showing the vicinity of the recently discovered submarine valley on Georges Bank. Many of these were given out to callers who had heard about this valley from the newspaper articles which have appeared in local papers. More, however, were sent out to seismologists and geologists in this locality, and to various fish companies, shipping concerns, and others interested in the matter.

Extremely favorable comment was received regarding this sheet, especially, on the part of shipping interests, concerning the rapidity with which it was issued after the close of the season's work. The greatest interest of all, however, was shown by the scientists, a number of whom have either written or called to express appreciation or to get additional information — and in several cases to suggest names of other scientists whom they would like to see get copies.

The Submarine Signal Company is especially interested in it and is sending copies to all fishing vessels equipped with Fathometers, with a note emphasizing its importance.

Deep Water Anchoring

The following extract was taken from a letter received by E. W. Eickelberg from Lieut. Fr. Vogt, who came to the SURVEYOR and EXPLORER from the Norwegian Hydrographic Service as an observer. Many of our officers became acquainted with him and will undoubtedly be glad to hear what he is doing.

"Last year I went to Bear Island and Spitzbergen in the Arctic Sea on a hydrographic expedition to sound out some new fishing grounds. It was very interesting, and we saw a lot of big ice.

"This summer has taken me to a more southern part of the world. I am in command of the 'Armaner Hansen', a two-masted auxiliary schooner of 57 tons, 12 men all told. In this number are included two professors doing oceanographic research work, especially deep sea current measurements. We left Bergen, Norway, on May 25th and have called at Plymouth, England; Lisbon, Portugal; Casablanca, Morocco, and Las Palmas, Canary Islands.

"We anchor at successive stations in great depths; the present station is our deepest — 4,000 meters. We use five bell-shaped anchors on a fifty meter anchor chain, which is again connected to a long 10 mm. wire of special strength. It has been a very interesting trip so far, both from the point of a navigator as well as a hydrographic officer.

"Our next call is at Madeira; from there we shall proceed to the Azores and homeward. Last summer was rather cold, but this summer has sometimes made me wish I had a little of all the ice we experienced last year."

"Lying at anchor 70 nautical miles north of Tenorife, Canary Islands, in 4,000 m depth."

Fr. Vogt, Hydrograf,
Norges Sjokartverk,
Oslo, Norway.

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The Director,
U. S. Coast & Geodetic Survey,
Washington, D. C.

July 2, 1930.

Dear Sir:

Mr. M. B. Ireland of this company has just returned to the office from field assignment, a few days of which were spent with Lieut. John Bowie in the vicinity of Washington, Indiana, as observer with his level party.

We feel from talking with Mr. Ireland and from reading his report relative to this assignment that the time was very well spent. He was able to secure several ideas that will enable him to handle such work more easily than would otherwise have been possible and to secure some actual experience in the work under Lieut. Bowie's instruction.

We wish to thank you for making this short assignment possible and to express to Lieut. Bowie our great appreciation for his kindness in the matter.

Very truly yours,
Brock & Weymouth, Inc.
By: T. P. Pendleton

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From a Port Pierce, Florida, Paper.

Port Pierce people will regret to see the U. S. Coast and Geodetic Survey boats Hanger and Natoma leave here. During their half-year's stay here the officers and men of these two boats have made many friends, and by their faultless conduct have impressed the community as men of high type and standing. The best wishes of the people of the city will follow them to their new assignments.

Promotion of Engineering Education.

For a number of years the Association has had a membership in the Society for the Promotion of Engineering Education and the executive committee has selected Captain N. H. Heck to hold the membership. The Monthly Journal of Engineering Education is re-

ceived regularly. Members of the Association may be interested in some of the articles and they will be briefly listed hereafter. Anyone writing the secretary may receive the number containing the article, with the understanding, however, that he will return it after a reasonable time or send it on to some other member if requested by the secretary to do so.

Feature article in the October, 1930, issue - "Can the Engineering Student be Taught to Manage Men?" by Prof. Elliott Dunlap Smith of Yale University.

Feature article in the November, 1930, issue - "History of the Development of Graphical Representation" by Prof. F. G. Higbee, State University of Iowa.

Captain N. H. Heck has available a number of reprints of the following articles: "Terrestrial Magnetism from the Viewpoint of the Engineer" and "Earthquakes, a Challenge to Science". Both are discussions in popular style of matters closely related to the Bureau's work in these subjects. He is willing to send copies to members of the field force interested as long as the supply lasts.

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News Notes from the Guide

The Director inspected the GUIDE at Aberdeen on July 26 and 27, and all of the officers were very pleased to meet him or to renew acquaintance with him in his new capacity as Director.

Professor J. S. Dodds of Iowa State College was a guest of the Coast Survey on board the Ship GUIDE from August 11 to 14, familiarizing himself with the newer methods of echo sounding and radio acoustic ranging control.

Announcements

Mr. and Mrs. Michael Kane announce the marriage of their daughter, Marcie, to Edwin C. Baum on Tuesday, September the ninth, nineteen hundred and thirty, Bel Air, Maryland.

Lieut, and Mrs. 2. J. Brown announce the arrival on September 10, 1930, at Washington, D. C., of a daughter, Barbara Ann Brown, weight 8 pounds, 12 ounces.

Mr. Charles Henry Gravelle announces the marriage of his daughter Florence Isabelle, to Mr. Henry James Healy on Tuesday, October seventh, nineteen hundred and thirty, Moorhead, Minnesota.

Mr, and Mrs. Charles Diment announce the marriage of their daughter, Margaret Muriel, to William Francis Malnate at Arlington,

Massachusetts, on Thursday, October sixteen, nineteen hundred and thirty.

Mr. and Mrs. John E. Milan announce the marriage of their daughter, Margaret Lee, to Robert Francis Studds, Lieut. U. S. Coast and Geodetic Survey, on Saturday, October the eighteenth, nineteen hundred and thirty, Norfolk, Virginia.

Mr. and Mrs. Charles Armstrong Schanck announce the arrival on October 23, 1930, of a daughter, Julia Schanck.

Mr. and Mrs. Amel Edward Rust announce the marriage of their daughter, Mary Bernice, to Mr. John Bowie, Jr., on Saturday, the fifteenth of November, nineteen hundred and thirty, Detroit, Michigan.

Mr. and Mrs. Paul Byrd Moore announce the marriage of their daughter, Margaret Stephens, to Mr. James Dennis Thurmond on Saturday, the twenty-second of November, nineteen hundred and thirty, Saint Louis, Missouri.

It is reported that L. W. Swanson has joined the ranks, but no further information is available.

It was with profound regret that we learned of the death of Chief Engineer Harry Ely, who retired from active service August 31, 1930. Although his health had been failing for some time, it was thought that rest after retirement might promote recovery. His sudden death in Baltimore, Maryland, on September 7 was a great shock to his many friends. The Association extends deep sympathy to Mrs. Ely in her bereavement.

The Association extends deepest sympathy to Commander Engle in the death of his wife, which occurred in Washington on November 22.

The news has reached us of the death of Mrs. Herman Odessey on Sunday, November 16. The Association extends deepest sympathy to Lieut. Odessey.

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EXTRACTS FROM "MESSAGE OF THE PRESIDENT OF THE UNITED STATES TRANSMITTING THE BUDGET FOR THE FISCAL YEAR ENDING JUNE 30, 1932"

Pay and Allowances, Commissioned Officers, Coast and Geodetic Survey:

Pay, commissioned officers: For pay and allowances prescribed by law for commissioned officers on sea duty and other duty holding relative rank with officers of the Navy, including one director with

relative rank of captain, six hydrographic and geodetic engineers with relative rank of captain, eleven hydrographic and geodetic engineers with relative rank of commander, twenty hydrographic and geodetic engineers with relative rank of lieutenant commander, fifty-four hydrographic and geodetic engineers with relative rank of lieutenant, fifty junior hydrographic and geodetic engineers with relative rank of lieutenant (junior grade), twenty-nine aids with relative rank of ensign, and including officers retired in accordance with existing law $665,371.

Repairs of Vessels, Coast Survey:

Vessels: For repairs of vessels, including traveling expenses of persons inspecting the repairs and exclusive of engineers' supplies and other ship chandlery, $143,000, of which amount not to exceed $52,000 is to be used for extraordinary repairs to the Ships GUIDE, PATHFINDER and PIONEER.

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THE ASSOCIATION

Financial Statement for the Period Dec. 10, 1929, to Dec. 6, 1930.

Receipts		Expenditures		
Dec. 10, 1929 - Balance as reported in December (1929) Bulletin	$254.99	Ceremonies in connection with launching Ship HYDROGRAPHER		$116.20
		Stencils, Dec. (1929) bulletin		4.50
Dues, 100 officers @ $3.00	300.00	Flowers:		
		J. F. Pratt	15.00	
Interest	2.19	W. B. Fairfield	15.92	
		Harry Ely	15.30	46.22
		June (1930) Bulletin		
		Rotaprints (plates)	7.96	
		Paper	10.00	
		Drawings	12.00	
		Stencils	15.00	
		Printing	11.00	
		Binding	16.45	72.41
		Postage		3.00
		S.P.E.E. dues		5.00
		Congressional Record		4.00
		Dec. (1930) Bulletin		
		Paper	15.00	
		Printing	10.00	
		Rotaprints (plates)	36.27	61.27
		Balance, Dec. 6, 1930		244.58
	557.18			557.18

Analysis of Balance Union Trust Co.	
Savings account	$162.59
Checking account	81.99
Total	244.58

Washington, D. C., December 6, 1930 - We, the undersigned, certify that we have examined the accounts of the Association of field Engineers for the period since the last audit and that the statement as given is correct. The records are in agreement with the above statement of account showing a balance on hand December 6, 1930, of $244.58.

Henry E. Finnegan
Marshall H. Reese.

Additional outstanding bills, mainly in connection with this issue of the bulletin (300 copies), are estimated at $85.00.

At a recent meeting of the Executive Committee of the Association, it was voted to reduce the dues for the year 1931 from $3.00 to $2.00.

O O O

Commander Seran, who represents the Bureau on the Interdepartmental Pay-Personnel Board, has furnished us with the following:

"The report of the Interdepartmental Pay-Personnel Board, in accordance with the request of the Congressional Joint Pay Committee, was forwarded by the Chairman of the Board to the Comptroller General on November 1 and was forwarded by him to Senator Reed and Representative French on November 15.

"As the Congressional Committee has requested that all information in regard to the report and the comments of the Comptroller General thereon be held confidential until released by the Committee, none of the details can be broadcasted as yet.

"A matter of interest in connection with possible action by the Congressional Committee was the resignation of Representative French from one of the minor House committees within a day or so after Congress convened. He gave as the reason for his resignation from the minor committee the heavy work that would be required of him in connection with the Joint Pay Committee.

"On the other hand, the House has already approved a provision in the Treasury-Post Office Department appropriation bill which prevents any promotions within the grade during the fiscal year 1932 of Civil Service employees, and the Chairman of the House Appropriation Committee has indicated the intention of that Committee of including a similar provision in each of the appropriation bills. The Interior Department bill, which has just been reported to the House at the date of this writing, has the provision.

"As to the prospects for pay-personnel legislation, it seems that one man's opinion is about as good as another's. I have been optimistic all the time that some legislation would be enacted, but

I may be over confident. The Secretary of the Navy in his annual report mentions the importance of increased service pay and the retiring Chief of Staff of the Array in his final report also mentions the importance of an increase. However, the President in his message to Congress made the statement that the Army and Navy officers were efficient and contented, which, by inference, would minimize the necessity of pay legislation. So there you are."

THE EXECUTIVE COMMITTEE
WISHES
EACH MEMBER OF THE ASSOCIATION
AND ALL OTHERS RECEIVING THIS BULLETIN
A MERRY XMAS
AND A
HAPPY NEW YEAR

"CAN YOU EQUAL IT"

I hereby claim to have built the tallest "tall signal" ever. built in the Coast Survey. See figure 26, Manual of Second and Third Order Triangulation and Traverse. Signal built on the east end of Mantangule Island, P. I. Except for its height, I am not at all proud of it.

K. T. Adams.

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During the summer of 1911, the officers of the Ship EXPLORER established what is thought to be a record in "high visibility".

The vessel was crossing the Gulf of Alaska from Dixon Entrance to the Shumagin Islands. At 7:30 P.M. on July 24th, after being at sea for thirty-six hours, a group of clear-cut snowclad peaks was observed to the northeastward.

Bearings on the peaks indicated that they could be none other than the Fairweather group, and the distance scaled about 330 miles.

The peaks were watched carefully for nearly 30 minutes and they gradually became sharper and more distinct until the fading twilight finally obliterated them. The altitude of the highest peak as measured by the sextant was 0° 07 .

Under ordinary circumstances, the mountains would have been visible only 150 miles, but because of some abnormal refraction, we saw them at about twice their normal range of visibility.

E. R. Lukens.

I hereby claim to have surveyed the area farthest away from any land that has ever been surveyed in the Coast Survey: Survey of Erben Bank, 554 miles southwest of the Parallones Island, made by the Ship GUIDE in 1929.

E. T. Adams.

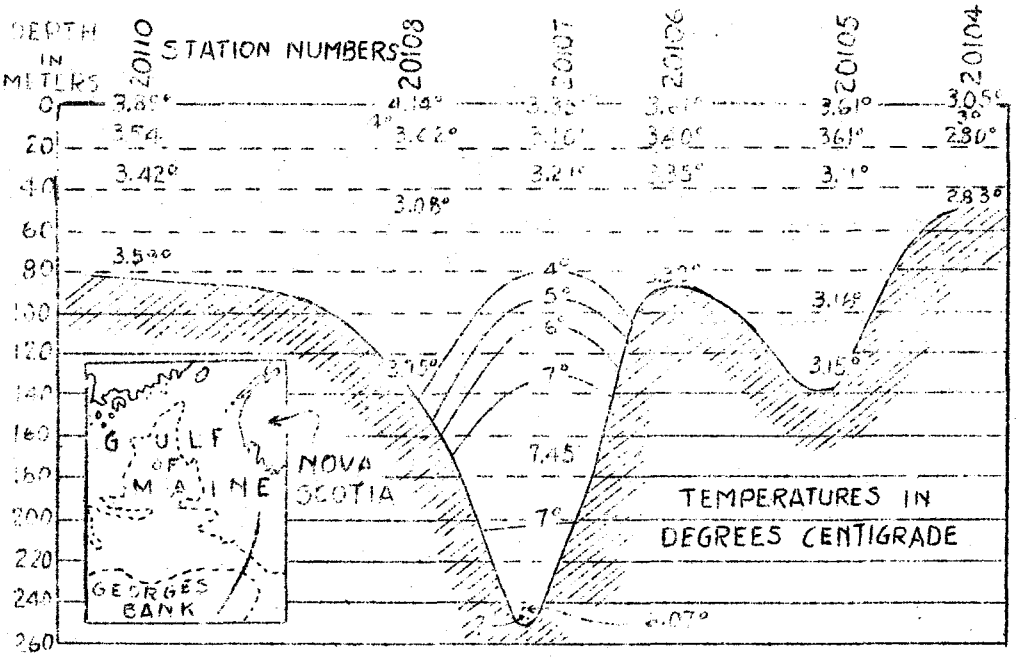
I claim to be the first, and probably the only, user of the longest leveling tripod on record. This tripod, with its legs folded together and with a precise level mounted on it, measured exactly seven feet from the bottom of the tripod to the center of the telescope.

The tripod was specially made in the Instrument Division for my use on first-order leveling, while I was engaged on that class of work in South Dakota, in 1925, and after the Chief of the Division of Geodesy, while inspecting my party, decided that the extra long tripod I was then using was just a foot too short.

Chas. M. Thomas.

We ordinarily think of water temperature as decreasing with the depth. How about the condition shown below? The sketch was taken from "Physical Oceanography of the Gulf of Maine" by Dr. H. B. Bigelow and shows a temperature profile running from the eastern part of Georges Bank across the Eastern Channel, Browns Bank and the Northern Channel for April 15 and 16, 1920. Other profiles obtained during the same season of the year within the Gulf of Maine proper show approximately the same surface temperature, but at depths corresponding to the bottom temperature here indicated they show considerably colder water. Dr. Bigelow. states that the higher temperatures and the higher salinities found in the Eastern Channel are evidences of an indraft of the warmer and saltier ocean water into the Gulf of Maine.

F. S. Borden.



WISE CRACKS

TO BE EXPECTED IN 1950 IF THE PROMOTION BILL DOESN'T PASS

The Commanding Officer orders the 3rd officer to climb a small mountain for triangulation. The 3rd officer answers "Captain, I can't climb that hill to-day; it's too cloudy and when the sun is not shining my rheumatism is pretty bad".

Rittenburg

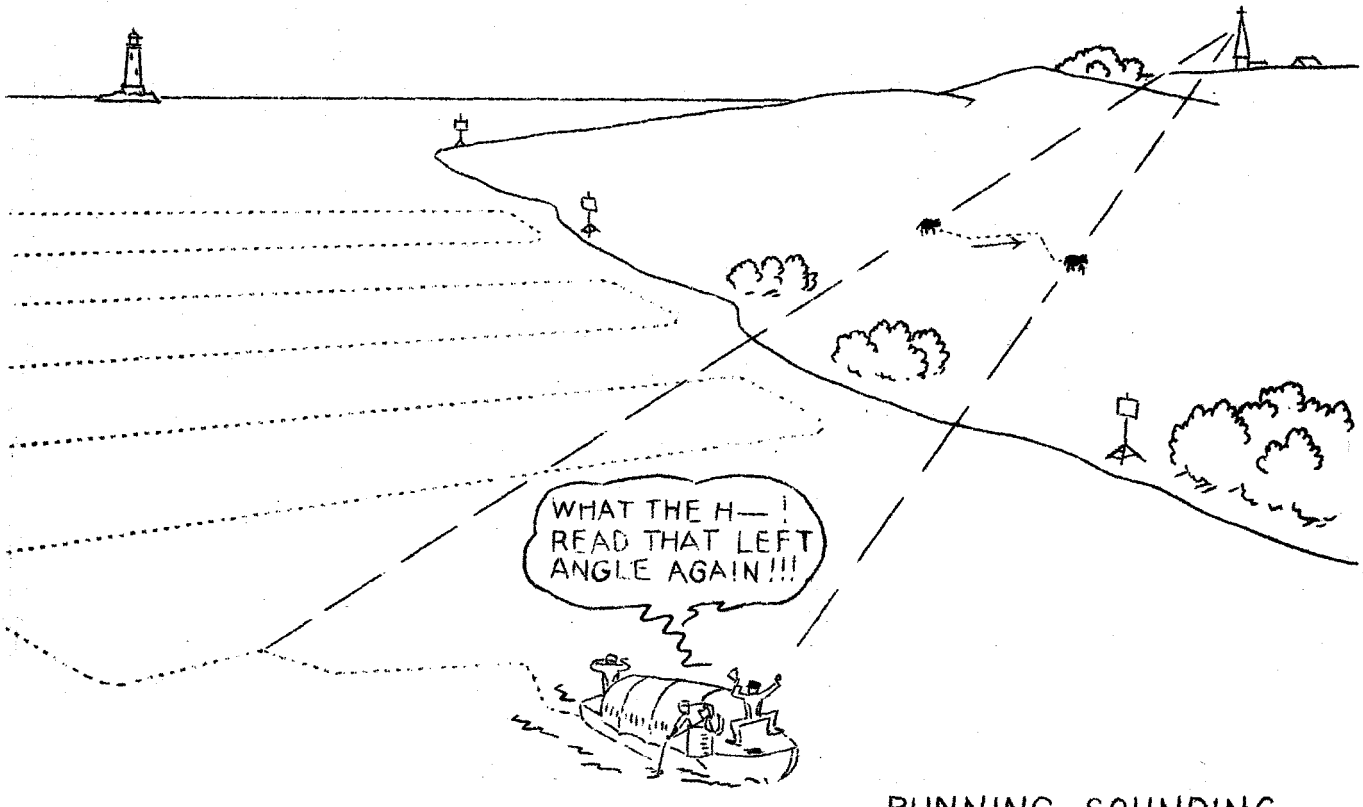
WILDER'S SUBSTITUTE FOR GOLF.

Wilder's substitute for golf, as given in the June bulletin, and his prescription for Commanding Officers, Executive Officers, etc., may have been a good thing in the olden days, but not now. They don't have time. What they need is an invension which will give them thirty-six hours in each day, or another needed invension which will permit them to be in about three places at one time.

Oh! for the good old days when a Commanding Officer was a person awed and respected by all, who spent most of his time in retirement in his cabin and let the others do the work.

Adams.

METHODS ILLUSTRATED



RUNNING SOUNDING LINES ON RANGES

Reject the last line! End the day!!"