ASSOCIATION
OF
FIELD ENGINEERS

U.S. COAST & GEODETIC SURVEY

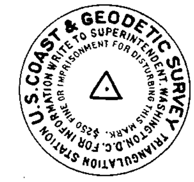
BULLETIN

JUNE 1931

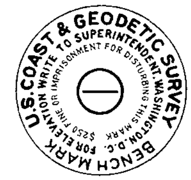
No. 3

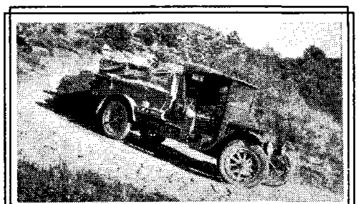
C.&G.S. Print 413

CONTROL SURVEYS

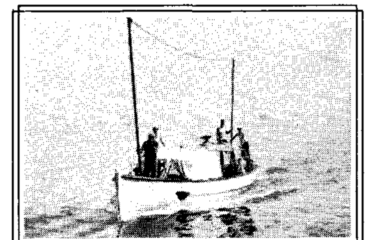


FIRST ORDER LEVELING IN INDIANA

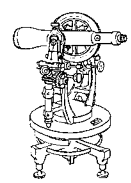




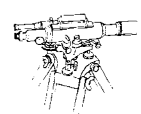
TOWING A FIR TREE FOR BRAKES~UTAH



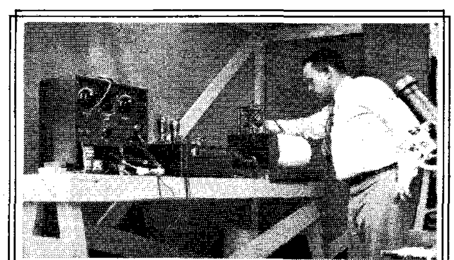
FLOATING R.A.R. STATION~HAWAII



LIGHT KEEPERS QUARTERS~MT. BAKER, WASH.



ΔN STATION SHUT EYE MT. CALIF.

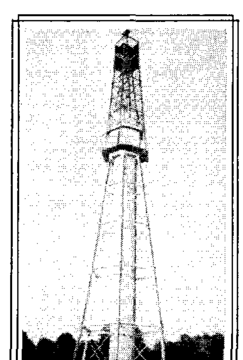


LONGITUDE OBSERVATION Δ HILL, MD., 1930

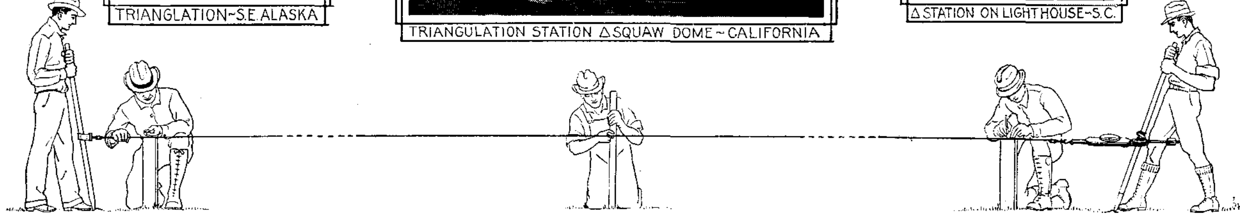
QUARTERS OF LEVELING PARTY~WISC.

TRIANGLATION~S.E.ALASKA

TRIANGULATION STATION ΔSQUAW DOME~CALIFORNIA



ΔSTATION ON LIGHTHOUSE~S.C.



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I.

THE BULLETIN

I. FROM THE OUTSIDE

BUREAU HYDROGRAPHIQUE INTERNATIONAL.
MONACO.

Adresse télégraphique, BURHYDINT. MONACO.
Tél. Code. BENTLEYS complete PHRASE CODE, 1921.

Adressez toute communication au Secrétaire-Général et dans la réponse prière de rappeler la date et le numéro de cette lettre.

No. I. H. B. 92\31-78\4

INTERNATIONAL HYDROGRAPHIC BUREAU.
MONACO.

Telephone, MONACO, 5-87.

7th. January 1931

Address all communications to the Secretary-General and in replying please quote the date and number of this letter.

Sir,

The INTERNATIONAL HYDROGRAPHIC BUREAU gratefully acknowledges the receipt of a copy of the December 1930 number of the Bulletin of the Association of Field Engineers, U.S. Coast and Geodetic Survey.

2.- If this number is a representative one, it may be stated without fear of contradiction that your Bulletin is one of the most interesting and valuable publications issued for the benefit of hydrographic and other Surveyors.

3.- Therefore it is of the highest interest to this Bureau and to the Surveyors of its Members and I venture to request

(a) that this Bureau be supplied with past and future issues (on repayment if necessary) and

(b) that the Bureau be permitted to give extracts (in English and French) from your Bulletin in its publications

In the hope that a favourable answer will be given to these requests

I have the honour to be,
Sir,
Your obedient Servant,

G. Spicer Simson

COMMANDER G. SPICER SIMSON D.S.O. R.N.
Secretary-General.

The Chairman
Executive Committee
Association of Field Engineers,
U.S. COAST AND GEODETIC SURVEY
Department of Commerce
WASHINGTON D.C.

C&GS. Print (R-169)

Department of Commerce
Office of the Secretary
Washington December 30, 1930.

MEMORANDUM

To: Captain Patton,
Coast & Geodetic Survey.
From: Mr. Kerlin.

The Secretary sent to Mr. Henry Morgan at 23 Wall Street, New York City, a copy of the December Bulletin of the Association of Field Engineers of your service which you kindly forwarded to him several days ago. I am enclosing a copy of a letter which the Secretary has just received from Mr. Morgan. Will you see that his name is listed to receive any future editions of the bulletin which may be issued?

M. K.

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23 Wall St., New York City
December 29,1930.

My dear Mr. Secretary:

I have been most interested to receive your letter enclosing a copy of the December Bulletin of the Association of Field Engineers - U. S. Coast and Geodetic Survey, telling of the work which the former Corsair has been doing during the past summer. It is most interesting, and we are all so delighted that the ship has proved useful to the service. I wish that it were possible to get one's name on the subscription list for this Bulletin, as it is a most fascinating publication. The designer of the cover is certainly most ingenious - it looks very familiar to me.

With renewed thanks and best wishes for the New Year, I am

Yours faithfully,
H. D. Morgan

Hon. R. P. Lamont,
The Secretary of Commerce,
Washington, D. C.

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On Board the CUNARD R. M. S. "AUSONIA"
Pier 56, New York City.
2 Jan. 1931

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

Dear Sir:

I beg to thank you for the "Bulletin" for December 1930 which I much appreciate and which covers ground of the very greatest utility to the navigator. Having had command in 1917-10 of one of His Britannic Magesty's sloops of war, I have read with the greatest interest the essay by Ensign Tribble, re-detonating Bombs on Georges Bank.

Wishing your department every success in the New Year,

I am Sir:
Your obedient servant,
P. A. Murclue,
Captain, R. N. R,

INTERNATIONAL HYDROGRAPHIC BUREAU

Monaco
January 16th, 1931.

My dear Captain Patton:

The December 1930 BULLETIN of the ASSOCIATION OF FIELD ENGINEERS of the U. S. Coast and Geodetic Survey recently received by the Bureau is so very interesting that I am taking the liberty to write this personal letter to you requesting that you send to me an additional copy of the December Bulletin and also a copy of the June Bulletin, which you mention in the first paragraph of your preface to the December Bulletin. As Captain Tonta expressed himself to me, it is the best thing of the kind that he has seen.

Should there be any expense for the additional copies please let me know and I will reimburse for them.

With best wishes for you and your staff for the New Year.

Sincerely yours,
(Sgd.) Andrew T. Long.

Captain Patton
Director of the U. S. Coast & Geodetic Survey,
Department of Commerce,
Washington. D. C.

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112 State Street, Boston, Mass.
Dec. 19, 1930.

Mr. R. S. Patton, Director,
U. S. Coast & Geodetic Survey,
Washington, D. C.

Dear Sir:

In this morning's mail a very plain envelope showed up from your Department, and on opening it up I found a most interesting book in the form of a Bulletin of December 1930 - showing the activities of the survey of Georges Shoal.

Not knowing who was responsible for sending me this volume, I write to offer my thanks and appreciation of it - and to say that it is interesting, is to put it very mildly indeed.

One glance of it is sufficient to show me that it will be enjoyable reading as well as instructive, and I feel honored to have this copy.

Yours sincerely,
KELVIN & WILFRID O. WHITE CO.
(Sgd.) Wilfrid O. White, President.

II. FROM THE INSIDE

Commander Borden:

I have been giving much thought in recent months to our Field Bulletin. It is something that, in my judgment, is meeting a long felt want in this Bureau, and I hope that our Association can keep it going indefinitely in the future.

The engineers and other technical employees of the Coast and Geodetic Survey have written a large number of scientific and engineering papers for various journals, but it is rather difficult to have published articles telling what should be done and how methods should change, etc. There are a limited number of engineers who are interested in "the details involved in the development of our apparatus and instruments. Our own people can use our journal or bulletin as a means of expressing their ideas as to how things might be changed for the better. We have lots of discussions over the lunch table here in Washington, D. C, on Coast Survey matters. On board a ship we have lots of discussions on instruments, methods, etc., in the wardroom. Many of the ideas that are developed in these discussions should be presented in the Field Bulletin in order that men on other ships and at other stations might have the advantage of them. In other words, the Bulletin is like a technical newspaper and we should not limit ourselves to merely telling what is the adopted policy of the Bureau or to describing an adopted method or an instrument that has been completed. We should tell what we are thinking of doing, what we think should be done, and then when something has started, our Bulletin should, with each issue, tell how far an instrument or method or policy has progressed. If we wait until things are finished, we destroy that enthusiasm of our people which could be aroused and maintained by telling them beforehand that we are doing something and that we would like to have suggestions from them. A notice of a completed event is usually dull reading, but we are always interested in learning that something is going to be done or that something has been started. We, in the Bulletin, can arouse the interest of our engineers and make them think with us.

I have frequently told the chiefs of party, working in the Division of Geodesy, that they should study their work with a view to helping the Bureau advance the science and art of geodetic surveying. I have told them that they are closer to the work than we here at this office and that many things must come to their minds which would be valuable to us here in Washington if they would only let us know about them. They have been told that great progress has been made in geodetic surveying during the past 20 years and that we will undoubtedly make further progress in the years to come. They have been told that it is reasonably certain that if they would let their imaginations run freely and cooperate with the officials at Washington by presenting their views orally and in writing we would be able to crowd into the next five or ten years the amount of progress that normally would come only in twenty years.

What I have said about the geodetic work will apply to every other class of work of this Bureau. We must stimulate our engineers and others to think over our work and problems and to see whether it is not possible to think out new ways of doing things that would be better. The Field Bulletin furnishes a place where the thoughts of our engineers can be perpetuated, and surely what one man thinks on a ship in Alaska is very apt to stimulate someone working off the coast of Florida to expand the idea that is first presented. Free discussion is the only means of progress, and since our engineers are so widely scattered, they can have this discussion in the Bulletin, and it is the only way in which, they can present their views.

Of course, the Bulletin must not contain a criticism by one engineer of any other member of the Survey, and suggestions for changing the existing program should be couched in such language as not to be offensive.

I think we need not fear that the discussions that are engaged in in the Bulletin will be construed as definite policies that are followed by the Bureau. I feel that if engineers outside of the Survey should read the Bulletin, they would understand the statements that are made or letters that are published and perhaps this might lead to constructive criticism and suggestions from the outside man.

I am writing as above to indicate two things; one is, that we keep the Bulletin going as it is, furnishing a medium for free and wide exchange of views and ideas; the other is, that we try to make it an official bulletin, published by the Government and sold by the Superintendent of Documents. We can carry out the first idea, for I think we all want the Bulletin to continue and succeed. The latter idea may not be practicable now, but within a few years perhaps we can have it changed from a Field Association Journal to a Bureau Journal, paid for from Federal funds.

If I can be of any assistance to you in furthering the interests of the Bulletin, do not hesitate to call upon me.

(Sgd.) W. Bowie
Chief, Division of Geodesy.

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Commander Borden:

In commenting on the Field Bulletin, I think the question of circulation is of importance.

In the first place, we must face an accomplished fact, that is, that the Bulletin has been sent to various people and has received strong commendation and the desire has been expressed that it be continued. It is quite likely that the same will be true of future bulletins and, if so, this should outweigh to some extent the danger of possible criticisms.

There is another point I think should be considered, that is, that the Bulletin can well be used to try out ideas which otherwise might appear in official manuals without having had the benefit of field criticisms. It is my opinion that if a proper disclaimer appears in a conspicuous place, we are In a position to answer any outside criticism and, on the whole, I think the gain will be greater than the loss.

Accordingly, while there would be some advantages in keeping the Bulletin entirely within the Bureau, I think the advantages of doing otherwise are even greater. We certainly can not ignore Mr. Morgan's request, and having granted one request, it is difficult to refuse others. If, however, there is to be circulation of this sort, it seems that, without expressing the least criticism of your work, which has been excellent, responsibility should be more widely spread either to a special editorial board or to the members of the executive committee, if they are willing to perform the duty.

I would like to suggest that in a future number you devote at least half the number to the non-hydrographic duties of the Bureau. Even though there is a special bulletin in the Division of Terrestrial Magnetism and Seismology which is somewhat similar to the one prepared by you, it is circulated only to the members of the Division and to the members of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and it is perhaps rather too technical for our field officers. However, each branch of the work has matters of interest on which the whole force should be informed.

(Sgd.) N. H. Heck
Chief, Division of Terrestrial
Magnetism and Seismology.

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Commander Borden:

Reading the Field Association Bulletin is to me a pleasant visit to the various field and office units of the Bureau with all travel expense paid by the Association. It provides a chance to exchange views and to express quite freely what we are doing and what we hope to do, and to indicate opportunities, as we see them, for improvements of methods or equipment. To know that throughout the Service constructive thought is being given to all the different phases of our work is stimulating for we have brought home to us the fact that the Bureau is alive and growing. The cost of sending copies to a selected and limited list outside the Bureau may be considerable, but the benefits to the Bureau will be great.

(Sgd.) E. H. Pagenhart
Chief, Division of Charts.

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Commander Borden:

The first thought that occurs to me in commenting on the Bulletin of our field corps is that, in any case, it should be continued along its present lines. Aside from its value as a medium for mutual exchange of ideas among officers engaged on similar field operations, it is most helpful to an officer, temporarily assigned to special work, in keeping him in touch with the other varied activities of the Bureau. During my last assignment as inspector of construction on the building of the Ship HYDROGRAPHER, for example, I would have been out of touch, with the developments of the new and modern field methods evolved within the past few years but for the Bulletin. And, too, they are coming thick and fast! It is quite probable, of course, that the officer of the past had many good ideas long since hidden and forgotten in reports in the files of the Bureau.

All lines of human endeavor during the past ten years have made epochal progress in the invention of newer and more efficient means and of intensive development of the older methods due, in a large measure, to developments brought about by the exigencies of the World War. As examples, the hydrography of ten years ago is scarcely recognized in the hydrography of to-day. Likewise, the topographic work of to-day trill soon be history.

We are fortunate in being in our Service during this constructive era. Yet we shall find ourselves in an unenviable position should we fail to keep step with current progress. We are falling in line at least, if not leading, due in considerable extent to our exchange of ideas through the Bulletin, which not only furnishes the medium of exchange but also in some measure the urge to create.

The Bulletin quite often will serve another useful purpose in furnishing the means of free discussion of methods before they find their way into the official publications and manuals of the Bureau. It is quite possible that some of these would not have appeared in official publications had they first received such discussion in the Bulletin and actual trial in the field by officers on active field operations.

In case of wider circulation, possible unfavorable criticism from outside sources of methods and procedure discussed in the Bulletin is less undesirable than similar criticism of the official publications of the Bureau, since, in the former case, the criticism is aimed at an individual rather than at the Bureau. In fact, constructive criticism is to be desired rather than shunned and should receive careful consideration. It generally results in improved products.

Contributions have been well distributed. I was especially glad to note the papers in the December Bulletin by our younger officers. This is indicative of more than passive interest in their work and should be encouraged since in a few years they will be the directing force of the Service.

The matter of circulation of the Bulletin will later assume greater importance than at present and should be given consideration at this time in order that abrupt change of policy in this regard need not be made after the publication may have received fairly wide circulation.

Science recognizes no boundaries and personally I favor a wide circulation among organizations similarly engaged both in this country and abroad, provided this can be accomplished without detriment to the Bulletin. By this is meant undue editing, which would tend to stifle the publication as a medium for the free and spontaneous exchange of ideas, suggestions and methods within our own corps and finally create the impression that an idea must be fully developed before publication in the Bulletin.

I feel, however, that the Director will never require editing beyond that of the Executive Committee of the Association, provided we take care that our papers are confined strictly to technical subjects and refrain from matters touching on the policies of the Bureau. Matters of general interest to the corps, as, for example, proposed legislation and related matters or matters on the policies of the Bureau, would generally originate in the Director's office and naturally should receive approval before publication. Such editing, however, will in no sense affect the spontaneity of the Bulletin.

The circulation of the publication outside our own corps beings up the question of the cost of the preparation of the number required to meet possible future requirements. While we may be quite glad to distribute the few required at present, the burden of a wider distribution would be excessive on our comparatively small organization. Consideration might well be given then to the propriety of placing a nominal charge for a yearly subscription or for single copies, only sufficient, however, to cover the actual cost to the corps as nearly as this may be determined.

I wish you continued success in the publication of our Service Bulletin. Please do not hesitate to call on me at any time that I may be of service.

(Sgd.) G. T. Rude,
Chief, Division of
Hydrography and Topography.

AERIAL PHOTOGRAPHY AND COAST SURVEYS

O. S. Reading, U. S.- Coast and Geodetic Survey.

The problem of keeping the topography on our charts up to date between complete resurveys has resembled that of the famous frog climbing out of the well who slipped back three feet every time he jumped up two. Each partial survey seems to introduce new complications or discrepancies. Aside from the surveys made by the field parties of the Bureau, nearly four times as many special surveys from other sources are applied to the charts each year in the effort to keep them up to date. Unfortunately, the information from other sources often lacks adequate data for accurate plotting on the charts and the cartographer must be content with an approximate position. In addition, the changes reported by others comprise but a minor part of the changes which occur, particularly topographic changes, such as new landmarks, wharves, bridges, dredging and filling, etc. The new result is that each large scale chart gradually slips lower and lower in accuracy of topographic detail until it is practically obsolete in this respect.

Aerial photography offers a particularly efficient means of breaking up this cycle; a means of keeping the topography of the charts up to date to an extent and with an accuracy never before contemplated. If four well defined points whose geographic coordinates are known appear in the overlap common to two aerial photographs, the remaining features of the overlap may be accurately plotted without further ground measures. If the terrain be level, a single photograph will suffice. The development of aviation has made it easily practicable to fly the coast each year, inspect the latest editions of the charts, and photograph the changes which should be charted. Such photographs show the new conditions as they actually are - not as they were planned, but often not completed; a distinction of importance when revising charts from construction blue-prints. This distinction often can not be made without a careful inspection on the ground or even a new survey of the locality.

New Photo Topographic Survey Necessary.

The requirement that three or four distinguishable points whose coordinates are known must appear in a photograph, if it is to be plotted without measurements on ground, is a severe limitation of revision by occasional photographs when the present condition of our surveys is considered. The original surveys are too obsolete and most of the revisions that have been made are too limited for the purpose. But air photo topography offers an economical and efficient means of making a basic survey which will supply plenty of such points for later revision by means of isolated photographs. (See accompanying plate showing a portion of photo topographic sheet 4567).

An increase in topographic detail on our charts is not necessarily contemplated as the points required for plotting revision photographs would be furnished on the photo topographic survey sheets.

It is this infinite number of such points, this infinite amount of topographic detail, which is one of the most outstanding advantages of the air photographic surveys. This detail is limited only by the character of the terrain and the scale of the photographs. It can be traced on the photo survey sheets for only the cost of the extra drafting required. It is sufficient for compiling almost any type of map and, therefore, saves many special surveys and the rephotographing and replotting of the same area by other organizations.

The permanency of such detail for the purpose of controlling future revisions may be indicated by a reference to the discovery by means of air photographs of portions of the road system established by the Romans in Great Britain. The location of the roads of the third century could be traced by differences in the vegetation which were apparent in the photographs but not on the ground. Although it is expected that the development of our country will require resurveys on larger scales within a century, it is evident that the photo surveys will furnish ample detail for revision purposes for an indefinitely long period of years.

A survey at this time of the vast areas of marsh and beach now considered of little value will be of incalculable usefulness in the future for settling litigation regarding property lines which are bound to arise when such lands increase in value. The old surveys by this Bureau have been used as evidence in all important litigation of this character.

In the study of shoreline changes, the faithfulness and dependability of the representation of detail is a great advantage, for changes are frequently so radical as to throw doubt on the accuracy of the surveys.

Note that the detail is traced from the photographs, not sketched between rod rendings as with the planetable, and is therefore much more exact and characteristic of each unique feature. This photographically exact detail is especially useful in charting irregular shorelines, complicated inside passages, and waterfronts of harbors. It enables the mariner in such close quarters quickly to identify his position when any uncertainty, due to sketched, generalized or obsolete topography, is most damaging.

The value of photographically exact shoreline for complicated channels may be illustrated by an experience of Lieutenant Rigg, while he was sounding the waters of the Ten Thousand Islands, Florida, with prints of the air photo topographic surveys for boat sheets. This area is a complicated network of channels between mangrove islands which all look alike to the unaccustomed eye. As the time available for the hydrography was extremely limited, Mr. Rigg employed a pilot or guide, who had spent all his life on the islands, to show him the best channels. The pilot knew his channels alright, even though they ran all over the place and were unmarked. One day, however, they worked a bit away from the usual routes and when the day's work was ended, the coxswain of the launch headed down a channel in the general direction of the houseboat on which the party was quartered. After a few minutes the pilot admitted he was lost and did not know which fork to take next. Mr. Rigg took out the boat sheet and found no difficulty in spotting the location of the launch from the photographically precise shoreline. With the sheet before him, he then conned the launch several miles through a maze of strange channels to the quarter boat. Needless to say, the pilot had all due and proper respect for Coast Survey officers and methods thereafter.

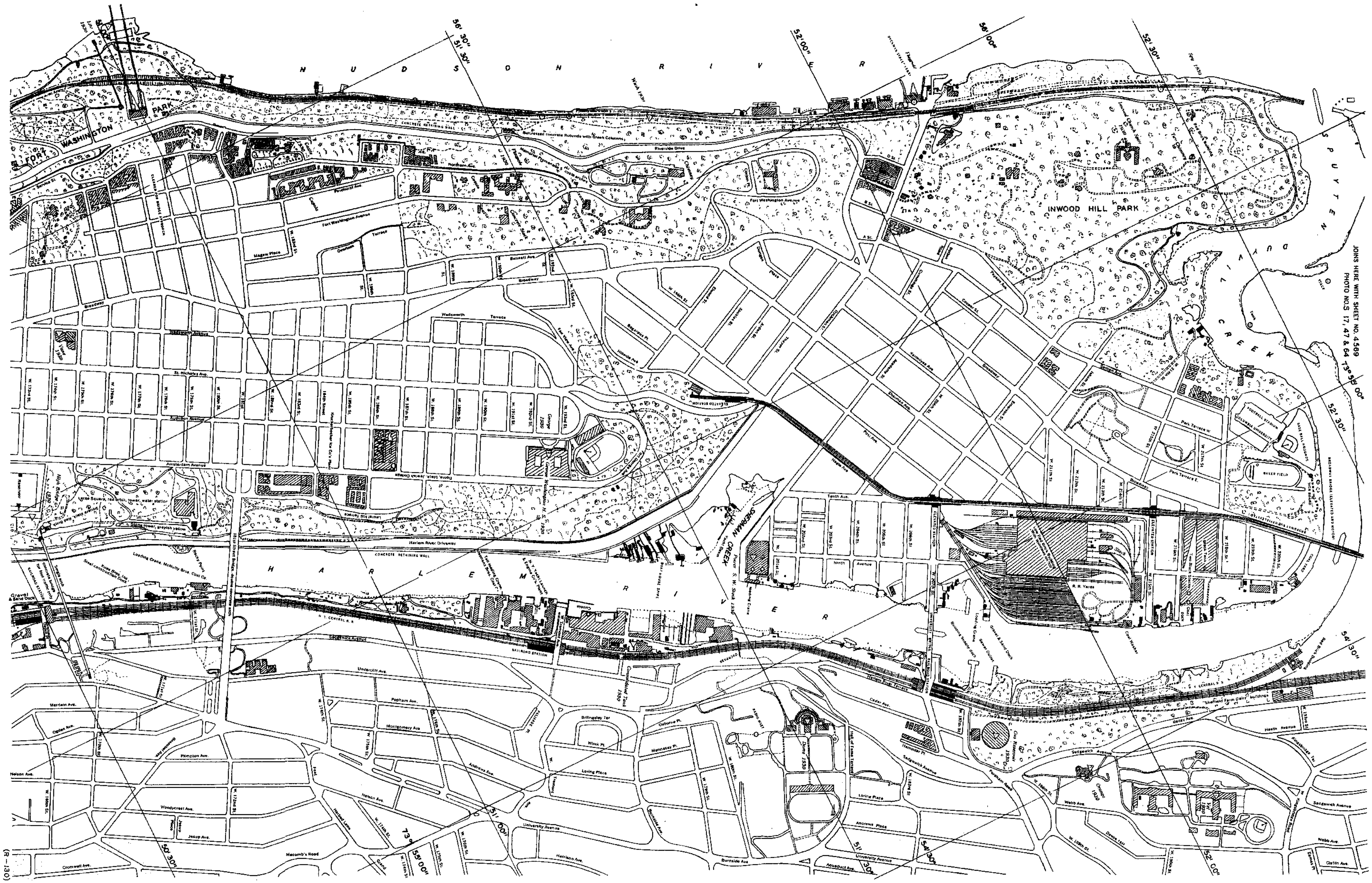
The drawing of contours from the photographs is not contemplated at present because the area most in need of resurveys, the South Atlantic Coast, is very flat. The detailed planimetry of the photo survey sheets as plotted at present will greatly facilitate the contouring of such terrain with the planetable where contours are needed for purposes other than charting. In more rugged areas very good form lines may be sketched on the photographs under a stereoscope from spot heights obtained on the ground. Should later needs require it, the expensive machines plotting contours directly from the photographs may be obtained. Such machines do not expedite planimetry with reasonably level photographs and moderate relief, nor are they suited to contouring very flat terrain.

The economy of the air photo topographic surveys for our purposes is indicated by the Florida East Coast sheets which cost $18.40 per mile of shoreline and $14.20 per mile of area (no contours were drawn). The average of the cost of all planetable projects of more than 100 miles in extent, since the cost analysis form No. 615 has been in use, is $47.25 per mile of shoreline and $106.18 per square mile with form lines. It will ordinarily be necessary to supplement the photo sheets with a traverse to locate signals for inshore hydrography. Such traverses cost $15.32 per mile in Florida. The cost of both photo base map and signal traverse, $33.72, is less than three-fourths of the cost of the planetable survey including only detail which can be located from a shoreline traverse.

Photo Topographic Sheets Excellent Base Maps.

It is believed that the highest graphic accuracy may be obtained in plotting our photo survey sheets by using a precision model of a five lens camera similar in general design to the one recently developed by the Army Air Corps. At an altitude of ten thousand feet, this camera photographs on a scale of 1:20,000, a field ten miles across. As the coastal triangulation stations are spaced not more than five miles apart, at least one and usually two or more will appear in each photograph. By means of suitable overlap, such an interlocking of the photographs may be secured as to give a most rigid plot. In this manner all the distinguishable detail of the photographs may be plotted as accurately as the draftsman can work on the scale used. Each clearly distinguishable feature thus will become a fourth order control point for plotting future photographs, hydrography, or other graphic surveys on equal or smaller scales.

In addition to their value for future chart revisions, the photo sheets also serve admirably as base maps for coordinating and compiling all the surveys of a locality. The larger metropolitan areas of the country have been compelled to make accurate detailed surveys in order to obtain base maps on which their many special surveys could be compiled and with which their future development could be intelligently planned. These metropolitan maps are usually based on the geodetic control and in other respects are also equivalent to the photo sheets. There exists a lamentable lack of coordination between the surveys of many other parts of the country. The original cadastral surveys were usually made when the land had little value and were often very cheaply and poorly executed in consequence. The boundaries so established are maintained by law. Later, as the localities



SECTION OF SHEET T-4567, HARLEM RIVER (compilation of air photographs). SCALE OF ORIGINAL SHEET 1:5000. SURVEYED, 1930.

commence to develop, railroad, highway and construction surveys are made. Such surveys are connected to the cadastral net for purposes of title or right-of-way registration, but they are made with such varying degrees of accuracy that any attempt to compile a map from such data leads to much confusion and uncertainty. There is great need, particularly among county engineers, for a base map, accurate enough to be trustworthy, coordinated with the geodetic datum so it will fit adjacent maps and on a large enough scale to show the details of developments. The air photo survey sheets show all features distinguishable on scales of 1:10,000 or 1:20,000 in their true relation to the geodetic control, including streets, roads and boundaries of larger fields as well as shoreline and landmarks. The cadastral surveys are so frequently connected to such detail that they can be plotted on the photo sheets with a minimum of expense for resurveys. Special construction surveys may also be plotted with equal facility. The development of the localities whose surveys have been so coordinated and mapped can not fail to be more intelligent and expeditious.

Summary: When this Bureau began topographic surveying, it achieved a reputation for outstanding accuracy and faithfulness in the representation of detail. With the growth of the country it has been impossible to keep up with the multitudinous changes and we have been forced to depend on miscellaneous maps and surveys often of doubtful accuracy. Aerial photography offers the opportunity to reestablish our former standard.

A basic photo topographic survey of the coast can now be made for less cost than a ground survey limited to revision of shoreline and adjacent detail only.

All types of maps on equal or smaller scales may be compiled by inexpensive supplementing of the photo survey sheets without repeating the photography or the plotting.

The air photo topographic survey will serve as a base map for coordinating and reducing to the geodetic datum the numerous special surveys, private and public, constructional and cadastral, of the coastal area. This coordinating will greatly increase the accuracy and usefulness of all types of maps of the localities so surveyed.

The photo topographic sheets will save their cost many times over by expediting future revisions. Wherever they are available, the topography of the charts may be kept up-to-date by occasional air photographs to an extent otherwise impracticable and with an accuracy and economy unapproached by any other method.

REVIEW OF ASTRONOMICAL WORK AND A STUDY OF ERRORS, GEORGES BANK, 1930

L. S, Hubbard, U. S, Coast and Geodetic Survey.

Methods Used.

The methods used for computing sights and ships' positions have been discussed previously in reports by. K. T, Adams and G. D. Cowie (Report No. 1, 1931 - Association Bulletin, December, 1930). Only two points will be considered here.

(1) Determination of Ship's Position.

The Sumner bisectrix method of determining the best value of the ship's position from a given set of observations was used. When a number of stars were taken for a set at one time, the following methods were used:

Stars considered of value enough to be used in the computations were given equal weight. Others were rejected as having no weight. When observations were taken on stars having about the same azimuths, a resultant of their Sumner lines was secured by bisecting their intersections. This resultant was treated as a Sumner line in combining with other Sumner lines. Each set of sights resolved itself into a figure of four Sumner lines with sides facing approximately North, East, South and West. Sumner bisectrix lines were drawn between the Sumner lines which faced each other. The intersection of the Sumner bisectrix lines was taken as the position of the ship.

(2) Determination of Position of Anchor of Buoy.

When sights were taken, the bearing and distance of the buoy were observed. The heading of the ship was noted, for this indicated in what direction the current was running, and hence in what direction the anchor of the buoy lay from the buoy. The scope of the chain was also known. Thus the bearing and distance of the buoy anchor from the buoy could be determined. The bearing and distance from the bridge to the buoy, plus the bearing and distance from the buoy to the buoy anchor gave graphically the bearing and distance of the buoy anchor from the ship's bridge.

Latitude and Departure Tables were used for summing the components of the bearings and distances to obtain the bearing and distance of the buoy anchor from the bridge. This bearing and distance was converted into differences of latitude and longitude by means of Polyconic Projection Tables.

Study of Errors

(1) Intercepts.

The distances of the Sumner lines in a set of star observations from the true position of the ship were called errors in observations. To obtain an idea of the size of this error and the cause of it, these distances, or "intercepts", were scaled on all accepted sets of star sights taken during the season. "Those intercepts are averaged to obtain the total mean intercept of the season and to compare the mean values obtained by the various observers with each other.

The total mean distance of the Sumner lines from the ship's position was .93 of a mile. The Sumner lines were from the observed bodies with respect to the ship's true position.

The mean distance of the various observers was as follows:

George D. Cowie (12 sets)	.89 mile
W. M. Scaife (14 sets)	.99 "
L. S. Hubbard (4 sets)	.87 "

The greatest difference from the total mean of any observer was .06 of a mile, or 111 meters. This would indicate that the personal errors in observations were small and that the errors were due to external factors, Plato No. 1 gives an abstract of the intercepts.

(2) Intercept Error Due to Difference Between Air and Water Temperatures.

It was noted in the star observations taken on Georges Bank, season of 1930, that the intercept errors were from 1/2 to 2 miles and that the Sumner lines were invariably FROM the ship's position. This means the observed angles were less than the correct angles, or, in other words, the observed horizon was higher than the correct horizon.

It was also noted that when star sights were taken, surface water temperatures taken were from l/2 degree to 6 degrees colder than the air temperatures taken at the same time. This would cause the apparent horizon to be lifted above the correct horizon in accordance with the following quotation from Bowditch, paragraph 301 (d):

"When the sea water is colder than the air the visible horizon is raised and the dip decreased; therefore the true altitude is greater than that given by the use of the ordinary dip table. When the water is warmer than the air, the horizon is depressed and the dip is increased. At such times the altitude is really less than that found from the use of the table"

A study of our observations substantiates this quotation in a general way, but our observations were not numerous enough to draw conclusions as to the amount of lifting of the horizon a given difference between air and water temperature would cause. A graph giving the results of observations is shown on Plate 1.

The graph indicates that the greater the temperature difference the greater the amount of the intercept. Some of the observations are wide of the line. These may be caused by differing temperatures in different parts of the area seen from the ship or by undetected streaks of low lying fog, which were common in this area.

This rough graph would indicate that an intercept would be .4 of a mile when water and air temperatures are equal and that the intercept

Plate 1

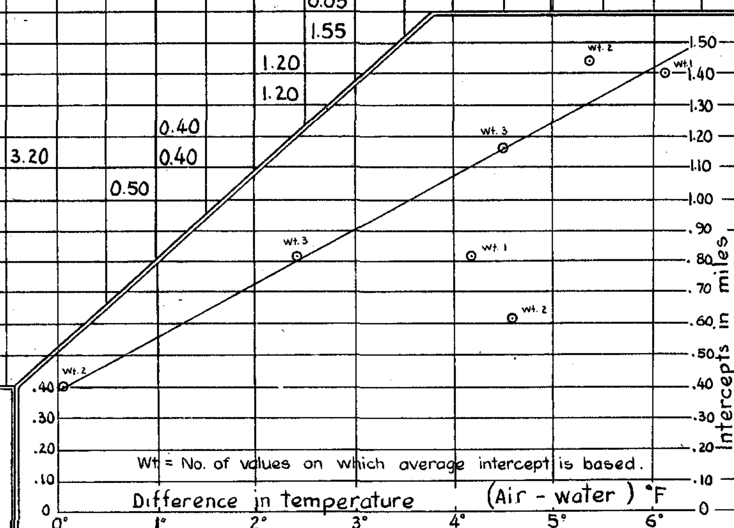
ABSTRACT OF STAR SIGHT INTERCEPTS IN MILES (1930)

Star Observed	OBSERVER: G. D. Cowie												W. M. Scaife														L. S. Hubbard				Avg. Intercept.
	Buoy W								Buoy Z		Buoy T		Buoy W						T		L		Y	Z			Buoy W			T	
	7/15 P.M.	7/16 A.M.	8/7 P.M.	8/11 A.M.	8/12 A.M.	9/4 P.M.	9/5 A.M.	9/5 P.M.	7/8 P.M.	7/9 P.M.	9/9 P.M.	9/10 A.M.	7/15 P.M.	8/7 P.M.	8/11 A.M.	8/12 A.M.	8/12 P.M.	9/5 P.M.	9/9 A.M.	9/9 P.M.	9/19 P.M.	9/20 A.M.	6/24 A.M.	6/10 P.M.	7/8 P.M.	7/9 A.M.	7/15 P.M.	8/7 P.M.	8/11 P.M.	9/9 P.M.	
Venus	1.00		0.23			0.65		0.83	0.80		0.30		1.50	0.75			0.20	0.50		0.60				0.70	1.80		1.45	1.22	0.15	0.20	0.76
Altair	1.30		0.50						0.90	1.65			1.50	0.75											1.80	1.90	1.40	1.31			1.30
Dubhe	1.80						0.80		0.81																		0.70				1.03
Antares	1.15							0.90						1.00											2.30			1.22	1.15		1.29
Polaris	0.70	1.35	0.05	0.00	0.90	0.80		0.75	0.80	3.00	0.80		1.00	1.00	0.42	3.20	0.20	0.30		0.40	0.50		0.73	1.00	2.40	2.05	1.30	1.37	1.30	0.20	1.02
Saturn						0.80		0.60			0.80						0.20	0.30		0.40	0.50							1.50	1.30	0.20	0.66
β Pegasi											0.30									0.60									0.15		0.38
Deneb	1.05			0.50	0.45		0.80									1.90			0.40								0.80				0.84
Spica	0.80								0.70				1.00											1.00	2.00		1.25				1.12
δ Capricorni		1.35								2.70																2.00					2.02
Hamal										3.40																2.40					2.90
Capella										1.65																1.40					1.52
Vega		1.35								3.20													0.73	0.70							1.49
Moon				0.70											0.42							1.55	0.73								0.85
Rigel					0.37											1.90						0.05									0.77
β Ursae Min.												0.65										0.05									0.35
Alpheratz																						1.55									1.55
Markab												0.65									1.20										0.92
Arcturus																					1.20										1.20
β Canis Maj.																			0.40												0.40
β Ceti				0.00	0.90											3.20			0.40												1.12
Enif						0.65		1.01										0.50													0.75
Sirius												0.65																			0.65
Jupiter				0.65											0.42																0.54
Nunki			0.00																												0.00
Procyon							0.80																								0.80
γ Eridani												0.65																			0.65
Mars		1.55																													1.55
Mean intercept	1.11	1.40	0.19	0.37	0.65	0.72	0.80	0.82	0.80	2.60	0.55	0.65	1.25	0.87	0.42	2.55	0.20	0.40	0.40	0.50	0.85	0.80	0.73	0.85	2.06	1.95	1.15	1.32	0.81	0.20	0.93

Weighted mean intercept of 30 sets: 0.93

REMARKS:- INTERCEPT = THE DISTANCE FROM SUMNER LINE TO SHIP'S POSITION.
IN ALL CASES THE SUMNER LINES WERE FROM THE OBSERVED BODIES WITH RESPECT TO THE SHIP'S TRUE POSITION.

SUMMARY OF INTERCEPTS: G.D.COWIE = 0.89. W.M.SCAIFE = 0.99. L.S.HUBBARD = 0.87. AVERAGE = 0.93.



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would be zero when the water is about 3 degrees colder than the air. Furthermore, it would indicate that when the water temperature is considerably warmer than the air temperature, as would occur off Georges Bank in the winter time, the Sumner line would be TOWARDS the star from the ship's true position.

A much longer series of star observations with water and air temperatures taken close to the time of taking the star sights is needed to draw definite conclusions as to the effect of differences between air and water temperatures upon intercepts.

(3) Effect of Brightness of Horizon upon Accuracy of Sights.

It was suspected that because the horizon in the west is lightest, and therefore best, during evening sights, and lightest in the east during morning sights, the sights taken in the morning might be consistently east or west of those taken in the evening.

An average of the sights at Buoy "W" taken in the morning was compared with an average of those taken in the evening. They are tabulated below. Degrees of longitude are omitted, because identical for all observations. Observers G.D.C. and W.M.S.

Minutes of Longitude A.M.	Minutes of Longitude P.M.
06.10	06.00
05.50	05.70
05.50	05.50
05.30	05.45
05.89	05.50
06.33	04.89
6)34.62	06.37
05.77	7)39.41
- 05.73	05.73

.04 A.M. sights .04' west of evening sights.

The average of the morning sights gives a value of .04' (74 meters) west of the average of the evening sights, a difference so slight that we conclude that the difference in brightness of the horizon does not alter the position secured by the observer.

(4) Rate of Change in Altitude of Celestial Bodies.

All observations taken will be inaccurate due to such factors as wind blowing in the observer's eyes, pitch and roll of the vessel, rapidity of motion of star, clearness of horizon and experience of observer. A means for testing the accuracy with which sets of sights were taken has been devised. The means depends upon the fact that in a given latitude a star with a given azimuth from an observer will have a rate of change in altitude which can be determined mathematically. If the observed difference in altitudes of successive sights is compared with the mathematically correct differences in altitude for the given intervals of time, the discrepancies between the observed and true values are an index of the accuracy of taking the sights.

Azimuth		Table One: Change in altitude in minutes of arc per minute of time, Lat. 41	Table One: Lat 42	Table Two: Time required for 1° change in altitude, Lat. 41 Min.	Lat. 41 Sec.	Lat. 42 Min.	Lat. 42 Sec.
180	0	0.00	0.00	∞		∞	
175	5	0.99	0.97	60	49	61	45
170	10	1.98	1.93	30	32	31	00
165	15	2.94	2.88	20	29	20	47
160	20	3.86	3.82	15	30	15	45
155	25	4.77	4.70	12	32	12	44
150	30	5.66	5.58	10	38	10	46
145	35	6.48	6.40	9	15	9	23
140	40	7.28	7.16	8	16	8	24
135	45	7.99	7.87	7	30	7	37
130	50	8.67	8.54	6	55	7	02
125	55	9.27	9.12	6	28	6	34
120	60	9.81	9.64	6	07	6	14
115	65	10.26	10.11	5	50	5	56
110	70	10.64	10.48	5	40	5	44
105	75	10.93	10.76	5	29	5	34
100	80	11.15	10.98	5	23	5	28
95	85	11.29	11.10	5	19	5	24
90	90	11.32	11.14	5	18	5	23

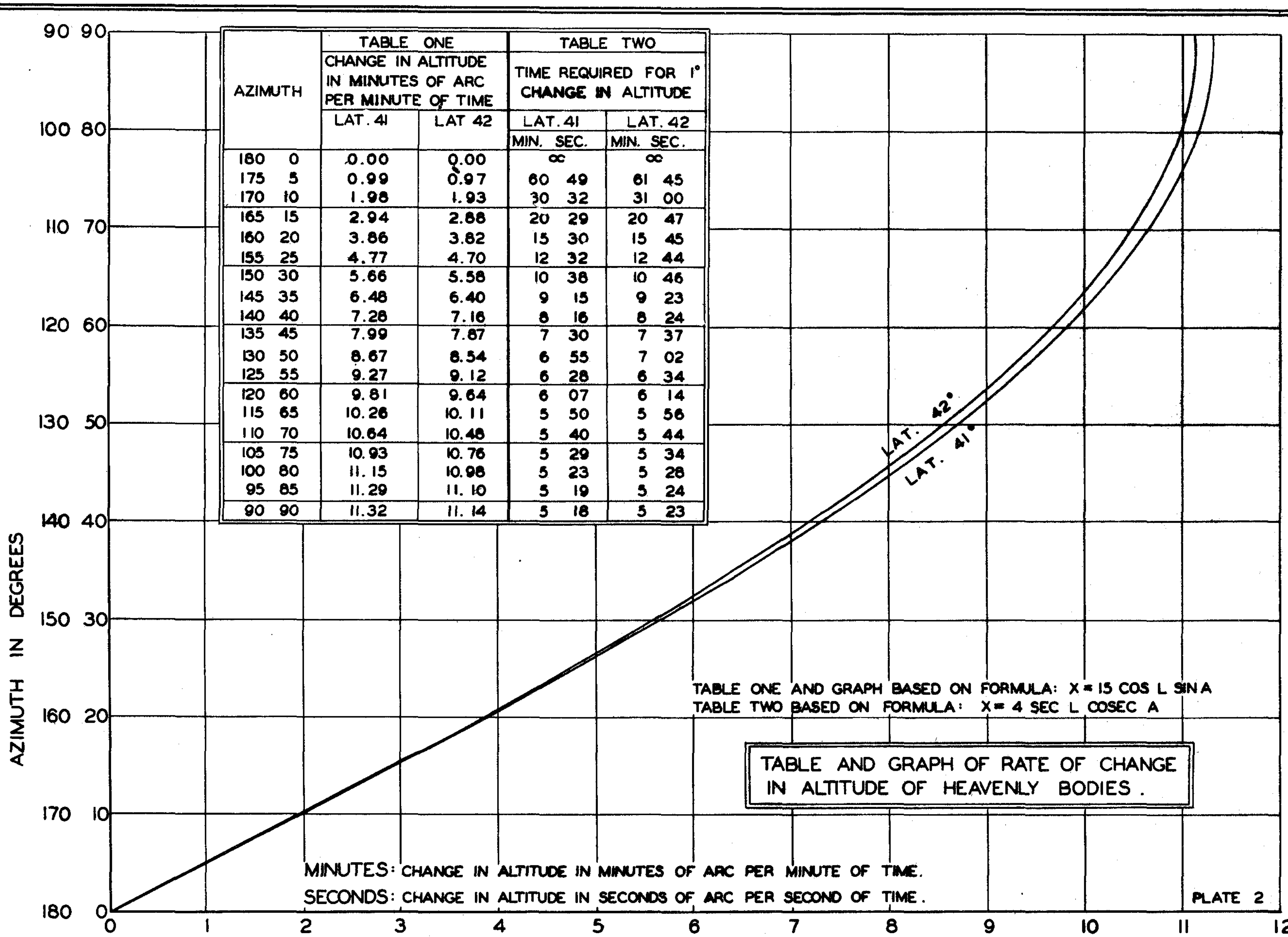

TABLE ONE AND GRAPH BASED ON FORMULA: X = 15 COS L SIN A

TABLE TWO BASED ON FORMULA: X = 4 SEC L COSEC A

TABLE AND GRAPH OF RATE OF CHANGE IN ALTITUDE OF HEAVENLY BODIES.

MINUTES: CHANGE IN ALTITUDE IN MINUTES OF ARC PER MINUTE OF TIME.

SECONDS: CHANGE IN ALTITUDE IN SECONDS OF ARC PER SECOND OF TIME.

PLATE 2

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Lieutenant-Commander Adams first devised tables for these values for work in the Hawaiian Islands, picking the values from K. O. Publication No. 203 and No. 204. Tables and graphs were made for the work on Georges Bank by the same method.

Such tables and graphs can be more readily and accurately constructed by means of either of the two following formulas:

$x = 15 \cos L \sin A$ Note: x equals the change in altitude,
or $x = 4 \sec L \operatorname{cosec} A$ Note: x equals time per 1° change in altitude.

The first formula is used for securing the values for "Change in altitude in minutes of arc per minutes of time". The second formula is used in securing the values for "Time required for 1° change in altitude".

An example of the tables and a graph for the latitudes of Georges Bank are shown on Plate 2.

In using the tables or graphs, it is necessary to know the azimuth of the star, either by sighting on it with a pelorus when it is observed, or by computing the sight before the observations are tested from the graph.

Practices Proposed.

It is suggested that the following procedures be experimented with during the season of 1931 on Georges Bank:

(1) Water Temperatures.

In order that the effect of the difference between air and water temperatures upon star intercepts can be more closely studied, it is proposed that the temperatures of the air and surface water be taken when star sights are taken.

(2) Weighting of Sights.

Lieutenant-Commander Adams recommends weighting of star sights according to the feeling of the value of the sights. This feeling would be influenced by factors like wind blowing in the observer's eyes, pitch and roll of vessel, rapidity of motion of star, and clearness of horizon.

Lieutenant-Commander Cowie objects to weighting of star sights because it depends upon the opinion of the observer.

It is felt that the rate of altitude change graphs offer a means by which the adverse effect of the four factors mentioned can be determined numerically, thus making the weight independent of the opinion of the observer; for the greater the adverse conditions, the greater will be the discrepancies. For instance, if the discrepancies between true and observed values on one star average twice as great as on a second star the first star sights should be given 1/2 the weight of the second. This assumes that not less than six sights are taken on each star.

The weighting of star sights was not done during the season of 1930 but will be tested during the season of 1931.

(3) New Type Sextants.

In a region like Georges Bank where frequently stars may be seen when the horizon is hazy or obscured in fog, a sextant independent of the horizon would be an immense advantage. It is understood the pendulum type of sextant gives results accurate only to within ten minutes. Bubble sextants are also inaccurate. Whether a sextant with a bubble sensitive to 1 minute of accuracy could be manipulated by an observer is not known. An article by P. Collinder, of the Royal Swedish Hydrographic Service, in the November, 1930, issue of "The Hydrographic Review" of Monaco, speaks of a gyroscopic horizon. He quotes an article by Monsieur Fave which states that a Fleuriais gyro-horizon gives an error of about 2 minutes in a single altitude, and this regardless of sea and swell. A trial of the gyroscopic sextant might be profitable.

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THE GRIEF BOOK

(From Engineering News-Record)

"Many engineering offices maintain a file or book for recording special difficulties arising on any job. In preparing specifications for a new job similar to one already built, it is customary in one office to bring out the trouble or "grief" book, and by its help to work out a better or simpler detail or substitute a new design. Sometimes a full office conference is held and the brains of the combined staff are focused on the problem which the incident has brought to the front. The value of such a method of recording difficulties and their handling is especially apparent in case of personnel which changes from year to year.

"Sometimes a grief book leads to the production of a manual of procedure and action with reference to many things aside from pure engineering. Government staffs like that of the U. S. Coast and Geodetic Survey have many such manuals continually being revised.

"Grief books in some form have been kept for years. So long as there is room for improvement, whether in human relations or in engineering details, such recording of troubles and their disposal should continue. Some lesson can be learned from each entry, and conscientious study of the record would soon do away with a world of paste-pot specifications."

PROGRESS ON THE EXPANDED PLAN FOR CONTROL SURVEY

Dr. William Bowie, Chief, Division of
Geodesy, U. S. Coast and Geodetic Survey.

On July 1, 1930, the Coast and Geodetic Survey entered a new era in its geodetic work. While its appropriations for the field expenses for this work had been $88,600 during the past fiscal year, that item was increased to about $316,000 for the present fiscal year. Besides, funds were furnished the Survey for some additional engineers for its regular staff. It will be seen that the present appropriation is more than three times the amount that was previously devoted to the control surveys.

The Expansion of the personnel engaged on geodetic work made it necessary at the beginning of the year to purchase additional instruments and a large amount of equipment in the form of trucks, towers and camp equipment. While the Bureau had a reserve supply of instruments and equipment, it was not sufficient to meet the demands of the expanded program and, consequently, a greater portion of the funds were spent for this purpose than will be the case in the future. The field work was devoted entirely to triangulation and leveling.

Triangulation

The following arcs of triangulation were completed during the present fiscal year:

From Columbus, Nebraska, eastward through Iowa to Chicago Heights, Illinois.

From La Crosse on the Mississippi River in Wisconsin eastward to a junction with the triangulation of the Lake Survey in the vicinity of Fond du Lac, Wisconsin.

From Cairo, Illinois, to Nashville, Tennessee.

From Cairo, Illinois, westward to Van Buren, Missouri, where a junction was made with an arc which had been extended eastward from the 93rd Meridian triangulation.

A short arc in North Carolina and Tennessee, made necessary by weakness in previously existing triangulation. The work consisted in reoccupying Stations White Rock, Big Knob, Rogers, Short, Fork, English, Big Butt 1930, Roan High Bluff, and the remeasurement of the old angles.

From Fort Smith, Arkansas, south along the 94th Meridian to the Gulf of Mexico.

From Mobile, Alabama, westward to New Orleans, Louisiana, and thence along the coast to Corpus Christi, Texas.

From the vicinity of Shreveport, Louisiana, eastward through Vicksburg, to Forest, Mississippi.

Work is now in progress on an arc of triangulation which is to extend along the Mississippi River from Cairo, Illinois, to St. Paul, Minnesota. This work is being done at the request of the Chief of Engineers, U. S. Array, who has transferred $35,000 to the Coast and Geodetic Survey to cover the cost of the project. Under a similar arrangement this Bureau had extended an arc of triangulation along the Mississippi River from Cairo to New Orleans in 1929 for the Engineers.

The Coast and Geodetic Survey for some years has been receiving $10,000 for geodetic work in areas of seismic activity. This work is done with a view of laying the foundation for testing earth movements between earthquakes or during an earthquake. It will be recalled that a few years ago the old triangulation extending from central Nevada westward to the Pacific Coast, down the coast to the Mexican border and eastward into Arizona was repeated. From the results an accurate knowledge of the changes in geographic positions of the stations was obtained and a report of this work has been issued as Special Publication No. 151, entitled, "Comparison of Old and New Triangulation in California".

During the first half of the present fiscal year a short arc of detailed first and second order triangulation was extended from Monterey Bay eastward across two or three fault zones. Work on a similar arc running east from Point Reyes on the California Coast was completed. On these two arcs, the triangulation stations were placed very close together where the arc crosses the fault zones. It will be possible, should an earthquake occur along any one of these faults where the triangulation crosses it, to determine with great accuracy the changes in geographic positions of the stations and to arrive at a decision as to how far from a fault earth movements take place. The triangulation executed for these earthquake studies is, of course, available for the control of surveys, maps and other engineering operations.

The work on triangulation was necessarily curtailed during the winter because it is not economical to carry on operations in the southern states with the same sized parties as are used in the north. It is planned that with the present appropriation the first and second order triangulation of the country will be completed in about thirteen years. While it is possible to work in the southern part of the country throughout the entire twelve months of the year, work can only be carried on in the northern part of the country to advantage during about seven months. The part of the country that can not be worked in during the winter is much larger than the part that can be worked in during the whole year. It is economical, therefore, to have larger parties in the north during the seven months that arc suitable for that area than those working during the other five months in the south. By this arrangement there will always be work for most of the engineers and non-technical employees throughout the year.

As a part of the triangulation operations, two parties were in the field determining astronomical longitudes. This work is necessary for the derivation of true azimuths at triangulation stations needed in the adjustment of the triangulation arcs. Another party has been measuring base lines for the triangulation and is still in the field executing this work in the southern states.

Leveling

The following lines of first-order leveling were completed during the present fiscal year:

Highlands to Pleasantville, New Jersey; Sea Isle Junction to Camden, New Jersey; Pendleton to Mt. Vernon, Oregon; Rockton, Illinois, to Escanaba, Michigan; Warsaw, Indiana, to Leipsie, Ohio; Eugene to Redmond, Oregon; Astoria to Newport, Oregon; Rainier, Oregon, to Kelso, Washington; Minneapolis, Minnesota, to Glasgow, Missouri; Ottumwa to Muscatine, Iowa; Mt. Vernon to Vale, Oregon; Elkhart, Indiana, to Walton, Michigan; Hebo to Salem, Oregon; Ladysmith to Green Bay, Wisconsin; Mt. Vernon to Arlington, Oregon; Newport to Albany, Oregon; Grayling to Detroit, Michigan; Drain to Reedsport, Oregon; Wisconsin Rapids to La Crosse, Wisconsin; Murfreesboro, Tennessee, to Stevenson, Alabama; Jackson, Kentucky, to Morristown, Tennessee; Grants Pass, Oregon, to Eureka, California; Lathrop to Bakersfield, California; Moccasin Gap to Roanoke, Virginia; Seligman, Missouri, to Shirley, Arkansas; Farwell to Sweetwater, Texas; Tullahoma to Rockwood, Tennessee; Nashville, Tennessee, to Tuscumbia, Alabama; Arcata to Redding, California; Niland to El Centro to Jacumba, California; El Centro, California, to Yuma, Arizona.

The following leveling lines will be completed or in progress at the end of the fiscal year:

Harpers Ferry, West Virginia, to Harrisburg, Pennsylvania; Crescent City, California, to Reedsport, Oregon; Winnemucca, Nevada, to Crane, Oregon; Malone to Utica, New York, and Abilene to Del Rio, Texas.

Field work is also in progress on a line of levels to extend from Philadelphia, Pennsylvania, to Lewes, Delaware. This line has been requested by the Chief of Engineers, U, S. Army, and the cost of the work, #3,000, will be paid by the U. S. Engineers.

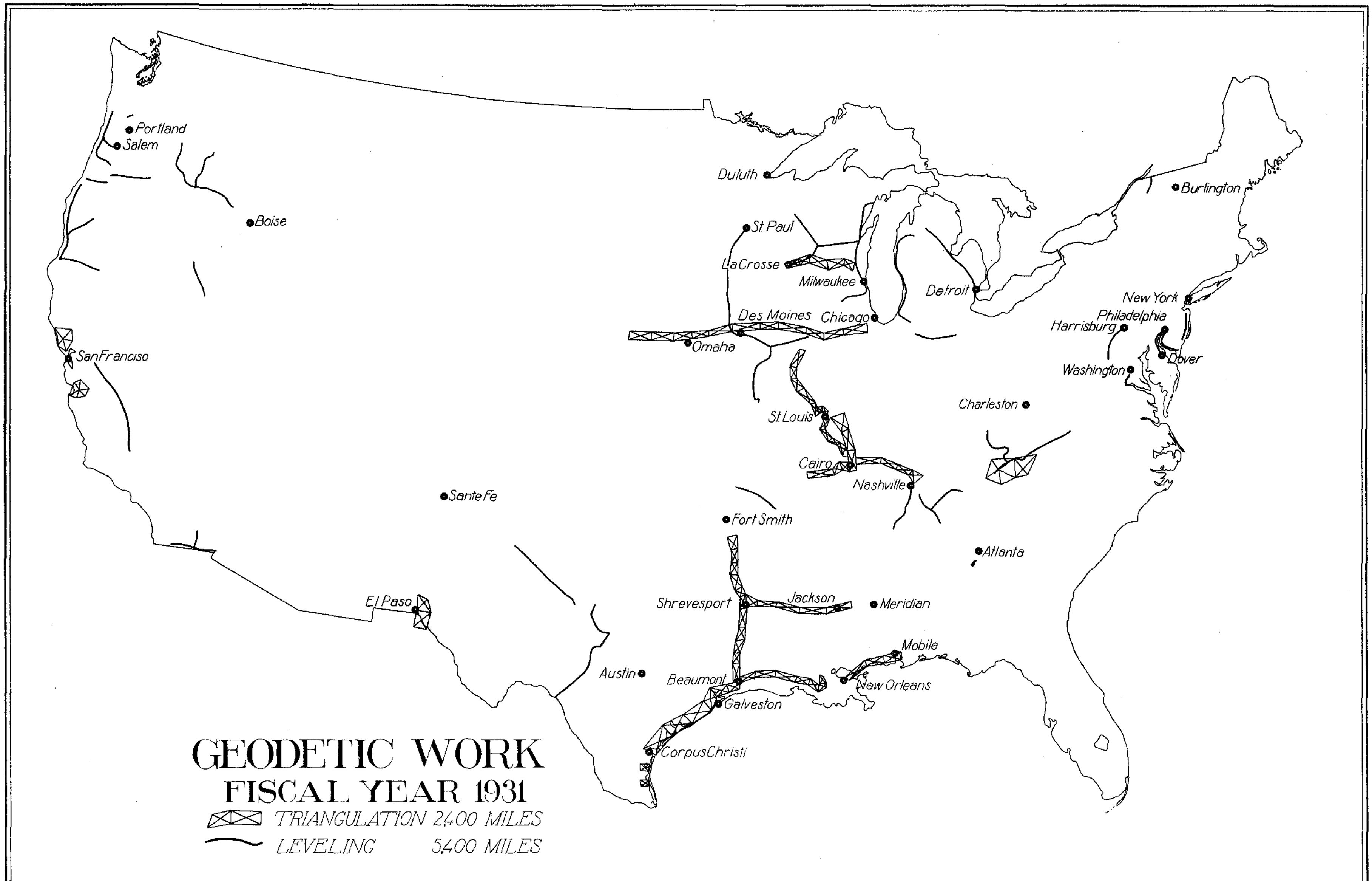
Office Work

Thirty thousand dollars ($30,000) of the new appropriation is available for the employment of personnel in the Washington office. There are now paid from this fund fifteen computers, one draftsman and one clerk. This addition to the regular office force of the Division of Geodesy of the Coast and Geodotic Survey has made it possible to push forward the computations and adjustment of the triangulation and leveling observations and the preparation of the data for publication.

The largest piece of work at the Washington office that is now under way is the readjustment of the triangulation net of the eastern half of the United States. About twelve men arc engaged on this work and it is expected that within a year the most probable values of the junction points of the arcs will be secured. When that has been accomplished the various sections of the triangulation net will be adjusted between the junction points. This adjustment, similar to the one carried out for the western half of the triangulation net, is absolutely essential in order that fixed geographic positions may be available. Every country has to go through the same process that has been followed here. An arc of triangulation is extended across an area and from it branch out other arcs. Adjustments are made of the arcs as they are run, but eventually it is found that in fitting the new arcs to old ones they have to carry larger corrections than are justified. There is distortion of the new work in consequence. All of this distortion is eliminated by adjusting the net as a whole. When this last adjustment is made, no further upsetting of geographic positions will be made. The new arcs crossing loops closed by existing arcs can be fitted into the old work without any violence being done to the recent work.

Work is in progress on the distribution of corrections to the elevations of bench marks resulting from the adjustment of the combined level nets of Canada and the United States. About 66,000 miles of leveling were involved in the adjustment which gave the most probable elevations of the junction points in both countries. Canada finds it impracticable at this time to adopt the elevations furnished by the general adjustment as only a few years ago an adjustment was made of the Canadian net and the results have been published and used as a basis for a number of large engineering works. The bench marks common to the two nets along the International Boundary will be given elevations by the United States resulting from the adjustment of the combined nets, and equations will be given showing the difference between the Canadian and United States elevations for these points.

So far as is practicable, the Director of the U. S. Coast and Geodetic Survey is planning to meet the most urgent needs of the officials of the Geological Survey and of other Government organizations and of state and county governments. After the present fiscal year, the triangulation net of the United States will be in such condition that no additional arcs will be needed for the main adjustments and, therefore, arcs will be placed where they are of the greatest immediate benefit. The officials of the United States Coast and Geodetic Survey are in very close cooperation with the officials of the United States Geological Survey with a view to planning the geodetic work in such a way as to meet the requirements of the topographic surveying and mapping operations. As a matter of fact, the additional appropriation was made to the Coast and Geodetic Survey because of the needs for the triangulation and leveling as the basis for the topographic work.



C&GS Print (R-162)

COASTAL TRIANGULATION

C. A. Egner, U. S. Coast and Geodetic Survey.

In laying plans for the establishment or extension of a scheme of triangulation, certain considerations are present which are quite common to all such projects regardless of location. Among these, without order of precedence, may be enumerated the following: (1) economy in reconnaissance and building, (2) coordination of existing work, (3) accessibility, not only for the observing party, but for those succeeding organizations and individuals who may at some future time make use of the stations and lines established, (4) provision for future extension laterally or within the confines of the figures themselves, and (5) permanence of stations.

The real value of such a scheme lies as much, in the way in which it serves other purposes as it does in the accomplishment of its immediate object.

Narrowed down somewhat, a scheme of coastal triangulation is one which must follow the customary rules of the game, but which has ends to serve which are not particularly geodetic. Hydrographic and topographic work which is required on the coast line and offshore areas, and on rivers and sounds adjacent thereto, must have triangulation for proper control. If not remote from a first order scheme, this work need not be of a high order of accuracy; it must, however, be comprehensive enough and strong enough to tie together all independent projects and gather together the loose ends scattered here and there from many years of previous surveying work.

Where the high grade, accurate type of triangulation can be placed along the actual coast, the problem is much simplified, for then the coastal scheme can easily be woven into it. It often happens that only a weak, extended scheme is possible close to the sea; then the control will eventually break down and a way must be provided for strengthening it at intervals by joining it to a higher order of work perhaps some distance away.

Some localities are favored by nature; high ground is found immediately back from the coast, and highways and waterways parallel the shore making transportation a simple matter. In other places there are few favorable conditions. The southeast Atlantic Coast from Georgetown, S. C., to Jacksonville, Fla., is not one upon which nature smiled particularly from a surveyor's point of view. Part of it, from Beaufort, S. C, to Savannah, Ga., is quite typical of this area and has recently offered a problem similar to the general one which must be met over two hundred miles of the Atlantic seaboard.

Here is an area of low ground for some ten miles or more back from the coast, broken by rivers and channels of tide water which divide the land into marshy islands covered by clumps of trees which reach a height of a hundred feet or more. Some islands arc quite extensive, formerly cultivated in large plantations of sea-island cotton justly famous for its quality; others are islands only by virtue of shallow muddy sloughs at high tide which cut them off from the large ones and from the mainland. Travel by boat is the only means of going from one to another. There are no bridges, generally speaking, for twenty miles inland. The larger rivers reach the sea normal to the coastline, with large sounds formed near their mouths. In the area under discussion, Port Royal and Calibogue Sounds are typical examples.

The roads found in this section are mostly on the mainland, and are likewise normal to the coast, acting as feeders for the main arteries some distance inland. They are almost valueless in transport problems parallel to the coast.

The rivers are large enough to be navigable for moderate sized craft, as are most of the smaller channels. In fact, access may be had to a large share of this swampy area at high tide in small boats.

Much of the country had considerable importance in the "good old days" when fine cotton was grown on these islands. This led to the building up of the towns on the shores of the sounds and rivers. In such cases as Port Royal Sound, this importance led to fortification and establishment of military areas which are prominent to-day. Parris Island is the training ground of the U. S. Marine Corps.

The offshore waters are similar from Sandy Hook to Florida, being shallow for miles and generally of a changeable nature due to deposits from the large streams. The flatness of the coast has necessitated a type of hydrography which is pertinent to the subject of control from the necessity of erecting and locating towers which can be seen a great distance offshore.

In recent years there has been a startling increase in motor boat travel between the northern seacoast cities and Florida. These boats are too small to brave the outside waters, so there has been a growing demand for a suitable inland waterway. This route has been developed through the area under discussion by taking advantage of existing rivers and channels improved where needed. It is natural that this route is very crooked, many sections lying close to the coast and others as much as twelve miles inland. The development of this route and its future improvement to accommodate vessels of greater draft has become a major consideration in Coast Survey plans in all work undertaken in these adjacent localities.

Likewise, the recent use of aerial photographs in mapping has reached the stage where there is contemplated such a method of mapping the entire Atlantic seaboard as a necessary adjunct to the revision of the survey of this waterway and coast. The character of the ground makes the usual topographic methods very laborious and offers an ideal site for such work.

In the upbuilding of this country in Civil War days, there was a great deal of activity by the Coast Survey in providing control and in surveying the navigable waters. Work started as far back as 1858 was supplemented frequently in the last century. Much has been done of a revision nature in recent years with more particular attention being paid to hydrography of the deeper sounds and offshore areas. Each separate survey has gone to previous work for its basis. Many stations have become lost and there has been much faulty remarking of old ones found. Each scheme has become successively weaker due to this fact. It is no exaggeration to say that the control had become a hodge-podge of fragmentary triangulation, every one detailed enough for the survey based upon it, but poorly coordinated with its neighbors.

Plans are now afoot for an arc of first order triangulation extending from New York to Miami. A prime function of this arc will be the coordination of all coastal surveys along this coast. The character of each section will largely determine the method used in tying this arc to these separate schemes.

Modern methods of carrying on first order work call for the use of steel towers. Transportation facilities are therefore imperative. For efficiency and economy, this indicates that the reconnaissance will be confined chiefly to that area which can be readily reached by truck. In view of the difficulties pointed out as regards transportation, it is highly probable that the first order scheme will be placed on the higher ground back from the low, swampy ground.

This work will involve lines of a length suitable for such work. Such a length will be too great to effectively tie the smaller schemes together for the reason that to do so the main scheme will have to be supplemented by figures reaching into the channels where the small schemes are placed. It will "go over the heads", so to speak, of these. The inside route, where near the coast, will have few, if any, points of contact. It is unsatisfactory to tie a line of a very small scheme to one of the main scheme for a number of reasons: (1) The main scheme will be observed at night; intersection on the smaller stations can not be made at night. It means daylight observing at both ends; also, the erection of poles and targets on these smaller stations and practically a supplemental party for this work which would be unable to maintain the progress of the first order observers, (2) The reconnaissance for the first order arc would have to become involved in the recovery and reconnaissance for the small parts too. It would be uneconomical to restrict the position of the main scheme stations to such places as will suit these connections. Experience shows that the recovery of old stations is no small matter. Frequently temporary stations have had to be built and located in order to find the one searched for. (3) If attempted by intersections only, with the drawbacks noted above, it will leave only isolated geographic positions without accompanying satisfactory azimuths and distances — little real basis for adjusting the smaller schemes. Also, there are few objects in this locality suitable for such intersection. Most tanks and stacks have been located by intersection from the smaller stations and are correspondingly weaker than those small stations themselves. These would provide small basis for adjustment and give no data for future expansion. The erection of towers on the coast expressly for this kind of location runs against the old problem of transportation, for they would have to be high and consume a great deal of time, and they would still have to be tied to the smaller lines.

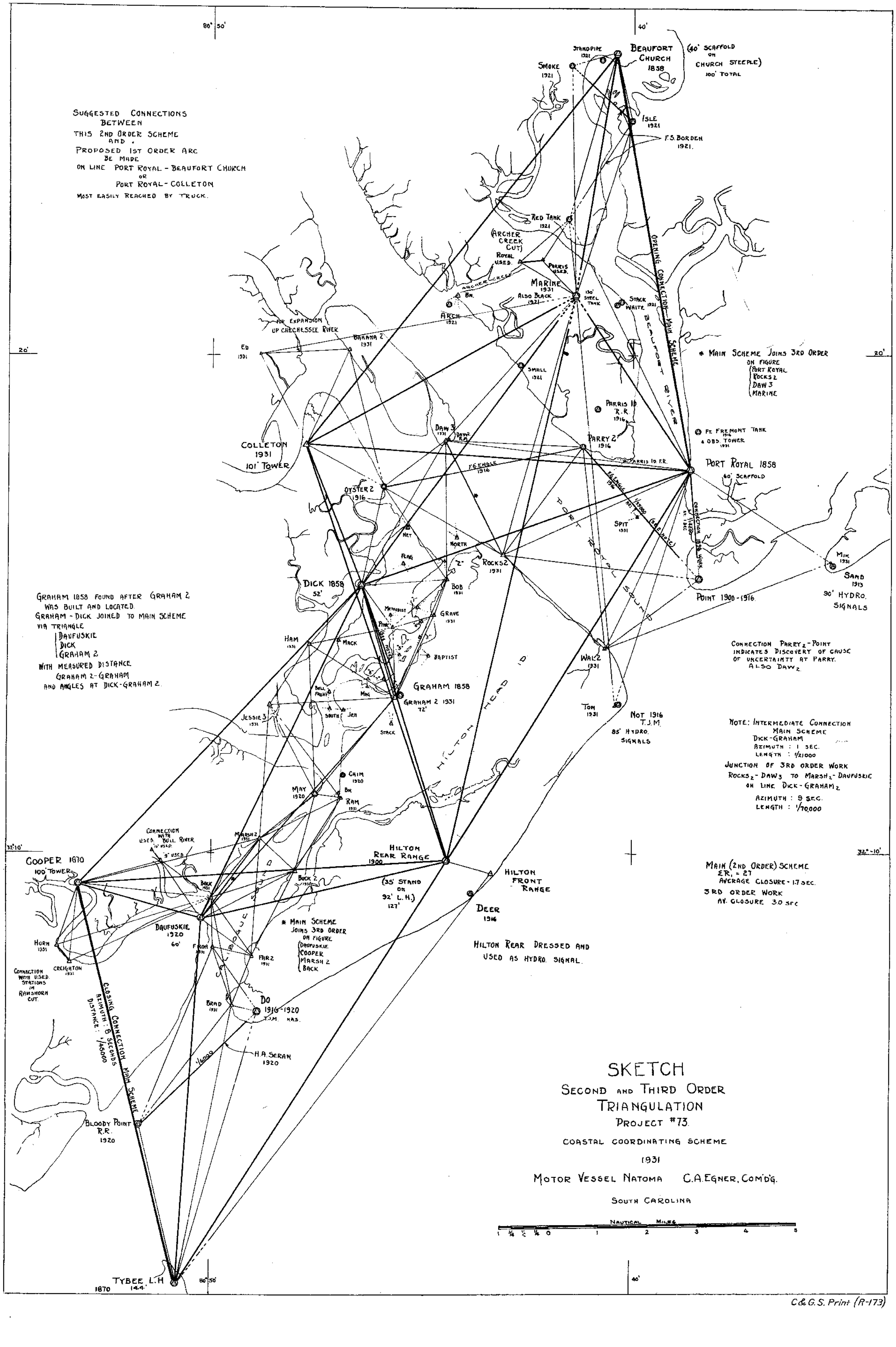
A recognition of these factors helps to define the problem of coastal triangulation. Such a scheme should combine the following advantages:

(1) Easy junction with the projected first order arc.
(2) Coordination of all existing work in the locality.
(3) Control for aerial surveys.
(4) Basis for future expansion.
(5) Usefulness in hydrography and topography.

On the ground, where the trees always seem higher, the mud deeper, and the launches slower, it was decided to make the layout in the manner shown in the accompanying plate. As in all such things, and as will be found in a similar way in the remainder of this long 200-mile section, there were difficulties and antagonistic elements, as well as some most fortunate ones. The work was done as a part of combined operations. This worked both ways. While it raised the unit cost due to a ship's overhead, and there was the constant necessity of keeping all operations parallel, thus handicapping each more or less as is always the case in combined operations, it had the distinct advantage in that the connections were made for immediate use. Difficulties were ironed out at once, lines were made to actually see through, points were selected advantageously for the hydrographer and topographer, checks were determined on the ground. Too much stress can not be laid on the above points. It was possible for one party to see the thing as a whole. Furthermore, there was a great saving in that it reduced to a minimum the expense of signal building. Towers and small signals alike were built only once, many of them serving for other operations when the trian gulation was finished.

Some of the reconnaissance was easy, some otherwise. Invariably the tall towers had to go higher than was first planned. In this area as well as along this coast, trees are a serious hindrance. The recovery of stations was difficult. There was unusual good fortune (combined with much preliminary work) in recovering six important stations of work done seventy years ago. No doubt that experience will be repeated by others elsewhere, for it has been found that the old stations were generally well marked and simply await sufficient search. There are many similar ones along this coast.

The plate attempts to show the general idea behind the work. The larger figures are of second order accuracy, based on recovered stations of a chain of single triangles of first order work laid down in 1858-1870. This was expanded as shown to make completed quads or similar figures. This forms the framework. Following this, a line of each of all the separate independent schemes in the locality was recovered, with a check if possible, and these were then woven into the frame. Lastly, a chain of third order figures was stepped down from these, carried through and tied again to the main second order work at the lower end. Spurs were run laterally to serve the offshore hydrography and to provide for expansion when that became advisable. Tied to the third order figures are numerous intersection stations for topographic and hydrographic control and for the aerial photography to come later.



C&G.S. Print (R-173)

In this way, each and every station is bound rigidly to all others, all the previous work now has the same basis, and when the first order arc passes this way, it is sufficient that a single line of the second order work be tied to it (for which provision has been made by the selection of two or more stations where this connection can be made) in order that this area be tied to all others along the coast.

Conclusion.

While it may seem that the problem presented and the method of solution chosen are ones which fit one localized condition, it is also true that these circumstances are to be met over an extended section of this coast involving much future time and expenditure of money. The general principles are common to all such schemes and this method is one which can be carried out by a party specially organized for the work or as a part of combined operations of a unit small enough to use these inland waters.

In general, it can be said that the problems of transport, of reconnaissance and building, etc., are much the same as will be found elsewhere, particularly from Winyah Bay to the St. Johns River.

COMMENTS ON THE ABOVE

F. S. Borden, U. S. Coast and Geodetic Survey.

Lieutenant Egner's article brings out many of the problems that must be considered in planning and executing coastal triangulation if the results are to serve past, present and future control purposes. The recent work accomplished by his party, as indicated on the accompanying reduced copy of his progress sketch, furnishes, in my opinion, the solution of the major problems that will be encountered on the south Atlantic coast.

The original basic scheme in that region is for the most part gone. However, on that scheme and on the many fragmentary schemes which are loosely related to it hangs every chart of the south Atlantic coast. In addition to hundreds of our own topographic and hydrographic surveys, there are other hundreds of U. S. Engineers' surveys, vitally essential to our charts, which are in one way or another dependent for position on this poorly coordinated triangulation system. It is obvious that any new coastal scheme, no matter how accurate or how comprehensive, can not be considered adequate unless it provides for binding all the elements of this older system to it.

Some of the previous small schemes are in themselves of satisfactory accuracy, but unfortunately most of them start from lines of doubtful length and azimuth. This condition has resulted largely from poor recoveries or from schemes having been started from lines based on inverse computations between tyre stations, one of which, at least, was of the intersection or fourth order variety. Such a take off almost invariably means that the work starts from a base having a high percentage length error and badly twisted in azimuth. In many instances this manner of starting a scheme of triangulation has been considered by the chief of party as an economic necessity. Not being able to find a conveniently located basic line, he has practically been forced by the high overhead of his party to use intersection stations, such as steeples, tanks, cupolas, etc. For the particular survey work in which he was interested, the control he established may have been satisfactory, but from the standpoint of complete coordination of triangulation for the locality, he was, in reality, only adding one more weak link to an already weak chain. It is apparent that a continuation of this practice means a gradual degeneration of triangulation and ultimately results in hopeless confusion. Satisfactory adjustment and publication are out of the question.

To prevent such degeneration of basic triangulation, it is my opinion that whenever a new scheme is extended along any coast, whether on the Atlantic or in Alaska, the chief of party should break up the main scheme and provide, by means of supplemental schemes, recoverable lines where they will be readily recoverable and accessible to serve all the purposes required of them. If this is done the economic necessity for using inverse computations as a means of obtaining a distance and azimuth will be avoided. As Lieutenant Egner has stated, the main scheme generally "goes over the head" of the detailed surveying work required. Its purpose is to carry strength through the system, and in the majority of cases, its practical use is given only secondary consideration.

The triangulation accomplished by Lieutenant Egner's party solves these problems. Not only does the scheme bind together all previous odds and ends and bring them out where the proposed first order arc can readily make line connections, but it provides frequent lengths and azimuths, having a high order of accuracy, where they are readily accessible for any of the following practical purposes:

(1) To make line connections, <u>without rapid expansion</u>, with U. S. Engineer control schemes.
(S) For the location, <u>with strong intersection angles</u>, of new permanent aids to navigation, landmarks, photo control points, tall hydrographic signals, etc.
(3) For the use, <u>in the most convenient form</u>, of other agencies or private engineers desiring accurate lengths and azimuths.
(4) For the extension, <u>with the minimum of delay</u>, of schemes up the tributary rivers.
(5) For the replacement, <u>without loss of accuracy or coordination</u>, of Lost basic stations.

Attention is called to the comprehensiveness of Lieutenant Egner's progress sketch. Because it is impossible to adjust and publish triangulation for long periods of time after it has been accomplished, it will be necessary to send copies of his sketch to our own survey parties and to outside agencies for some years to come. The detailed information shown on it is certain to be helpful to anyone interested in the control, or the extension of control, in that region. Furthermore, it will be of considerable assistance to the mathematician who eventually adjusts the triangulation along the South Carolina coast.

ORGANIZATION OF PARTY ON THE SHIP OCEANOGRAPHER FOR HYDROGRAPHIC WORK ON GEORGES BANK, 1930

F. L. Peacock, U. S. Coast and Geodetic Survey.

The locality of the 1930 surveys was the eastern portion of Georges Bank. The edge of the continental shelf is farther from land in this locality than any place elsewhere along the coast of the United States. The position fixing was limited to methods other than visual fixes on land objects.

Currents in this area are strong with the maximum three knot current encountered almost daily approached. Under such conditions, precise dead-reckoning surveys are inadequate to meet present day requirements.

The instructions for the work proposed to combine precise dead-reckoning methods with all of value that could be obtained from radio acoustic ranging and the use of the radio direction finder. This necessitated a floating stationary unit to act as a hydrophone station and radio compass station in addition to the mobile surveying unit. The Ship LYDONIA was the floating stationary unit. The Ship OCEANOGRAPHER was the mobile surveying unit.

The combination of methods specified necessitated the obtaining and recording of an enormous amount of data in such shape that the smooth plotting could be accomplished with confidence and with the maximum facility practicable. Coordinated effort of personnel and central control were essential.

The work of accumulating and recording the data aboard the mobile surveying unit was early seen to center about six stations, namely, the Chartroom, the Bridge, the Radioroom, the Bombing Station, the Logs, and the Standard Compass. On the OCEANOGRAPHER these six stations are more widely separated than is ordinarily the case on our survey vessels.

In order to have coordinated effort and the proper degree of central control, communication systems interlocking all stations were necessary. Communication between several stations at the same instant without conflict was also a requirement. This necessitated several separate systems. Telephone, signal light, speaking tube, whistle signals, and messenger were all utilized.

COORDINATION OF TIME:

To insure that there would be no confusion between records, it was essential that accurate time of the same standard meridian be kept at all stations. This was accomplished by frequent comparisons of time pieces. It was attempted to keep the clocks in the chartroom, the radioroom, on the bridge and at the bombing station in unison to a second of time. Time comparisons were made over the communication lines at such times as would not interfere with other communications and were about hourly.

CHARTROOM STATION;

Personnel:

- Officer in charge.
- Fathometer Officer.

Apparatus:

- Chart table.
- Field Sheet.
- Fathometer.
- Sounding record.
- Electric log.
- Clock.

Communications:

- To Radioroom — telephone and messenger.
- To Bombing Station — telephone (indirect).
- To Bridge — Speaking hatch.
- To Taffrail Logs — Messenger.
- To Standard Compass — Messenger.

Duties:

- Officer in charge:
  - Full direction and supervision.
  - Specify courses to be steered and plot all data received.
  - Specify sounding intervals, position intervals and bombing intervals.
- Fathometer Officer:
  - Read fathometer and electric log
  - Record:
    - Soundings by fathometer.
    - All log readings.
    - All changes of speed and course.
    - All bombing times.
    - All times of visual and radio bearings.
    - All visual bearings.
    - Other data as directed or necessary to make sounding volume complete.
  - Transmit all messages to and from the officer in charge which must pass over the telephone.

BRIDGE STATION:

Personnel:

- Watch Officer.
- Helmsman.
- Two messengers.

Apparatus:

- Steering Compass.
- Steering Wheel.
- Pelorus.
- Clock.

Communications:

- To Chartroom — Speaking hatch and messenger; also whistle signals.
- To Radioroom — Speaking tube.
- To Taffrail Logs — Whistle signals.

Duties:

Watch Officer:

Con ship.
Con helmsman.
Observe visual bearings.
Sound fog signals when necessary and see that they do not interfere with other signals or with R.A.R. reception.
See that taffrail log readers take station.
Give signal for log readings.
Obtain reading of ship's head at all radio compass bearings.
Obtain distances to all buoys passed close to when abeam.
Record all changes of course and speed and all visual and radio compass bearings.

Helmsman:

Steer ship.
Note ship's head at instant of visual and radio compass bearings.

Two messengers:

Take station to read taffrail logs as directed.
Read taffrail logs on signal, record same and take them to chartroom to be recorded in sounding volume.
Carry messages as directed.

RADIOROOM STATION:

Personnel:

Chronograph Officer.
Radio operator on watch.

Apparatus:

Standard wave transmitter and receiver.
Short wave transmitter and receiver.
Chronograph and allied apparatus.
Radio direction finder.
Clock.
Bomb record.

Communications:

To Chartroom — telephone and signal light.
To Bombing Station — telephone and signal lights.
To Bridge — Speaking tube and buzzer.

Duties:

Chronograph Officer:

To maintain R.A.R. apparatus in working adjustment.
To operate chronograph.
To observe radio compass bearings.
To scale chronograph tapes.
To keep bomb record; also to record in bomb record wind and current data as received from station ship and all radio compass bearings.

Radio Operator:

Under direction of the chronograph officer, to maintain short wave radio communication with the station ship as necessary and to assist in obtaining radio compass bearings.

BOMBING STATION:

Personnel:

Bombing Officer.

Miscellaneous part-time assistance.

Apparatus;

Bomb materials.

Electric heating element.

Clock.

Communications:

To Radioroom -- Telephone and signal lights.

To Chartroom -- Signal light.

Duties:

Bombing Officer:

To supervise the making of bombs.

To drop lighted bombs at the regular specified intervals and at other times as directed.

Assistants:

To assist in the making of bombs under the direction of the bombing officer.

TAFFRAIL LOG STATION:

Personnel:

Two messengers from bridge.

Apparatus:

Two rated taffrail logs.

Record book.

Communication:

From bridge — whistle signal.

To chartroom — personal travel.

Duties:

To read and record the taffrail logs on signal from the bridge and carry these readings to the chartroom for permanent recording in the sounding volume.

STANDARD COMPASS STATION:

Personnel:

One seaman, relieved each hour.

Apparatus:

Standard compass.

Record book.

Clock.

Communication:

From officer in charge — messenger.

Duties:

To read and record the ship's head by standard compass on each minute and half minute.

NOTES ON ROUTINE:

Some further notes on the functioning of the organization above detailed are necessary to a full understanding of its workings.

The usual position interval was fifteen minutes or on the hour, the quarter hour, the half hour and the three-quarters hour. Positions were also recorded at each change of course or speed, at each visual hearing and at all bombs. In so far as was practicable, all these were caused to happen at the regular position intervals, but sometimes they necessarily occurred at odd times. All logs were read at each position unless impracticable.

Soundings were recorded each minute in depths less than forty fathoms and each two minutes in depths over forty fathoms except that all critical soundings (not strays) were recorded and on steep slopes soundings were recorded as fast as possible to read them and write them down.

The bombing interval was ordinarily every half hour on the hour and the half hour. This was frequently shortened to fifteen minutes on development work. In tying in to the station ship during heavy fog, it was also customary to tie in with a series of six or more bombs while passing the LYDONIA, all detonated within a twenty-minute period.

The following chronological table is fairly typical of what occurs in a half hour period on sounding line under this scheme:

h. m. s.	
10:55:05	Officer in charge instructs slight change of course on next position.
10:56:00	Radio operator requests LYDONIA to stand by to observe radio compass bearing.
10:56:10	Radio operator starts sending signal on standard wave.
10:56:50	Radio operator ceases sending signal.
10:57:00	Radio compass bearing received by radio from LYDONIA together with time of observation and is recorded in the bomb record and reported to chartroom.
10:58:00	Taffrail log readers sent to station at taffrail logs. Tuning of short wave set tested.
10:58:30	Chronograph officer instructs bombing officer to stand by with a specified size of bomb. Visual signal shows in chartroom.
10:59:00	Radio operator requests LYDONIA to stand by to receive bomb on short wave set.
10:59:15	Bombing officer signals "ready". Visual signal shows in radio-room and chartroom.
10:59:45	Bombing officer lights fuse.
11:00:00	Whistle blows on bridge. Bomb dropped overboard. Switch closed at bombing station and pulled for long dash. Light flashes in front of chronograph officer. Light flashes in front of Fathometer officer. Chronograph started by chronograph officer. Radio operator sends long dash to LYDONIA. Taffrail logs read. Fathometer read. Electric log read. Visual bearing of LYDONIA observed on pelorus. Ship's head noted. Course changed.
11:00:19	Bomb registers on chronograph tape.
11:00:20	Bridge reports visual bearing.
11:00:25	Messengers arrive in chartroom with taffrail log readings,
11:00:48	Bomb return registers on chronograph tape.
11:00:50	LYDONIA reports amplitude of bomb current. Chronograph stopped.

11:01:00 Radio operator requests LYDONIA to send signal for radio compass bearing. Bridge notified to stand by to read ship's head.
11:01:10 Signal from LYDONIA starts.
11:01:30 Radio compass bearing observed. Buzzer sounds on bridge. Ship's head noted.
11:01:40 Signal from LYDONIA ceases. Bridge advises chartroom and radioroom of ship's head at instant of bearing. Radioroom reports radio compass bearing to bridge and chartroom.
11:02:00 Chronograph officer scaling tape.
11:03:00 Messengers return to bridge.
11:05:00 Chronograph officer reports bomb distance to chartroom.
11:10:00 LYDONIA reports by radio the direction and velocity of current and wind as observed at 11:00:00.
11:12:00 Wind and current data received in chartroom and also recorded in bomb record.
11:13:00 Bridge messengers take station at taffrail logs.
11:15:00 Whistle blows on bridge. Taffrail logs read, fathometer read. Electric log read.
11:15:30 Messengers arrive in chartroom with taffrail log readings.
11:17:00 Messengers return to bridge.
11:25:00 Officer in charge instructs slight change of course at next position.

The foregoing table does not, of course, detail all happenings. The Fathometer and standard compass readings have been continuously observed at the prescribed intervals and recorded. Many data, not specifically mentioned in the table, have been systematically recorded and the chronograph tapes have been folded, indexed and filed away. The plotting on the field sheet has been brought up to the 11:15 o'clock position.

Should the bridge whistle and the light flash indicating "bomb over" not be simultaneous, each time is noted and recorded by the Fathometer officer as a position. The electric log is read on each in such cases.

EFFECTIVENESS:

The organization detailed has proved highly effective in obtaining the desired data and in getting it recorded in available form.

The principal hindrance to full effectiveness during the 1930 season was lack of sufficient officer personnel.

The outlined organization requires five persons capable of exercising discretion and judgment in considerable degree.

To operate efficiently throughout the twenty-four hours of the day would require fifteen such persons. On account of the necessity for the station ship, it is important that the productive hours of the mobile surveying unit be a maximum.

Only seven officers were available on the OCEANOGRAPHER during the 1930 season. They were utilized as follows:

Officer in Charge -- one available -- no relief.
Watch Officers -- two available -- watch and watch.
Chronograph Officer -- one available -- no relief.
Fathometer Officer -- two available -- watch and watch.
Bombing Officer -- one available -- no relief.

The loyalty and interest of these officers was such that periods of fifteen hours or more of full operation were very frequent.

The organization outlined does not presume to be the final word in organization for this class of work. It represents only the experience of the first season. Much improvement rath further experience is foreseen.

Attention is directed to the following; possibilities: The addition of another electric log and an engine revolution indicator in the chartroom would obviate any necessity for taffrail logs. This would be a decided advantage in waters where fog is so prevalent and traffic so heavy.

The installation of a gyro-compass, automatic steerer and course recorder will eliminate any necessity for reading the standard compass and greatly reduce the labor of preparing the courses steered for plotting.

These two steps would reduce the number of stations from six to four and concentrate the supervision required just that much.

It is possible that enlisted personnel could be secured capable of handling the bombing station safely with only moderate officer supervision. Considerable discretion should, however, be exercised in putting this into effect on account of the serious consequences attendant upon any detonation of explosives aboard the vessel itself.

For future work of this kind, an increase of responsible personnel to the following extent is recommended:

Officer in Charge	Commanding Officer and Executive Officer alternating.
Watch Officers	Three officers, 4 hours on and 8 hours off.
Chronograph. Officer	Two officers alternating.
Fathometer Officer	Three officers, 4 hours on and 8 hours off.
Bombing Station	One officer. TWO bombing electricians, 4 hours on and 8 hours off. Officer to exercise adequate supervision at all times.

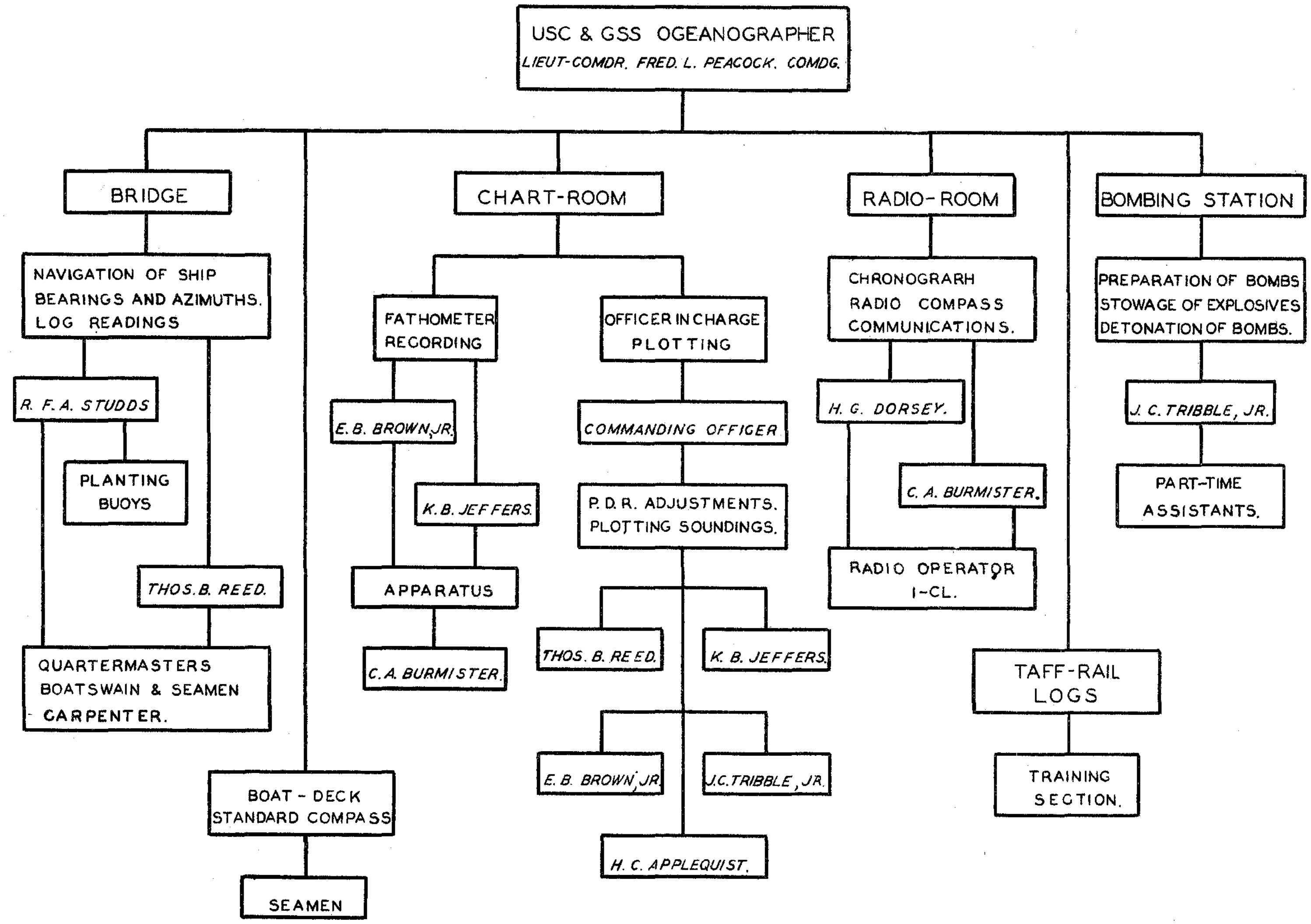
Number of officers required, 11 besides Chief Engineer, or four more than the number available last season.

The party organization for the 1930 season is shown on the accompanying plate.

PARTY ORGANIZATION

U.S.C. & G.S.S. OCEANOGRAPHER

1930



C&GS Print (R-165)

COMPILATION OF AERIAL PHOTOGRAPHS OF THE EAST COAST OF FLORIDA

W. J. Chovan, U. S. Coast and Geodetic Survey.

The east coast of Florida, southward from Ormond, was photographed with a four lens camera by the Army Air Corps in 1928. Compilation from the photographs of standard 1:20,000 scale topographic sheets, without contours, was undertaken by the Coast and Geodetic Survey and has been completed except for certain areas south of Miami for which, until recently, no control has been available.

CONTROL.

The following ground control (see Fig. 2) was used in making the compilation:

(a) Triangulation or Traverse Stations: These were spaced approximately two miles apart along the coast. The majority had been established by field parties engaged on hydrographic survey projects in the locality. They were sufficiently well described and referenced to permit being located on the photograph.

(b) Photo Control Topographic Sheets: The purpose of these (scale 1:20,000) was to give added control mostly in the direction of the trend of the coast. The information shown thereon amounts to that usually shown on a shoreline revision sheet. The work was accomplished by ship sub-parties in connection with the location of inshore hydrographic signals. For the specific purposes of photo control, a considerable number of objects identifiable on the photographs were located, as were the centers of roads leading back from the shoreline and the centers of intersecting roads near the shoreline.

(c) Supplemental Control: Where the control under (a) and (b) was confined to a very narrow strip along the shoreline, it was necessary to supplement it in the interior, inasmuch as the photographs embraced a strip from 3 to 5 miles wide. This was done by the party which made the field inspection of the character and culture of the country. Roads normal to the coast at approximate distances of five miles apart were traversed with a 300-foot steel tape. Solar azimuths were obtained on the traverses. Distances along the traverses between cross roads, railroads, etc., were noted.

Marking Control Points on Photographs

All control points mentioned above are identified under the stereoscope and the positions carefully pricked on the photograph with a needle point. The accuracy of the radial plot depends upon the accuracy with which these points are identified and marked.

Marking Subsidiary Control Points.

In order to keep the adjustment of detail as small as possible when tracing from photographs, not less then nine well distributed points on each picture of the composite photograph were selected, for example: Nine points should appear on the center, tail and two wing pictures as shown in Figure 1.

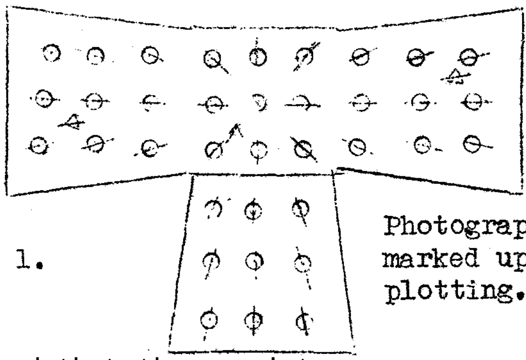


Figure 1. Photograph marked up for plotting.

It will be noted that those points appear approximately in lines of threes on each picture. Each line of points must show in a zone of overlap common to a series of three photographs. The points in question must be images of well defined natural objects so that exactly the same points can be identified and marked on each one of the series of three overlapping photographs. The point where its lens axis intersects the central print is called the principal point of the photograph. The principal point is indicated by collimating notches which register on the margins of the photograph as the exposure is made. Before the margins are trimmed off when mounting the composite prints, the principal point is marked on the center print of the intersection of lines drawn from these notches or pricked through by means of a templet held on them. If the principal point or optical center of a photograph happens to fall on the image of some well defined object, it is used as the center point, but if this can not be done, another point is chosen along line of flight and as close to the principal point as possible (Figure 3). This selected point will hereafter be referred to as the center point. All radials are drawn from the principal point and not from the center point. The center point is used to hold the azimuth while making the radial plot and later as a control point in adjusting detail. If any important features are noted on the photographs while marking subsidiary control points, such as docks, landmarks for charts, etc., they should also be identified and marked.

It can be seen (Fig. 3) that the center line of points over the center and tail pictures are the successive centers of photographs and represent the direction of the line of flight.

Triangulation points are marked on the photographs with small red triangles and all other points with small red circles. The principal point of each photograph is marked in pencil with a small cross.

Short, straight, red lines radiating from the principal point are now drawn through all subsidiary points. It is important that these

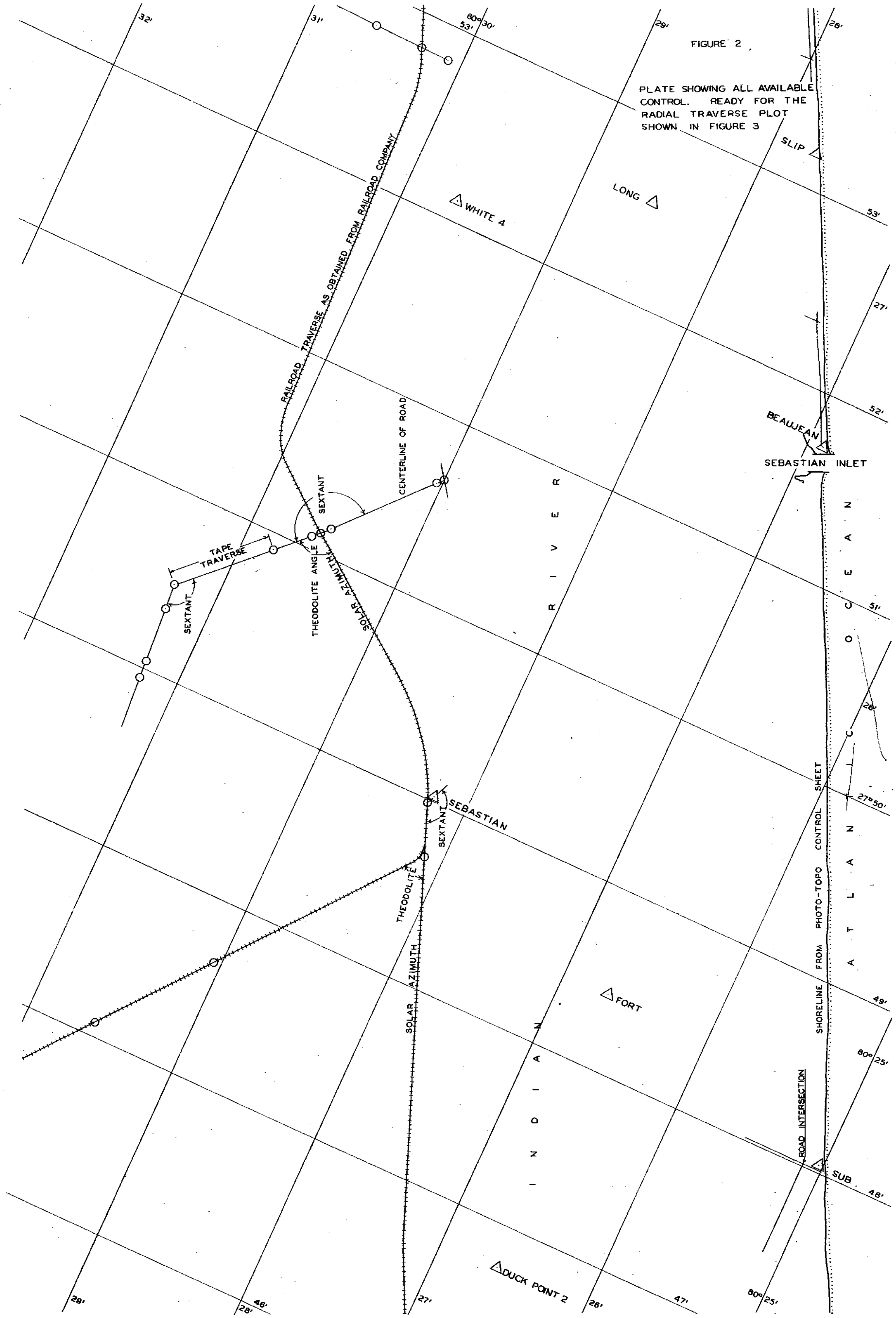


FIGURE 2.

PLATE SHOWING ALL AVAILABLE CONTROL. READY FOR THE RADIAL TRAVERSE PLOT SHOWN IN FIGURE 3

(R-137)

radial lines and the lines subsequently traced over them on the celluloid sheet be kept as fine as practicable. The fineness of the draftsmanship of the radial plot and the precision with which the control is spotted on the photographs are the factors which have most influence in determining the accuracy of this method of reducing the photographs.

PRELIMINARY PLOT.

The photographs were taken at an altitude of about ten thousand feet, with a lens of 6½-inch focal length. This gives an approximate scale of 1:19,000. However, as is generally the case, constant altitude was not held throughout so that a preliminary plot, made by the following method, is used to obtain the average scale of the photographs of the sheet in question: Only the center points are used in making this plot. The first photograph is placed under a celluloid sheet in approximate orientation and the position of its center point and the image of the center point of the following picture are marked on the sheet. Radial limes are also drawn through all triangulation stations appearing on that photograph. The following picture is then placed under the celluloid sheet, making the images of the same points coincide with the dots previously marked on the celluloid. When these points do not coincide, due to a difference in scale, the difference is averaged and the azimuth retained. The position of the center point of the following picture is marked and radial lines are drawn through all triangulation stations appearing on this picture. The intersections of the radial lines traced from the pictures locate the triangulation stations on the preliminary plot. The same procedure is followed throughout the sheet with the remaining photographs. Due to the averaging of the differences between centers of pictures, a triangle of error may appear at the position of some of the triangulation stations.

The most probable positions for such stations are marked on the celluloid. The distances between all triangulation stations appearing on the celluloid are measured and tabulated, and the scale factor determined as follows:

TABLE 1

Stations	Celluloid distance measured on scale 1:20,000	True Distance	Scale Factor (column 2 divided by column 3)
White 4 - Duck Pt. 2	11744	11087	1.059
" - Sub	11342	10700	1.060
" - Sebastian 2	6551	6186	1.059
Long - Fort	8708	8211	1.060
Slip - Beaujean	3235	3062	1.056
Slip - Duck Point 2	12734	12030	1.058
" - Sub	11132	10510	1.059
Sub - Beaujean	7891	7449	1.059
Average scale factor			1.059

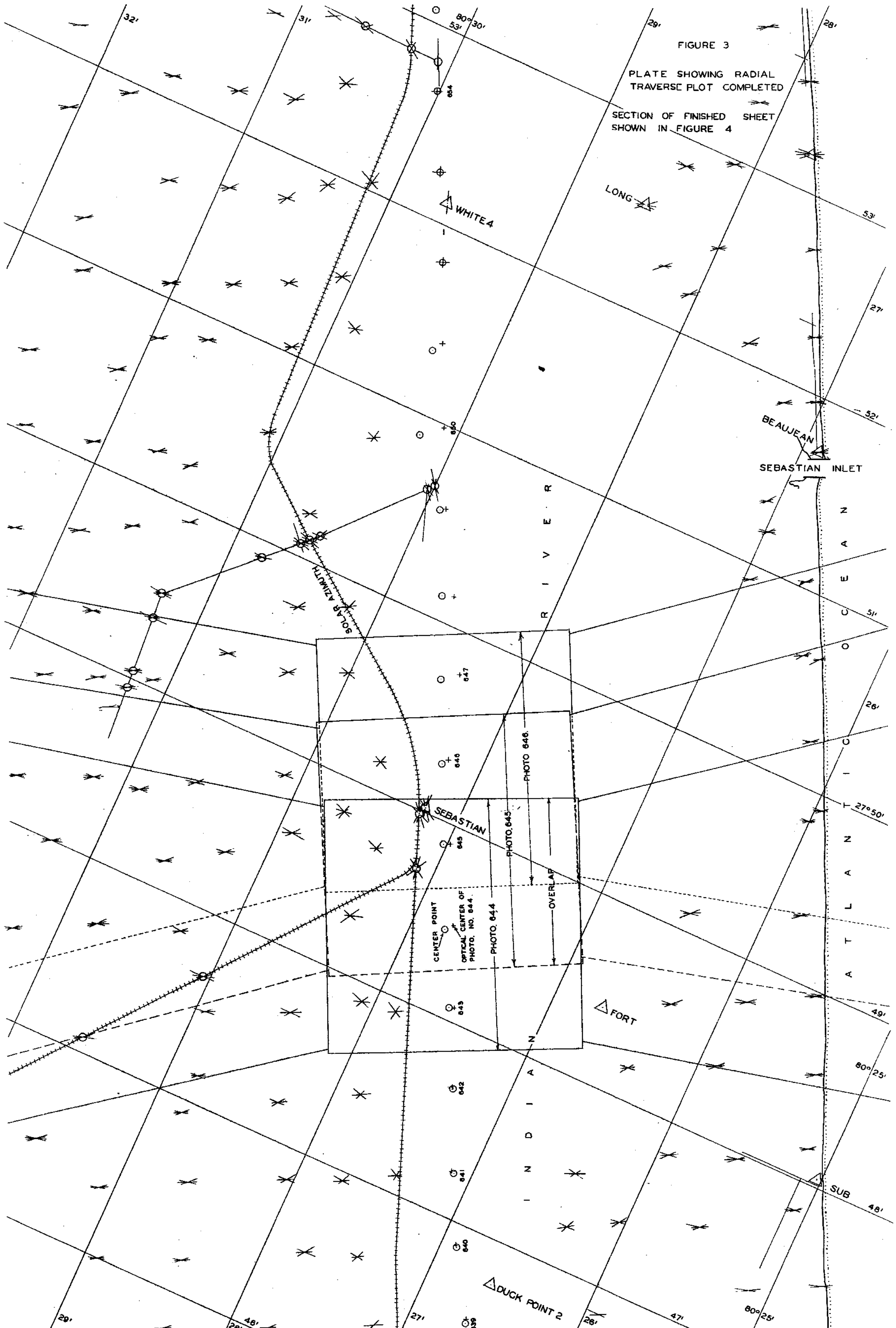


FIGURE 3

PLATE SHOWING RADIAL TRAVERSE PLOT COMPLETED

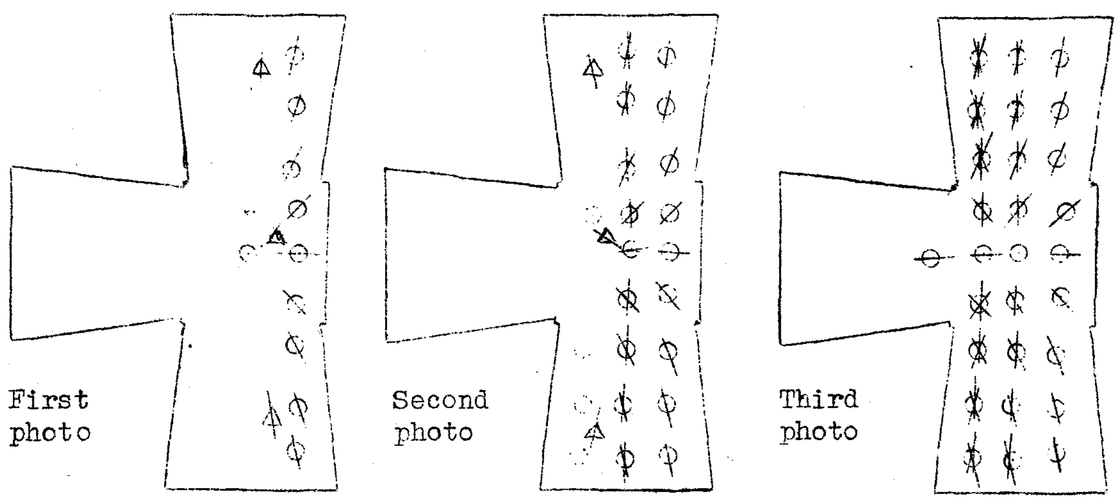
(R-136)

Since the sheet projection, which, is on celluloid, is to be on the average scale of the photographs and since a 1:20,300 meter scale is used in measuring distances, it is necessary to apply the scale factor to all measurements used in laying down the projection and to all scaled distances used in applying ground control points and features to the celluloid. The photo control topographic sheet, previously mentioned, and all the earlier topographic surveys of the region are reduced or enlarged to the average scale of the photographs. The shoreline shown on the photo control sheet is then traced on the celluloid in black ink and that shown on the old topographic sheets is traced in blue ink. Blue ink is used for tracing the old shoreline as this color is screened out when the compilation is reduced to 1:20,000 scale by the photo lithographic method.

THE RADIAL PLOT (Figure 3)

The vertical aerial photograph is in reality a perspective projection of the locality photographed. Consequently, any radial line drawn from the principal point through any point on the photograph determines the direction of that point. It can be seen that an overlap of more than 50 per cent is needed in order to locate subsidiary points to make the plot rigid.

In starting the radial plot, two successive photographs having the most control points thereon are chosen. The positions of these two photographs on the projection are plotted by holding their radials through the control points. In other words, this is similar to plotting a hydrographic sextant fix. Assuming the principal point to be the position of the ship and the radials from this point through the control points to be the sextant angles taken from the ship, the photograph is used as a multiple arm protractor to plot the position and azimuth of the photograph on the projection, in the same manner as the hydrographic fix is plotted. The pictures are held in position by weights, and all radial lines appearing on these two photographs are traced on the celluloid sheet.



First and second photographs plotted by radials through control; third and succeeding photographs plotted by radials through intersected points abreast center of preceding photographs.

A line of intersected points is thus obtained locating subsidiary points abreast the center of the second photograph. These intersected points are used to plot the third photograph of the strip, treating it also as a multiple arm protractor and holding the photograph in azimuth by means of the center points leading back through the tail print. In this manner the series of points abreast the center of the third photograph is located. The process is continued throughout the strip. The radial plot is checked as progress is made by means of the ground control plotted on the sheet. If the radial plot position does not check the ground control position, the mounting of the composite pictures and the identification of the common points are carefully checked. A new radial plot is then made and adjusted, throwing most of the adjustment into those pictures having the most scale distortion and tilt. Figure 3 shows a completed radial plot.

The points determined by the radial plot are pricked with a needle point and inked with blue ink. All radial lines are erased. The sheet is well rubbed with pumice and is now ready for tracing detail from pictures.

TRACING DETAIL FROM PHOTOGRAPHS.

The photograph is placed in proper relation to the map and the desired detail from each photograph is traced on the celluloid.

The middle third over the center and two wing pictures are traced from each photograph, proportioning by eye between the intersecting points located by the radial plot when the tilt distortion is small. Whenever the tilt distortion is large, the photograph is photostated and the tilt taken out. The photostat is used in tracing the detail of that photograph.

The standard conventional symbols are used showing the character of the country. The photo field control shore party noted on the photographs the character of the country along accessible roads. The culture in inaccessible localities is determined by the similarity to that noted on the photographs.

The names of towns, points, rivers, and degrees and minutes of the projection are lettered with a Wrico pen. The other names appearing on the sheet are printed on gummed back paper by the Printing Section and are glued in the proper place on the sheet.

The completed celluloid sheet is photographed to the standard 1:20,000 scale and printed on Whatman's paper by the usual photolithographic process in the Printing Section. At the same time an extra print is made on Whatman's paper for possible use in field revisions. Several prints are also made on chart paper for special distribution to interested parties. Figure 4 shows a copy of a section of one of the completed sheets reduced approximately 60 per cent.

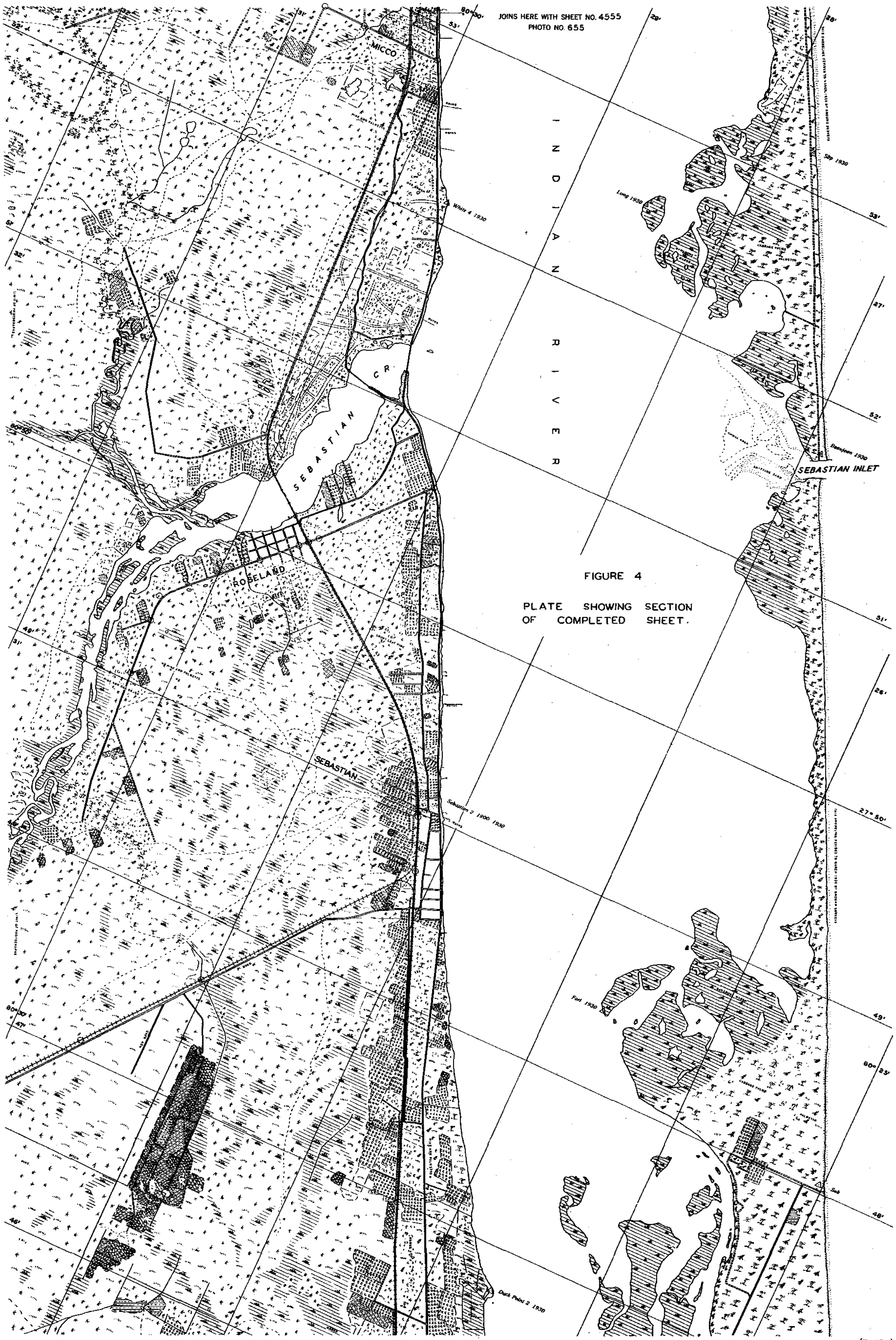


FIGURE 4

PLATE SHOWING SECTION OF COMPLETED SHEET.

(R-135)

The HYDROGRAPHER

Commander G. T. Rude
U. S. Coast & Geodetic Survey
Inspector of Construction.

The inspector of construction on the United States Coast and Geodetic Survey Ship HYDROGRAPHER has been asked by your editor to give some reason or reasons to allay the growing suspicion that we have been stalling for the past two and a half years and that there is no such vessel. For many months he himself entertained grave doubts that there would be such a vessel, with a contractor-vocally strong and financially weak, with Bankruptcy Courts, Receivers, Trustees in Bankruptcy, whereases and wherebys, and what nots. In fact, at one stage of the construction, the inspection staff was talking with a lisp because of the legal phraseology required.

The Deficiency Act of December 22, 1927, appropriated $350,000 for the construction and equipment of one survey vessel. Separate bids were invited for the construction of the vessel and the installation of machinery and for furnishing the propelling and auxiliary machinery. The lowest acceptable bids for the propelling and auxiliary machinery amounted to $109,623 in the aggregate. Ten bids were received for the construction of the vessel and the installation of the machinery, ranging from a low of $213,000 to a high of $389,000, averaging $327,477.

The keel of the HYDROGRAPHER was laid in July, 1928, at the plant of the Spear Engineers, Inc., Portsmouth, Virginia. The contractor had three other contracts with seniority over our vessel. The major efforts of their yard were given the other contracts and the keel of the HYDROGRAPHER was finally completed in January of 1929. Desultory efforts of the contractors were given our vessel until they became insolvent in September of 1929. At that time the vessel was in the neighborhood of fifty per cent completed and the plans about sixty per cent completed. If any officer has formed the idea that the inspector of construction was living on a bed of roses during these months, it is hoped that he himself goes through such an experience before he finishes his career.

On September 24, 1929, a Receiver was placed in charge of the defunct corporation by the District Court for the Eastern District of Virginia.

Immediately upon the contractor becoming insolvent, all Government material on the premises, including plates, shapes, auxiliary machinery required of the contractor by the specifications, and all construction plans, were seized by the inspector of construction under a Court Order and removed to storage at the Norfolk Navy Yard.

The Receiver contended that the plans and the material could not be taken by the Government's representative without payment therefore to the Bankrupt Estate and prayed (a legal, not a religious term) the Court to have the previous Court Order vacated. The Government won this phase of the case.

Immediately upon the contractor becoming insolvent, stops were taken to have the work on the HYDROGRAPHER continued by contract or otherwise by virtue of Article 9 of the Standard Government Form of Contract. Our Bureau notified the contractor on September 19, 1929, that the Government had taken cognizance of the fact that work on the construction of the HYDROGRAPHER had ceased and informed the Surety Company.

An attempt was made to get a private yard in the immediate vicinity to take over the contract for completing the vessel, but the quotation was considered excessive. The Norfolk Navy Yard was then requested to take over the construction to the point of launching and moving the vessel to the Navy Yard. The amount of Navy Yard construction was later extended to the completion of the vessel to and including the main deck and the installation of the greater part of the machinery.

On October 14, 1929, formal authority was requested of the Receiver in Bankruptcy for permission to have the Norfolk Navy Yard enter the plant. This was refused and the matter was then taken up with the Referee in Bankruptcy, and finally on October 17th with Judge Groner, sitting in Richmond. Judge Gronor's decision was in favor of the Government, signing a Court Order late in the afternoon of the 17th in Richmond. Early on October 18th the inspector of construction obtained certified copies of the Court Order as authority for the Commandant of the Norfolk Navy Yard to enter the plant and work was immediately started and continued without interruption, through later court procedure and petitions, to launching on December 19, 1929.

As an example of the attempts of parties in Norfolk to frustrate the efforts of the Government to prosecute the work on our contract, upon failure to obtain consent of the Referee in Bankruptcy to enter the plant with Navy Yard workmen, the Referee was informed at 11:00 A.M. that the inspector of construction intended to take up the matter immediately with Judge Groner in Richmond. The inspector left Norfolk by automobile at 12:15 P.M. Upon arrival in Richmond it was found that word had been noised around of the Government's intentions and that Judge Groner had received telegrams from Norfolk requesting him to delay action until the following Saturday at Norfolk. It required two hours to persuade Judge Groner to sign the Court Order. This would have required a few minutes but for the telegrams.

On October 28, 1939, the inspector of construction was served with a warrant to appear as the Government's representative before Judge Groner, sitting in Norfolk, to make answer to a petition by the Receiver in Bankruptcy to have the original Court Order, obtained in Richmond, vacated or modified and to have the Government pay a rental of $200 for each calendar day of occupation of the Bankrupt's plant, in addition to paying for all plates, shapes, plans, etc.

The case was called November 6, 1929, and postponed to the 9th and then to the 12th. In the meantime construction on the HYDROGRAPHER was continued by the Norfolk Navy Yard without interruption or actual interference with the work.

During the discussion of the case on November 6, an offer was made the Court by parties from Washington, D. C, for the purchase of the Bankrupt's plant for $15,000. The decision of the Court on this sale was also to be handed down at the time of the other decisions in the case.

At the calling of the case on November 6, the Fairbanks-Morse Company, who claimed a reserve title contract to the air compressor in the Bankrupt's plant, filed a petition with the Court to prohibit the Government's use of this compressor under any circumstances. A decision on this matter was also promised later.

The case was again called before Judge Groner on November 12. The Court approved the sale of the plant with the provision that the Government be allowed a reasonable time to complete the HYDROGRAPHER to the point of launching and to make use of the plant and equipment, including the air compressor, without rental.

No further legal complications arose. The Norfolk Navy Yard completed the vessel to the point of launching. She was launched and towed to the Norfolk Navy Yard on December 19, 1929, Miss Cecil Lester Jones being the Sponsor. Immediately following the launching a luncheon was given at the Monticello Hotel at Norfolk to Miss Jones at which Admiral Cluverious, Commandant of the Norfolk Navy Yard, acted as host and toastmaster.

During the time the Norfolk Navy Yard was engaged on the construction, invitations for bidding were sent to shipyards on Chesapeake Bay for completing the vessel from the point left off by the Navy Yard. The Warwick Machine Company of Newport News, Virginia, was the low bidder in the amount of $129,960. The bids ranged from this low to a high of $240,000.

After opening the bids, Congress was requested to make an appropriation of $106,500, the amount of the Surety, for completing the vessel, since suit can not be brought against the Bonding Company until after the vessel is completed.

The contract with the Warwick Machine Company was signed on April 23, 1930. The vessel was delivered to them at the Norfolk Navy Yard on May 21, 1930, for towing to their pier at Newport News. On June 30 their contract for completing the vessel was 2-8/10 per cent completed. The work progressed slowly but steadily and the vessel was completed within contract time at 8:00 P.M., March 24, 1931.

Dock trials were held on March 25 and the sea trials on March 26. On April 16 at 6:20 P.M., the HYDROGRAPHER left Norfolk for Washington, D. C. The vessel made a very satisfactory run up the Chesapeake and Potomac, arriving at Washington at 10:20 A.M., on the 17th. On April 23, command of the vessel was transferred to Captain W. E. Parker and she left Washington on April 27 for Norfolk preparatory to field work on Georges Bank.

The HYDROGRAPHER is excellently planned as to quarters. The Diesel-electric installation, with pilot house control of the propulsion motor, gives the bridge perfect control of the vessel at an instant. The Chernikeef log, the fathometer, the radio direction finder, the gyro compass with its repeaters, the Sperry high intensity are searchlight and the other modern equipment on this vessel will make for a very efficient surveying unit.

The gyro repeaters on the wings of the bridge are particularly helpful in piloting at night. On the trip from Norfolk to Washington the run was made well up the Potomac during darkness and accurate positions were determined with the repeaters quickly and with little effort from rather acute angles between lights and lighted beacons. With the high intensity arc searchlight, buoys were "picked up" well in advance of the need.

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ORIGIN OF LONGITUDES OF EARLY MAPS

Ferro, the most southwesterly of the Canary Islands, is known chiefly as the place whence longitude was reckoned by early geographers.

Ptolemy about 150 A.D., in his attempt to map the known world by means of a network of parallels and meridians, took as prime meridian the farthest point of the Canary Islands, this being the most westerly point of the world then known. This meridian thus became the assumed line dividing the eastern and western hemispheres and its conventional value (not true value) is placed at 17° 39' 46".

The meridian of Ferro continued to be used with more or less accuracy after the discovery of America.

With the introduction of Greenwich longitude, geographers in their maps now employ the even meridian of 20° west of Greenwich as the dividing line of the hemispheres.

THEODOLITE CIRCLE TESTS

John Bowie, Jr., U, S. Coast and Geodetic Survey.

The object of this work was to test the 9-inch circle No. 3 and the six 6-1/2-inch circles recently graduated for the U. S. Coast and Geodetic Survey.

A room was selected in the basement of the South Building at the Bureau of Standards to conduct the tests. Observing conditions were made as ideal as possible, temperature and atmospheric conditions were: constant, and good, stable foundations for the instruments were available.

A 4-foot wooden stand was placed in the center of the room for the theodolite and the six precise levels, used as collimators,. were placed three at each end of the room. The collimators were placed in the same horizontal plane as the telescope of the theodolite so that observations could be made without raising or lowering the telescope. A special electrical attachment was made to the eyepiece of each collimator to illuminate the cross-hairs. One storage battery furnished current for the theodolite and collimators.

The collimators were set in sidereal focus with the telescope of the theodolite in order to use the vertical cross-hairs in the collimators as objects upon which to point.

The wooden tripod for the theodolite was cemented to the concrete floor by means of plaster of Paris. The precise levels were mounted on their tripods and these were also cemented to the floor by plaster of Paris.

Observations began on January 10th, but it was soon found out that the values of the angles varied from day to day, some as much as 15 seconds. It was decided that the changes must be due to some movement in the tripod legs, so they were discarded and the collimators mounted on brackets which were fastened to the concrete walls by means of rawhide plugs and lag screws. This solved the problem as no appreciable change in any angle was noticed after the brackets and collimators had set for a few days. A slight vibration was transmitted to the collimators through the concrete walls of the room, but this did not delay observations as the vibrations of the collimators were vertical.

The first circle tested was the 9-inch No. 3. The circle has previously been tested in the field in Louisiana in 1939, on the roof of the Coast Survey building in the spring of 1930, and then twice at the Bureau of Standards in 1930 on their circle testing machine. The early Coast Survey tests showed the circle to be unserviceable for field use, while the Bureau of Standards circle testing machine showed the contrary.

In order to eliminate any question of the quality of the theodolite affecting the observations, Parkhurst Theodolite No. 308 with 9-inch circle graduated by Fennel, which had been in continuous use in the field for the past two years with excellent results, was used in testing Circle No. 3. Five sets of observations were made with the 9-inch Fennel circle to be used as a standard. Then the circles were interchanged and three sets of observations made with Circle No. 3 in Theodolite No. 308. Mr. B. L. Page, who is connected with the Bureau of Standards, assisted in the tests and did half of the observing. Observations made by different observers checked very satisfactorily and eliminated any question of personal equations affecting the results. This work was done in January and February, 1931.

The usual method of observing was followed, dark electric bulbs were used to cut down any glare on the observer's eyes, springs and string were used to steady the theodolite, the horizon was closed on the first set of observations made with each circle to test for drag, and all possible precautions to insure good results were used.

The results of the observations were studied by comparing the means of the "groups of four" in the 16 positions, i.e., the means of positions Nos. 1-4, 5-8, 9-12 and 13-16. The means of the first 8 and the second 8 positions were also compared. Circle No. 308 gave very consistent results, the maximum difference between the means of the first and second 8 positions being 1.12 sec, while the same results with Circle No. 3 gave a maximum range of 8.06 sec. A curve of the residuals of each angle was plotted and while Circle No. 308 gave consistent curves, Circle No. 3 gave variable results with the first 8 positions being high and the second 8 being low. These results were of the same characteristics as the previous tests on Circle No. 3 and proved that something was wrong with the circle. The circle was then tested the third time on the Bureau of Standards circle testing machine, which this time gave results which checked those obtained with the theodolite. A comparison of the number of rejected positions obtained from the observations of the 2 circles showed no rejections for 5 sets of observations with Circle No. 308 and 31 rejections for 3 sets of observations with Circle No. 3. Further tests were made by the Bureau of Standards and it was found that the graduations of the circle formed an ellipse, the difference in diameters being 0.001 in.

The 6-1/2" circles were next tested; two sets of observations were made with each on different days, all observations being made with the 6-1/2" Parkhurst Theodolite No. 313.

The 6-1/2" circle graduated by Berger was first tested. The results disclosed very irregular graduations, there being unusually low positions at the end of each set of observations for any angle except the one which was 167 degrees from the initial.

Before testing the other 6-1/2" circles in the theodolite, each was tested to see if the graduations were elliptical. Circles Nos. 2, 5 and 6 were found to be round, while Nos. 1 and 3 were elliptical.

In circle No. 2, 14 positions plotted 2 or more seconds from the means, the largest being 3.7 sec. The curves were irregular, showing high and low spots in the graduations.

In circle No. 5, six positions plotted 2 or more seconds from the mean, the highest being 2.4 sec. The curve was of a saw-tooth nature, caused by high and low values on consecutive positions. The differences between the means of the first 8 and second 8 positions were small, due to the high and low positions balancing each other.

Circle No. 6 was practically the same as No. 5, the high and low points being a little more pronounced. There were 10 positions plotting 2 or more seconds from the mean, 3.6 seconds being the highest value.

Circle No. 3 was known to be elliptical to a small degree. The residuals plotted a very ragged curve, being high in the first 8 positions and low in the second 8, very similar to the 9" circle No. 3, 29 positions plotted 2 or more seconds from the mean, the largest being 4.1 seconds.

Circle No. 1 was not tested because it was more elliptical than No. 3.

In conclusion, none of the new circles is perfect and it is doubtful if No. 5, which is the best of the lot, will give good results in the field on all occasions.

The system of collimators and sidereal focus proved a very successful way of determining the quality of a circle before sending it to the field. If a permanent room could be obtained to make these tests, much time and money could be saved in the future and the quality of a circle could be definitely established in a very short time.

A test was made on the theory of sidereal focus the last day to determine if a small movement of the center of the theodolite would change the angles. The center of the theodolite was moved 5/16 in. at right angles to the initial and no change was noted when the angles were reobserved. Hence, it is not necessary to keep the base of the theodolite in position on the tripod when changing circles.

The new 6-1/2" Parkhurst Direction Theodolite is a very neat instrument. It handles easily, has all the important advantages of a larger theodolite, and should give first order accuracy with a good circle. The telescope lenses are exceptionally good, giving a very clear and distinct field of view.

An angle, 180 degrees from the initial, will give good results on any circle. This is duo to the micrometers being in practically the same positions in respect to the circle.

REMINISCENCES OF WIRE DRAG WORK

N. H. Heck, U. S. Coast and Geodetic Survey.

At present there is not as much wire drag work being done as some years ago, partly because the more important work is finished and partly because of lack of funds to undertake the remaining work.

There are still large areas where the use of the method is indispensable for the safety of navigation. Other methods will probably develop the existence of most shoals, but some may be missed and more likely the least depth, which is the thing the mariner cares most about, will be missed.

I have seen a rocky pinnacle charted as an 11 fathom shoal become, after four successive groundings of the drag, each time set so as to pass over the least depth previously found, an 11 foot shoal. Each time a more careful sounding than customary in the most careful hydrography when the drag is not used was made with the additional advantage of having the drag buoys as a guide, and yet the sharp pinnacles were missed. I have been on a coral reef in Porto Rico, with general depths of about two fathoms and perfectly clear view of the bottom, and swung a leadline at 11 feet within 6 inches of a 5-foot coral projection without touching it.

In view of these considerations, some reminiscences about past occurrences during the period when I was on this work may be of interest.

Back in 1904 when the work started, a number of vessels of the Navy, using Penobscot Bay for maneuvering, had struck bottom, and striking the granite rocks of Maine leaves a very definite impression. A number of yachts en route for Bar Harbor struck bottom in an important channel. The first attempt to meet the situation was with the pipe drag, by which method a 36-foot pipe was carried below the vessel, which proceeded at a moderate speed. Some important finds were made, but the method was clumsy and expensive on account of the overhead of the vessel and the frequent need for repairs to apparatus. I spent one season under Captain Faris on this work on the EXPLORER. The same objection of too great overhead applied to the first season of wire drag in Frenchmans Bay when launches of the BACHE and the BLAKE were used with the vessels standing by much of the time. Several years later the first wire drag work by a wire drag party, independent of vessels, was started in Eggemoggin Reach, Maine, under my direction. Our first effort was to prove the deep water clear and all known shoals were carefully avoided. As a result, we made fast progress and startled the office by telegraphic request for another smooth sheet before the season was half over. Curiously enough six years later we went over this same region examining the shoals and finding a considerable number of important dangers.

The development of the wire drag was a long story, with many persons taking part, but in those days few of our personnel realized the scientific possibilities which have since been developed in our hydrographic work. It was a matter of search for materials, inventions and application of new methods just as is going on to-day in the acoustic work. For example, we first used telephone wire, which did very well, but invariably broke when we struck bottom. We found a wire developed first by Krupps in Germany and later improved by Roebling which met all requirements.

Many interesting things happened in this work. For example, there was the project of the so-called Beehler Channel into Key West. Commodore Beehler was Commandant at the Naval Station at Key West and he conceived the idea that a straight channel might replace the existing main ship channel. I received instructions to test out this possibility. The difficulty at Key West is to pass the inner reef, a mass of mushroom-shaped coral heads and other formations extending 16 to 20 feet above an otherwise flat bottom and in many places as thick as the trees of a forest. The idea turned out to be quite impossible, but one day we thought we had found a channel. Approaching the reef with the intention of finding the obstructions on a given line, and using a 500-foot drag, it became very hazy and just as we came to the reef, we were unable to get a position. When we finally got a position we had passed through the reef. We tried to repeat the performance and found it quite impossible. We must have missed by inches at least six of the large coral heads. In the main channel we found a pinnacle which might have changed history. It was directly in the channel and the MAINE might easily have struck it when outward bound in her start for Havana, We caught the drag on this several times and the divers who placed the dynamite for the Army engineers to remove it found several large wire drag sinkers and various wires festooned around it. When coral heads are blown up the pulpy inner portion floats and looks very much like pumice.

One day we encountered a very strong current in a place where strong currents had never before been noted. There were no particular indications of bad weather, but that night a very heavy norther arrived, showing that in the Keys lying between the Gulf of Mexico and the Straits of Florida barometric conditions may have powerful effects even before their existence is realized.

On one occasion in Maine a sub-party under Mr. Swick (now mathematician in the Division of Geodesy) was searching for a reported shoal off Penobscot Bay directly in the path of battleships going to the Rockland trial course. He had to give up work because of the large number of lobster pots and had to make the search later. However, since the area had not yet been reached in the regular survey, Mr, Swick decided to run a line in the homeward bound direction to make it a full working day. He had just decided to call it a day when the signals were temporarily obscured and a fix was delayed. Just as they became clear, the drag went aground. A 22-foot rock, not even known locally to exist, was found, and of course, charted, but not buoyed. Some years later the battleship ARKANSAS, not yet accepted but en route to the tiral course, was proceeding with a local pilot. The vessel struck this rock, and on examining the pilot's chart, it was found that his chart was old and did not show the rock. That he was a good pilot otherwise was proved by the fact that the rock plotted exactly on the course he had laid out on his chart. However, the answer was $80,000 worth of damage and considerable delay in the delivery of the vessel.

That the newspaper man can often see interest in what appears to be very routine to us was never better exemplified than by the performance of a writer, of the Boston Transcript. He went out one day and, to my view, it was a day of very routine character, but he wrote up as interesting an account of an operation of the Coast and Geodetic Survey as has ever been written.

Perhaps the most striking thing that happened was the development of the wire sweep. After returning from England from special duty with the Admiralty on anti-submarine devices during the War, I spent several months at the New London Naval Experimental Station (the forerunner of the present Naval Research Laboratory in Anacostia) before returning to duty in the Coast and Geodetic Survey. During this period we were all trying to see what application could be made of the war time devices. One day it occurred to me that, with modification, the mine sweep principle might be applied to wire drag work. I simply put the idea away for future reference. After some interesting duty in Lake Washington, Seattle, locating the trees of a forest which, perhaps a thousand years ago, sank beneath the lake in almost vertical position and were an obstruction to navigation, I was assigned to command of the EXPLORER on wire drag and combined operations in Southeast Alaska. We found on hand a large amount of buoys, metal floats and other materials hastily stored by Messrs. Colbert and Daniels when they discontinued work to enter the Navy. Much of this material was obviously in bad condition, but we selected a considerable amount which seemed to be all right. We started work with a drag 12,000 feet in length and the first day went all right. The second day just as we were about to start work the entire drag with most of our wire drag equipment except wire, of which we had an ample supply, sank beneath the surface in perhaps two minutes' time. All the buoys and floats were crushed. It looked bad for our season's work and Mr. Senior, Executive Officer, and Mr. G. C. Jones, who was in charge of the drag work, had gloomy faces. I saw only one thing to do - try out the sweep idea and use gasoline drums for buoys. We put rounded wooden bottoms on them to partially streamline them and later found means to pump air into them. This worked out so well that, while we ordered no more equipment, the season's output was the largest to date for Alaska and, in fact, the wire sweep work went so fast that it was hard to keep it from getting ahead of the control. This speeding up resulted in finishing the important work of sweeping the main channels of Southeastern Alaska by several years over estimated time.

Since the sweep wire was continuous to the vessel and without a rope section intervening as in the wire drag, an interesting fact was observed. When the sweep struck a rock, it did not catch immediately but slipped along while taking its grip. As a result, the wire acted like a banjo strong and actually a tune was played with varying notes which could be heard all over the vessel. This is probably the longest string instrument in existence since on one occasion the rock was 1 1/4 miles away.

The World War caused untold loss, but it is interesting to note that in the work that has been described and in the acoustic sounding and radio position finding, which are a direct outcome of war-time developments, we have added and are adding important amounts to the war salvage.

LONG ISLAND SOUND MYSTERY SOLVED BY WIRE DRAG PARTY

B. H. Rigg, U. S. Coast and Geodetic Survey.

In the early part of July, 1930, while dragging in the middle of Long Island Sound, the drag, set at an effective depth of 42 feet, hung in a charted depth of 53 feet of water. The tender sounding on the obstruction obtained a depth of 38 feet, with indications of shoaler depth.

Several attempts to clear the drag failed and it was decided to take it in. Solidly hooked, it looked for a time as if we would have to part it. Suddenly something let go and the wire came sliding in bringing a vessel's mast to the surface. The freshness of the paint and the condition of a running light attached to the mast gave evidence that it had been in the water but a short time.

The spot was marked "unfinished" on the field sheet and a location of the obstruction with the note "probably a wreck" was sent to the Washington office.

A short time after this as the party was preparing to leave the dock, a little old man came bustling down to the dock and asked for the captain of the launch. He introduced himself as Captain Timmons and said his business was salvaging sunken ships. We later found that Timmons was 71 years old and was the oldest salvage man on the Sound. He brought with him a copy of a marine magazine with a copy of the notice that had been sent to the office reporting the obstruction.

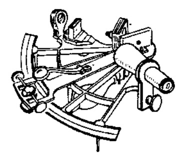
The location was pointed out on the chart and the mast was shown him. With a piece of the wreckage and our story as a guide, he returned to Brooklyn to try and identify the boat. As a clue, he knew the approximate height of the vessel, obtained from the difference between the charted depth in the locality and the sounding obtained on the top of the wreck, namely, 53-38.

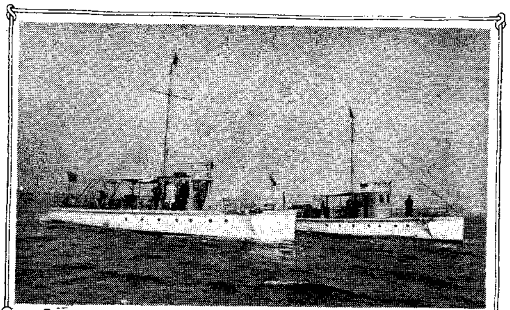
We soon heard from Timmons again; this time he greeted us with the smiling statement that he was sure the obstruction we had located was a missing oil barge. As if in answer to this, the body of a man, identified as the captain of a missing oil barge, was found a week later about six miles from the spot where we had pulled up the mast.

Timmons organized a company and a diver went down on the wreck. He reported it to be resting upright in the mud and in perfect condition; also that it was the boat Timmons thought it was. The boat known as Reliable Fuel Oil Supply Barge No. 3 had sailed about dusk from Brooklyn on January 30, 1930, bound for Bridgeport, Connecticut, with a cargo of oil. No one could be found that had seen or heard of her after that night. At the time of her disappearance, the crew consisted of an engineer and a captain. The engineer was never found. After the disappearance of Barge No. 3, two women appeared at the insurance office and claimed the insurance of the missing captain, both offering proof that they were married to him. As neither of the men could be proven dead, the matter could not be settled until the boat was found.

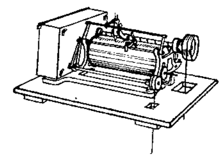
After three days' work with divers and a floating crain, the craft was raised and towed into Brooklyn. The water was pumped out and 300 pounds of live fish were found in the hold.

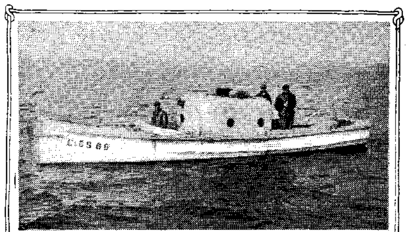
WIRE DRAG SURVEYS
LONG ISLAND SOUND





WIRE-DRAG LAUNCHES MARINDIN AND OGDEN





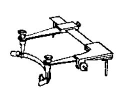
DRAG TENDER

AFTERMAST OF SALVAGED TANKER

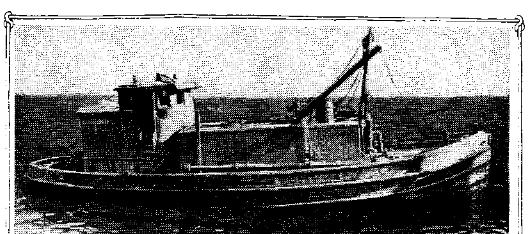
TYPES OF INTERMEDIATE BUOYS

END BUOY

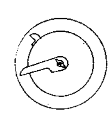
SETTING OUT THE DRAG



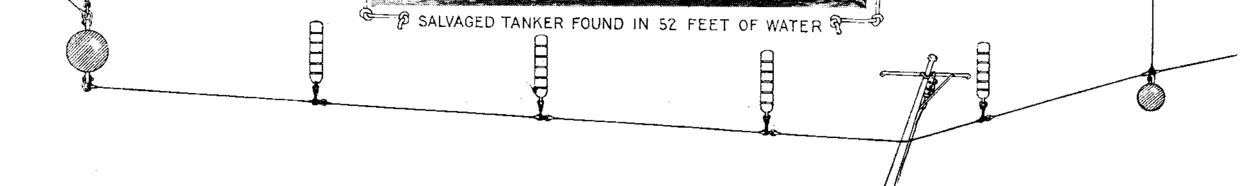
W. D. BUOY SPACER



SALVAGED TANKER FOUND IN 52 FEET OF WATER



W. D. COMPUTER



MESSAGE FROM A NEW DIVISION CHIEF

Secretary, Association of Field Engineers,
U. S. Coast and Geodetic Survey,
Office.

Dear Commander Borden:

Upon my assignment as Chief of the Division of Hydrography and Topography of this Bureau, may I ask that you carry a message in the Bulletin to our officers scattered far and wide, bespeaking their continued cooperation in the work of this Division? Its successful functioning, as of any worthwhile organization, depends upon no single individual but to the greatest extent upon the zeal and interest of the individual members, each in his separate station. Otherwise it fails, for among organizations, as in nature, the stagnant find no place.

I would like to assure the officers in the field that I in turn shall do my utmost to strengthen the organization and further their interests as well. I want them to come to the Division with their problems; continue the advancing of suggestions and solutions of newer and better methods and procedure for the prosecution of our work. While all the suggestions may or may not be practical, each alike shall receive sympathetic consideration at the hands of the Chief of the Division.

We compose a corps of versatile, keen officers interested in our duties and cognizant of the high standards and attainments of the Service. Through the Bulletin which you have launched and so ably edited, we have now a medium for the expression of the ideas continually evolving in the minds of those officers actually engaged on field work. Without this medium of circulation in the past, this urge to improve procedure, to invent newer and better methods, has to some extent been smothered, or at least not given free expression. The Chief of the Division desires to encourage the dissemination of the products of these minds, not only among the members of our own corps, but among other world organizations similarly engaged.

In bespeaking the cooperation of the officers assigned to this Division, I have in mind the Bureau as a whole, disregarding the lines of divisions as imaginary and for the purpose of administration only. Let us all strive toward the advancement of the U. S. Coast and Geodetic Survey.

(Sgd.) G. T. Rude
Chief, Division of
Hydrography and Topography.

PLOTTING THREE POINT FIXES WITHOUT THE USE OF A PROTRACTOR

A. M. Sobieralski, U. S. Coast and Geodetic Survey.

The Hydrographic Manual, page 86, outlines a method for plotting three point positions without the use of a protractor.

Briefly, the method consists of plotting on the boat sheet, smooth sheet or on tracing cloth a system of intersecting arcs of circles, each circle corresponding to the locus of some angle between two adjoining stations. The positions can then be plotted by interpolation between the arcs corresponding to the observed angle.

The method should find wider application because of its obvious advantages under certain conditions. It eliminates the errors due to eccentricity and errors of graduation in the three arm protractor and largely compensates for the displacement of positions due to distortion of the sheet.

While there is considerable work involved in preparing the arcs, etc., the ease with which the plotting can be done and the increased accuracy more than compensate for the time spent, there being a considerable saving if a large number of positions using the same signals are to be plotted.

The method could be used advantageously whenever the signals come near the end of the protractor arm.

It is the only way to plot satisfactorily closely spaced lines using distant signals. Under such circumstances, the three arm protractor is unsatisfactory because of the errors due to the limitations of the protractor and distortion of the sheet. It is impossible to verify such a sheet as the same position will not plot in the same place after the sheet has been subject to any atmospheric changes.

In addition to smooth plotting, the method should find application on boat sheets, where the ease and speed with which positions can be plotted should be of great assistance under many conditions.

As described in the Hydrographic Manual, the method is recommended for enlargements of certain areas, but it will be found useful on all sheets where the positions are at any great distance from the signals.

While the arcs can be plotted by locating a number of points with a protractor, it is advisable to compute the positions of the centers of the arcs and lay them off with a beam compass.

Lt. Comdr. G. C. Mattison recently submitted a special report on the method of constructing the arcs and Captain E. P. Ellis, Assistant Chief, Field Records Section, submitted a report which included tables to facilitate the computations.

The following extracts from these reports describe the method of constructing the arcs and the computations involved:

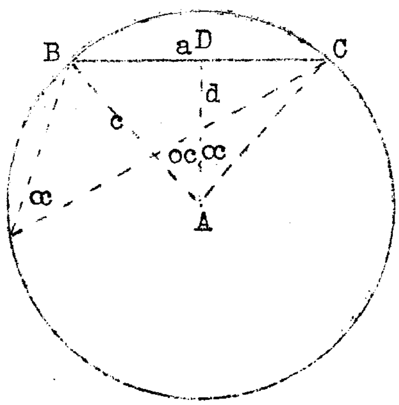


Fig. 1.

a = distance between signals B and C
oc = observed angle between B and C
A = center of circle which is locus of all points where angle oc can be observed
d = perpendicular bisecting BC = AD
c = radius of circle

$$d = \frac{a}{2} \cot \alpha$$

$$c = \frac{a}{2} \operatorname{cosec} \alpha$$

There are four steps in computing and drafting:

First - Determine the distance between the signals or stations, either by scaling from the sheet or by computation. BC, Fig. 1

Second - Erect perpendicular AD to line joining the two stations at its middle point. This may be done graphically, but greater accuracy can be obtained, when the signals are triangulation points, by computing the geographic position of an assumed point on this line in the locality where the centers will lie. All the centers will lie along this line.

Third - Compute the distances "d" corresponding to the required angles by the formula $d = \frac{a}{2}$ cot oc . The attached tables giving the values of 1/2 cot oc prepared by Captain Ellis will facilitate the computation. These distances should be plotted on the line AD.

As the angle at the center of the circle is equal to 2 oc , the position of the center of the line AD can be determined graphically by setting the protractor at 2 oc.

Fourth - Lay out the arcs with a beam compass, using centers on line AD and radii passing through the signals.

While the arcs can be drawn directly on a boat sheet, for smooth plotting it would be preferable to lay them out on tracing cloth on which the intersections of the parallels and meridians have first been drawn. Any distortion in the tracing cloth can then be practically eliminated by adjusting to these intersections. Separate tracings could be prepared for different combinations of signals. Such tracings should be forwarded to the office with the sheet.

Lt. Comdr. Mattison makes the following comments on the method:

Accuracy - Unquestionably, the accuracy is far greater than can be obtained with a protractor, especially when the sheet is subject to distortion.

<u>Ease of plotting</u> - The time required to plot a position is loss than that necessary to set the angles on the protractor. The ease of plotting is especially noticeable in rough weather. I believe that it would be advisable to prepare boat sheets in this manner to within a reasonable distance from shore.

When it is desired to develop a shoal on a large scale at such a distance from shore that the signals do not come within the limits of the sheet, the arcs may be drawn on a smaller scale and enlarged as described in the Hydrographic Manual.

Another method for drawing the arcs is suggested by Lt. Comdr. Mattison. (See Fig. 2)

Some method of estimating the angles will be available. Assume two points such as A and B on one of the arcs and compute their geographic positions. Compute the radius of the circle by the formula $c = \frac{a}{2} \operatorname{cosec} \alpha$, and locate the center by intersecting arcs. Repeat this process for another angle. Centers of arcs for other angles can be interpolated along the line joining these centers, or additional points may be computed.

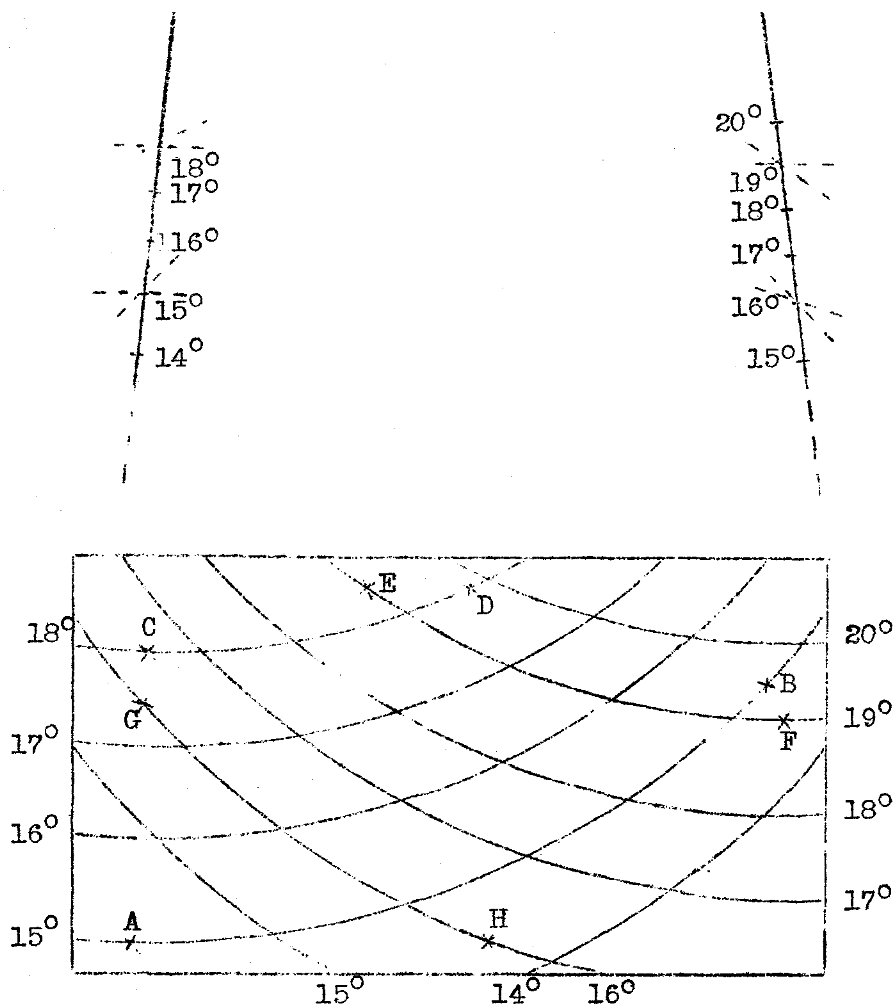


Fig. 2

* 1/2 Cotangent

1°00'	28.6450	8°00'	3.5577	15°00'	1.8660	22°00'	1.2375
10'	24.5519	10'	3.4841	10'	1.8445	10'	1.2273
20'	21.4820	20'	3.4135	20'	1.8235	20'	1.2171
30'	19.0942	30'	3.3456	30'	1.8029	30'	1.2071
40'	17.1839	40'	3.2803	40'	1.7828	40'	1.1972
50'	15.6208	50'	3.2174	50'	1.7630	50'	1.1875
2°00'	14.3181	9°00'	3.1569	16°00'	1.7437	23°00'	1.1779
10'	13.2158	10'	3.0985	10'	1.7248	10'	1.1685
20'	12.2709	20'	3.0422	20'	1.7062	20'	1.1591
30'	11.4519	30'	2.9879	30'	1.6880	30'	1.1499
40'	10.7352	40'	2.9354	40'	1.6701	40'	1.1408
50'	10.1028	50'	2.8847	50'	1.6526	50'	1.1319
3°00'	9.5406	10°00'	2.8356	17°00'	1.6354	24°00'	1.1230
10'	9.0375	10'	2.7882	10'	1.6186	10'	1.1143
20'	8.5847	20'	2.7423	20'	1.6020	20'	1.1057
30'	8.1749	30'	2.6978	30'	1.5858	30'	1.0971
40'	7.8024	40'	2.6546	40'	1.5699	40'	1.0887
50'	7.4622	50'	2.6128	50'	1.5542	50'	1.0804
4°00'	7.1503	11°00'	2.5723	18°00'	1.5388	25°00'	1.0723
10'	6.8634	10'	2.5329	10'	1.5237	10'	1.0642
20'	6.5984	20'	2.4947	20'	1.5089	20'	1.0562
30'	6.3531	30'	2.4576	30'	1.4943	30'	1.0483
40'	6.1253	40'	2.4215	40'	1.4800	40'	1.0405
50'	5.9131	50'	2.3864	50'	1.4659	50'	1.0328
5°00'	5.7150	12°00'	2.3523	19°00'	1.4521	26°00'	1.0252
10'	5.5297	10'	2.3191	10'	1.4385	10'	1.0176
20'	5.3560	20'	2.2868	20'	1.4251	20'	1.0102
30'	5.1927	30'	2.2554	30'	1.4120	30'	1.0028
40'	5.0390	40'	2.2247	40'	1.3990	40'	.9956
50'	4.8941	50'	2.1948	50'	1.3863	50'	.9884
6°00'	4.7572	13°00'	2.1657	20°00'	1.3737	27°00'	.9813
10'	4.6277	10'	2.1374	10'	1.3614	10'	.9743
20'	4.5049	20'	2.1097	20'	1.3493	20'	.9674
30'	4.3884	30'	2.0826	30'	1.3373	30'	.9605
40'	4.2778	40'	2.0563	40'	1.3255	40'	.9537
50'	4.1725	50'	2.0305	50'	1.3140	50'	.9470
7°00'	4.0722	14°00'	2.0054	21°00'	1.3025	28°00'	.9404
10'	3.9765	10'	1.9808	10'	1.2913	10'	.9338
20'	3.8852	20'	1.9568	20'	1.2802	20'	.9273
30'	3.7979	30'	1.9333	30'	1.2693	30'	.9209
40'	3.7144	40'	1.9104	40'	1.2586	40'	.9145
50'	3.6344	50'	1.8880	50'	1.2480	50'	.9082

* Formula for use of table: d (meters) = BC (meters, distance between signals on sheet) multiplied by tabular value for given angle.
Example: oc = 10°, BC * 0.5 meters, d = 0.5 (2.8356) = 1.41780 meters.

29°00'	.9020
10'	.8959
20'	.8898
30'	.8837
40'	.8778
50'	.8719
30°00'	.8660
10'	.8602
20'	.8545
30'	.8488
40'	.8432
50'	.8376
31°00'	.8321
10'	.8267
20'	.8213
30'	.8159
40'	.8106
50'	.8054
32°00'	.8002
10'	.7050
20'	.7899
30'	.7848
40'	.7798
50'	.7749
33°00'	.7699
10'	.7651
20'	.7602
30'	.7554
40'	.7507
50'	.7460
34°00'	.7413
10'	.7366
20'	.7321
30'	.7275
40'	.7230
50'	.7185
35°00'	.7141
10'	.7097
20'	.7053
30'	.7010
40'	.6967
50'	.6924
36°00'	.6882
10'	.6840
20'	.6798
30'	.6757
40'	.6716
50'	.6676

37°00'	.6635
10'	.6595
20'	.6556
30'	.6516
40'	.6477
50'	.6438
38°00'	.6400
10'	.6361
20'	.6324
30'	.6285
40'	.6248
50'	.6211
39°00'	.6174
10'	.6138
20'	.6102
30'	.6065
40'	.6030
50'	.5994
40°00'	.5959
10'	.5924
20'	.5889
30'	.5854
40'	.5820
50'	.5786
41°00'	.5752
10'	.5718
20'	.5685
30'	.5651
40'	.5618
50'	.5586
42°00'	.5553
10'	.5521
20'	.5489
30'	.5457
40'	.5425
50'	.5393
43°00'	.5362
10'	.5331
20'	.5300
30'	.5269
40'	.5238
50'	.5208
44°00'	.5178
10'	.5148
20'	.5118
30'	.5088
40'	.5059
50'	.5029

45°00'	.5000
10'	.4971
20'	.4942
30'	.4913
40'	.4885
50'	.4857
46°00'	.4828
10'	.4800
20'	.4773
30'	.4745
40'	.4717
50'	.4690
47°00'	.4663
10'	.4635
20'	.4608
30'	.4582
40'	.4555
50'	.4528
48°00'	.4502
10'	.4476
20'	.4450
30'	.4424
40'	.4398
50'	.4372
49°00'	.4346
10'	.4321
20'	.4296
30'	.4270
40'	.4245
50'	.4220
50°00'	.4195
10'	.4171
20'	.4146
30'	.4122
40'	.4097
50'	.4073
51°00'	.4049
30'	.3977
52°00'	.3906
30'	.3837
53°00'	.3768
30'	.3700
54°00'	.3633
30'	.3566
55°00'	.3501
30'	.3436
56°00'	.3373
30'	.3309
57°00'	.3247
30'	.3185

58°00'	.3124
30'	.3064
59°00'	.3004
30'	.2945
60°00'	.2887
30'	.2829
61°00'	.2772
30'	.2715
62°00'	.2659
30'	.2603
63°00'	.2548
30'	.2493
64°00'	.2439
30'	.2385
65°00'	.2332
30'	.2279
66°00'	.2226
30'	.2174
67°00'	.2122
30'	.2071
68°00'	.2020
30'	.1970
69°00'	.1919
30'	.1869
70°00'	.1820
71° - 109°	.1722
72° - 108°	.1625
73° - 107°	.1529
74° - 106°	.1434
75° - 105°	.1340
76° - 105°	.1247
77° - 103°	.1154
78° - 102°	.1063
79° - 101°	.0972
80° - 100°	.0882
81° - 99°	.0792
82° - 98°	.0703
83° - 97°	.0614
84° - 96°	.0526
85° - 95°	.0437
86° - 94°	.0350
87° - 93°	.0262
88° - 92°	.0175
89° - 91°	.0087
90°	0

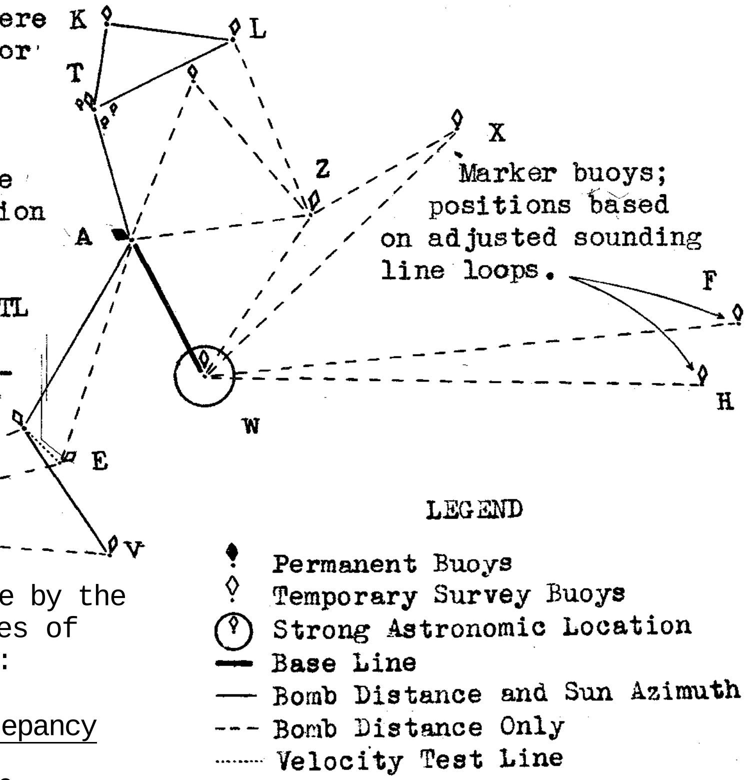
COMPUTATION AND ADJUSTMENT
OF BUOY CONTROL NET
GEORGES BANK, 1930

I. OFFICE COMPUTATION; The following method, adopted after analysis had been made of position, azimuth and distance determinations, was used in making the computations:

(a) The astronomical position of buoy "W" was held fixed and the positions of all other buoys were related to it by computed or measured azimuths and distances.

(b) All sun azimuths were held fixed with the exception of KT, UA and UV.

(c) The triangles ZAL, ATL and KTL were computed from two known sides and the included angle. All the remaining triangles were computed from three known sides.



Computation of the scheme by the above method gave double values of distances (meters) as follows:

Line	Computed	R.A.R.	Discrepancy
LA	35632	35596	36
LZ	30307	30331	24
KT	13891	13853	38

Three double values for azimuths of lines were also obtained. The discrepancy in the azimuth of the line KT, which is the only one entering into the positions of the buoys used on the season's work, is 13 minutes.

No adjustment was considered necessary for positions of the buoys used for the control of the 1930 season's work since the discrepancies were small for this class of work and since what were considered to be the strongest values were in each case employed in computing the scheme.

II. FIELD ADJUSTMENT (SHIP LYDONIA): In the office computation, the length AW and its observed azimuth were held fixed; also the astronomic position of W. Westward to Buoy B only the lengths were held; therefore, observed azimuths UA, UB and the compass azimuth of EU were rejected. As computed by the office all the observed azimuths lie to the left of their computed azimuths, indicating a chance for improvement by giving some weight to the observed azimuths.

Following a study in the field, computations were made as follows: A mean between observed azimuth UA and the computed azimuth UA was taken. The triangle UAW was then computed with sides AU and AW held in length and azimuth. This threw all error on line UW which comes out as follows: Observed length - 29531 meters; computed - 29426 meters. Since logarithm of sine Angle A changes 13 in 7th place and sine Angle W changes 14 in 7th place, it is proposed to change side UA by adding 60 to measured length, making UA become 34275 meters. Recomputing 2 sides and included angle gives lengths as follows: UW (computed) = 29470; UW (observed) = 29531. The position of U was then computed with these data.

The office computation of triangle UVB was accepted. For the computation of the position of Buoy "B", the observed azimuth and observed length of UV were held fixed. (Observed data: Azimuth 310° 50' 34"; length 20002 meters).

From data obtained in the computation of triangles UVB and AWU (and the true bearing and length of EU), the position of Buoy E was computed through each triangle. In these computations, two sides and the included angle of each triangle were used as follows:

(1) Triangle UAE; The side UE as observed, UA as assumed and the included angle at U as determined from the calculated, azimuth of UA and the observed azimuth of UE.

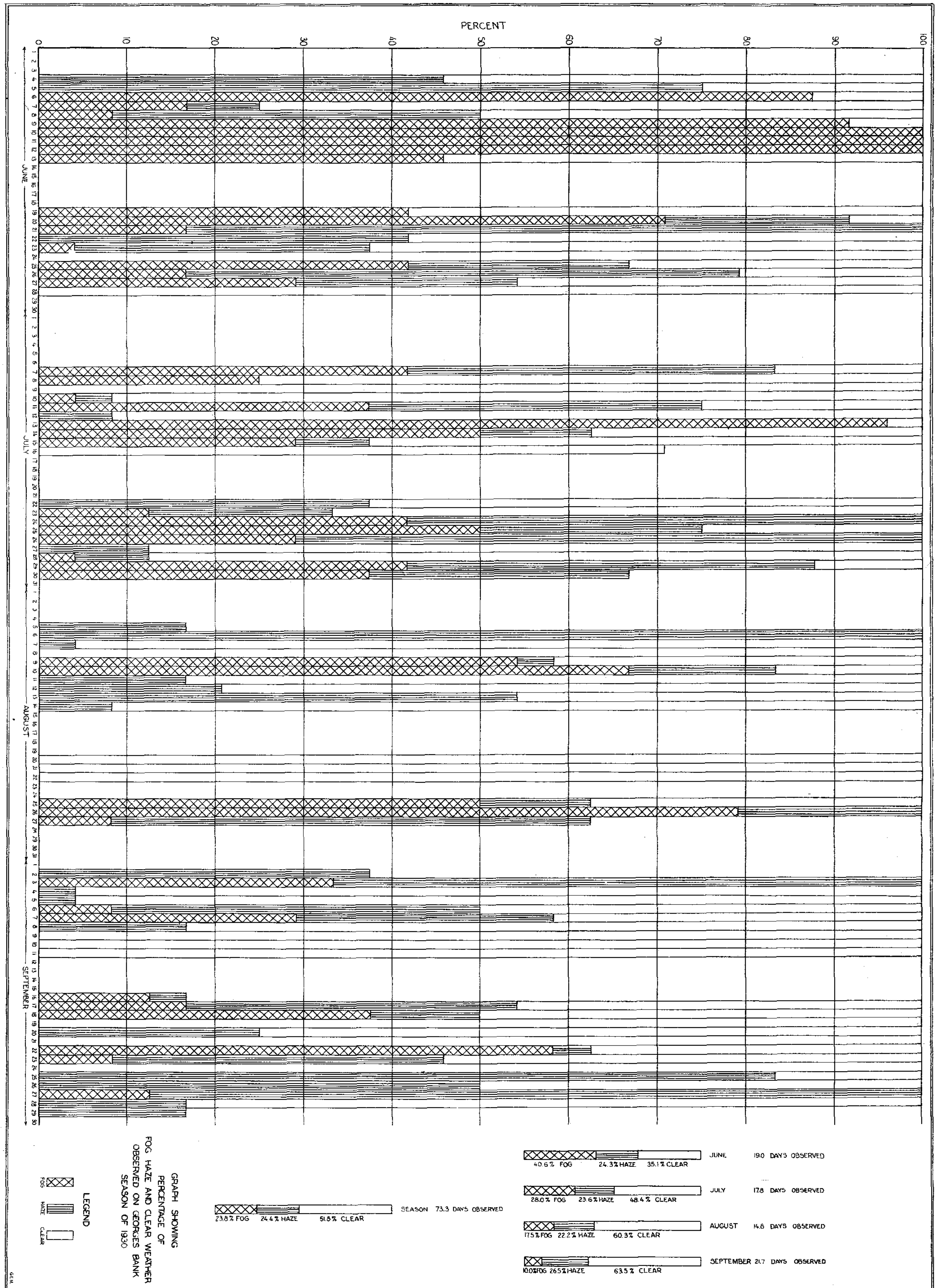
(2) Triangle UEB: The sides UE as observed and UB as computed and the included angle at U as determined from the calculated azimuth of UB and the observed azimuth of UE.

In this way all the closure error was thrown into the sides AE and BE, making differences as follows:

AE	(observed) = 37448;	(computed) =	37522	meters
BE	" = 45535;	" =	45542	"

In the office method of computing the Triangle KLT, sides LT and KL and their azimuths were held fixed. This left discrepancies on the length and azimuth of KT of 38 meters and 12' 53" respectively.

It was felt in the field that both the length and azimuth of KT were likely to be as good as the lengths and azimuths of either other side. Accordingly, the azimuth closure was distributed between the azimuths of KT and KL, changing the angles at L and T by 6' 26" each, and the angle at K by 1". In the computation of this triangle, KT becomes 13852 meters, as compared with 13891 by office computation, and KL becomes 19623 meters, as compared with 19595 meters.



C&G.S. Print (R-163)

REDUCTION OF INCLINED ANGLES TO HORIZONTAL ANGLES

F. B. T. Siems, U. S. Coast and Geodetic Survey
(abstract)

The report of Commander Siems discusses the treatment of inclined and vertical angles, as regards corrections to be applied to them, in computing the horizontal angle for use in determining azimuth between buoys by reference to a celestial azimuth. It shows why corrections for parallax and refraction should not be applied to the observed vertical angle or inclined angle. However, if only the inclined angle is observed, in which case the true altitude must be computed from the time of observation, the refraction and dip must be added and the parallax subtracted in order to enter the formula with value of "h" corresponding to observed altitude. Index and semi-diameter corrections must, of course, be applied to observed inclined and vertical angles.

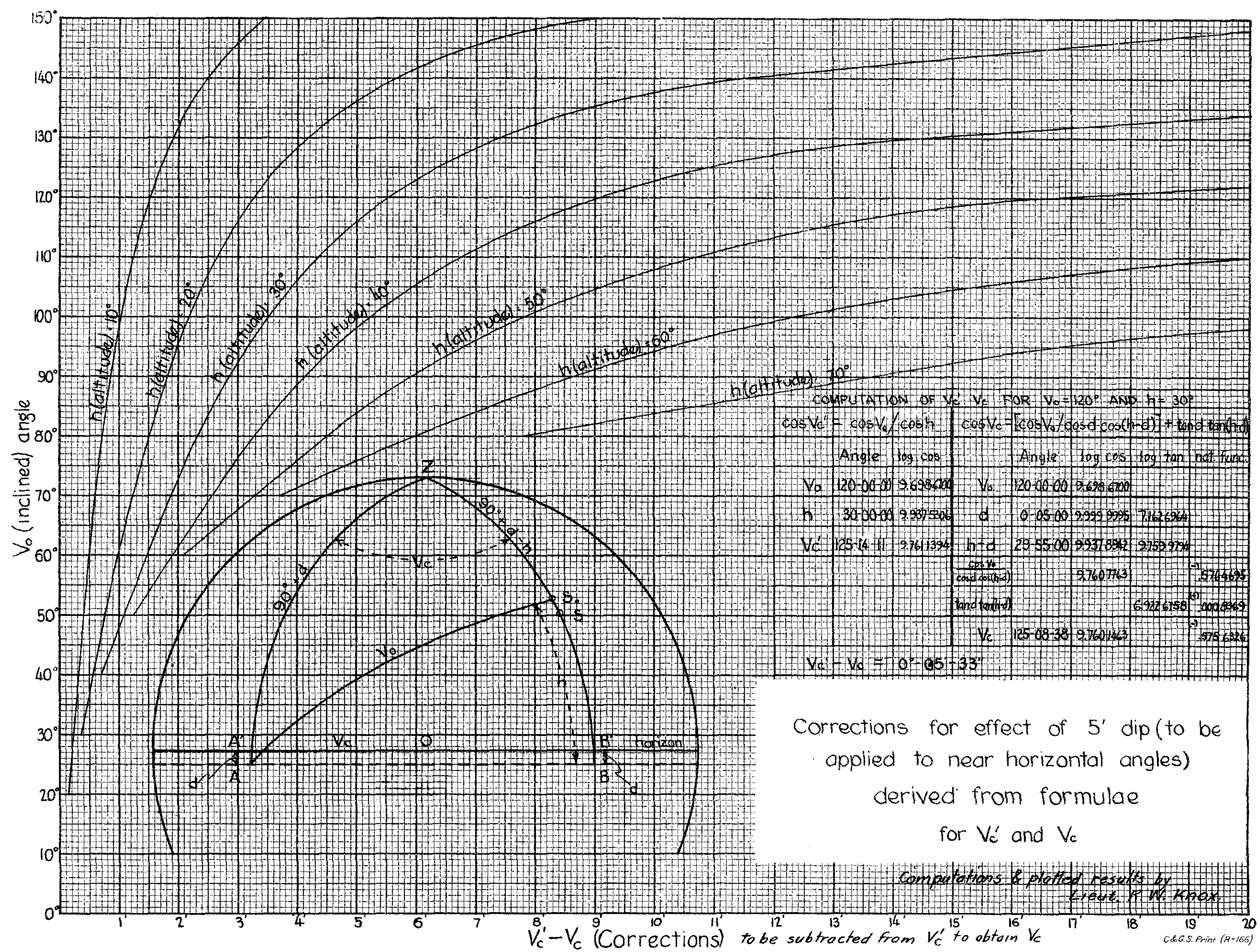
Commander Siems states that in cases where the observed inclined and vertical angles are affected by dip, a "near" value (Vc^1) of the horizontal angle would be obtained in the formula $Vc^1 = \frac{\text{Cos Vo}}{\text{Cosh}}$ and that the difference between the "near" and "true" values (Vc^1 - Vc) is a positive quantity and comparatively small for altitudes under 60° and for a combination of inclined angles and altitudes whose sum is under 160°. He derives the formula for the "true" horizontal angle (Vc), for a given dip, as $\text{Cos Vc} = \frac{\text{Cos Vo}}{\text{Cos d cos (h-d)}} + \text{tan d tan (h-d)}$. Holding the dip and altitude constant, the difference (Vc^1 - Vc) becomes a function of the inclined angle which may be represented in the form of a graph. A series of those graphs is submitted for altitudes 10°, 20°, 30°, etc., plotted on the same coordinate paper, for a constant dip of 5' (corresponding to "height of eye" on the SURVEYOR) and from these (Vc^1 - Vc) can readily be found for any combination of altitude, and inclined angle. From inspection of the graphs, it can be seen that in using altitude greater than 60° and combined inclined angles and altitudes whose sum is greater than 160° the value of (Vc^1 - Vc) may be considerably greater than the dip itself.

Sample computations of the term "Vc^1 - Vc" and the graphs referred to above are shown on an accompanying plate.

To find (Vc^1 - Vc) from the graphs for a given observation, as, for example, Vo = 97° - 32', h = 22° - 10', d = 5', a section of curve between the 20 and 30 degree altitude graphs is proportionally drawn to represent the 22° graph where it will intersect the horizontal line 97½° of inclined angle; (Vc^1 - Vc) is then found corresponding to this intersection point, namely, 2.3'. The true horizontal angle would then be derived as follows:

log cos 97° 32'	9.11761 (n)
" " 22° 10'	9.96665
log cos Vc^1	9.15096 (n)

$$Vc^1 = 98^\circ\ 08.3'$$
$$Vc^1 - Vc = 02.3'$$
$$Vc = 98^\circ\ 06.0'$$



COMPUTATION OF Vc' Vc FOR Vo = 120° AND h = 30°
cos Vc' = cos Vo / cos h
cos Vc = [cos Vo / cos d cos(h-d)] + tan d tan(h-d)
Angle | log cos
Vo | 120-00-00 | 9.698 6700
h | 30-00-00 | 9.937 5306
Vc' | 125-14-11 | 9.761 1394
Angle | log cos | log tan | nat. func.
Vo | 120-00-00 | 9.698 6700
d | 0-05-00 | 9.999 9995 | 7.162 6964
h-d | 29-55-00 | 9.937 8942 | 9.759 9794
cos Vo / cos d cos(h-d) | 9.760 7763 | (-) .576 4695
tan d tan(h-d) | 6.922 6758 | (+) .000 8369
Vc | 125-08-38 | 9.760 1463 | (-) .575 6326
Vc' - Vc = 0°-05'-33"
Corrections for effect of 5' dip (to be applied to near horizontal angles) derived from formulae for Vc' and Vc
Computations & plotted results by Lieut. R. W. Knox.
h (altitude) : 10°
h (altitude) : 20°
h (altitude) : 30°
h (altitude) : 40°
h (altitude) : 50°
h (altitude) : 60°
h (altitude) : 70°
Vo (inclined) angle
Vc' - Vc (Corrections) to be subtracted from Vc' to obtain Vc
Z
O
Vo
Vc
horizon
C&G.S. Print (A-166)

NOTE ON REDUCING INCLINED ANGLES TO DIFFERENCES IN AZIMUTH

W. D. Lambert, U, S. Coast and Geodetic Survey.

In computing the effect of dip (and perhaps of the parallax and refraction of the moon in cases where a computed altitude is substituted for a measured one) on the reduction from the inclined angle to the true difference in azimuth, it is not necessary to solve an oblique spherical triangle. It may be simpler to proceed as follows:

(1) Reduce from the inclined angle (Vo) to the true difference in azimuth (Vc) neglecting dip (and perhaps parallax and refraction) by the formula*

$$\cos Vc \doteq \frac{\cos Vo}{\cos h},$$

here h is the altitude of the center of the celestial object.

(2) Let d_1 be the correction to the altitude of the center of the celestial object; if the altitude is measured, d_1 is merely the dip of the horizon and is essentially positive; if, on the other hand, the computed altitude of the moon's center, uncorrected for parallax (p) and refraction (r), is used.

$$d_1 = p-r$$

and is also essentially positive.

Let d_2 be the dip of the terrestrial or marine object sighted. If d_2 is some low, floating object nearer than the horizon, then d_2 is also positive and

$$d_2 > d_1 \text{, if } d_1 \text{ is merely the dip of the horizon.}$$

On the other hand, if the object sighted is something above the level of the eye, such as a lighthouse lantern or a hill, d_2 is essentially negative.

Let d_1 and d_2, be expressed in minutes of arc and decimals of a minute; than apply to Vo the following differential corrections, which will be likewise in minutes:

(a) For d_1 $\quad - \left(\frac{\tan h}{\sin V_c}\right) d_1$

(b) For d_2 $\quad \left(\frac{\tan h \sec h}{\sin V_c} \cos V_o\right) d_2 \doteq (\cot V_c \tan h)\, d_2$

The formulas themselves indicate their range of usefulness.

If the corrections (a) and (b) are large, they are to be avoided because conditions are essentially unfavorable to accuracy. If better conditions can not be obtained, the rigorous solution of the oblique spherical triangle must be used as being better than nothing. Corrections (a) and

---

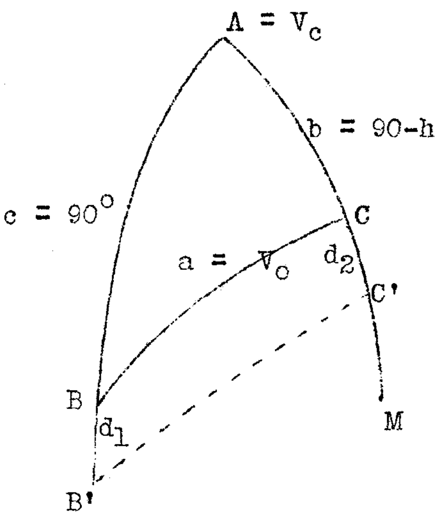
*It is assumed that the inclined angle Vo contains the correction for the semidiameter of the celestial object.

(b) are obviously large when Vo is small or when h is nearly 90°, that is, when the celestial object is near the zenith.

These differential formulas can be used to compute graphs like those of Commander Siems.

Note that if the celestial body is near the horizon, its vertical diameter, being shortened by the rapid diminution in refraction with elevation, is less than the diameter inferred from the Ephemeris. The inclined semidiameter, which is applied as a correction to Vo to reduce from the limb to the center, is likewise affected by refraction.

Proof



In Chauvenet's Trigonometry, p. 240, in equation (not numbered) just before (285) put

$$da = 0$$
$$c = 90°$$

and solve for dA.

$$d\,V_c = dA = \frac{\cos b \cos A\, db - \cos b\, dc}{\sin b \sin A}$$

Since A is the approximate value of V_c and dA the correction to V_c we have

$$db = d_2$$
$$dc = d_1$$

From these, corrections to V_c due to d_1 and d_2 are easily derived as given.

-- o -- o -- o -- o --

COMMENTS ON THE ABOVE

F. B. T. Siems

I would say that the differential equations of Mr. Lambert would correspond to my graphs when $d_1 = d_2$. My report dealt exclusively with terrestial and celestial objects containing the same dip; in other words, the terrestial object was considered as lying in the visible horizon. This condition would obtain in observing on a buoy four or five miles, or farther, away as would generally be experienced in buoy control work.

Instead of using two differential formulas, it appears that it would simplify matters to enter formula $\cos V_c = \frac{\cos V_o}{\cos h}$ with a corrected value of h corresponding to an altitude above the level of the terrestial object. This would make $d_1 = d_2$ = (dip of terrestial object) and require only one differential formula.

THE EARTH AS AN ENGINEERING STRUCTURE

Dr. William Bowie, Chief, Division of
Geodesy, U. S. Coast and Geodetic Survey.

A radio talk presented Friday, January 30, 1921, under the auspices of Science Service over the Columbia Broadcasting System.

Human beings have lived on the earth for many thousands and possibly millions of years, but it is only within the last few decades that man has found out some of the essential and fundamental facts connected with the earth that are needed to discover those processes which have continuously changed the elevations and geographic positions of points on its surface.

The earth is not so mysterious after all, unless we acknowledge that all science is mysterious. If we use the fundamental principles of physics and engineering, we are able to attack and understand earth problems much more clearly than if we merely assume that the earth is a puzzle and that everything that is happening on its surface is mysterious.

There are some things that we know rather definitely about the earth its shape and size, for example. These have been determined by very accurate observations made on the stars for latitude and longitude and by the measurement of distances between the astronomical stations by means of triangulation. As the distances are measured with great accuracy, the dimensions derived for the shape and size of the earth are correspondingly accurate. It is rather interesting to note that the most accurate determination of the dimensions of the earth was made by the Coast and Geodetic Survey, These dimensions have been internationally adopted by the International Geodetic Association as the most accurately known ones.

We know the density of the earth, which is about five and one-half times the density of water. The density of the surface rock averages about 2.7 times that of water. Since we know the average density of the earth and its size and shape, we also know its total mass. We know that the earth is not a stable structure - it is yielding continuously to forces which are acting on it. Areas that were once beneath the level of the sea are now high in the air as plateaus or mountains. We know this because sea shells are present in these elevated rocks and it is certain that the amount of water on the earth's surface was never so great as to have stood at the elevations at which we find the fossil remains of the sea animals. There are areas that once were above sea level and had mountains and plateaus, which are now below the surface of the sea. There are areas where rocks are found which have been pushed horizontally for a mile or more.

The earth is subject to tremors from earthquakes, which occur at frequent intervals. An estimate has been made that there are approximately 8,000 known earthquakes every year. These are the quakes whose tremors are recorded on a very delicate instrument called the seismograph. There are not very many seismograph stations in the world, hence it is reasonably certain that if such stations were placed close together there would be recorded yearly many more thousands of earthquakes.

There are many volcanos on the earth's surface belching forth lava, rock and smoke. These volcanos must be vents in the outer portion of the earth, which extend down to regions where the temperature is so hot that the rock is melted with the rupturing of the rock above.

We know that the temperature of the earth increases as one goes down from the surface. The temperatures at different depths are taken in mines and in wells that are drilled for oil or water. The increase in temperature with the depth changes from place to place, but the average is 1 degree centigrade for about 100 feet in depth. If this rate continued down to the center of the earth, the temperature of the center would be many thousands of degrees. Wo do not know whether the temperature increases all the way to the center, but at least it must continue for some miles below the surface, for otherwise we could not have hot springs, volcanos and out-flowing lavas.

We know that at present there falls to the land area of the earth annually an average of about thirty inches of water in the form of rain. The best estimate of the time of the beginning of the formation of sedimentary rocks was approximately a billion and a half years ago. There must have been rain at that time for sedimentary rocks cannot be formed unless there is running water. We may assume as a certainty that at the beginning of our present sedimentary age, a billion and a half years ago, the earth's surface was irregular, probably as irregular as it is to-day. If the rate of rainfall has been continuous during this billion and a half years, there could have been three-quarters of a million miles of rain. When water falls to the earth as rain, it tends to go to lower levels, to the valleys and rivers, and eventually much of it goes back to the sea. This water carries with it in suspension and solution much soil and organic matter. It has been determined by the Geological Survey that the rivers of the United States in 9,000 years carry to tidal waters an amount of material in suspension and solution equivalent to a layer of earth covering this country one foot thick. This rate of erosion or moving of material to tidal waters may seem very slow to us, but it amounts to a mile of erosion in about forty-five millions of years. Since rain has been falling for approximately a billion and a half years, thirty miles of material could have been removed if for any area this rate could have been maintained. Of course, no such amount of erosion could have occurred in any particular area.

The waters of the ocean, if spread uniformly over the whole earth, would be about 9,000 feet in thickness, somewhat less than two miles. This water has been used over and over again thousands of times during the sedimentary age in order to furnish the rain that has fallen back to the earth. This is the reason why the sea water is so salty. Every bit of water that goes to the ocean has some solid matter in solution. During the evaporation this solid material is left, it is not taken up into the atmosphere. Eventually the waters of the sea became saturated, as they are to-day.

The evaporation of the sea water is necessarily due to the heat received on the earth from the sun, and we may therefore say that we shall have rain as long as the sun shines. When the sun ceases to exist, if ever, the earth will become an inert mass, because it will become extremely cold and there will be no evaporation and rain.

During the processes of erosion and transportation of material from the continents to the tidal waters, there is a disturbance of the equilibrium of the earth - some parts are overloaded and other parts are underloaded. This causes a pressing down under the heavy weights of sediments, such as we have at the mouth of the Mississippi River. Areas which have been undergoing erosion, such as the Rocky Mountains, have been made lighter and the earth's material under those mountains tends to rise up.

It has been found by geodetic engineers working in different countries, but principally by the Coast and Geodetic Survey of the United States, that the outer portion of the earth, to a depth of approximately sixty miles, is composed of solid rock. This rock will break when forces are acting upon it for a sufficiently long time, provided the forces are of sufficient strength. The interior of the earth, on the other hand, has been found to be composed of material that will yield like plastic material to forces that are acting on it for long periods of time, say tens, hundreds, or thousands of years. This interior material behaves like an elastic structure when forces are acting on it only for a short time. Such forces are the tremors that go out from an earthquake and the tidal forces of the sun and the moon, which change phase several times a day.

The result of this condition of a solid shell and a plastic interior is that under the very heavy loads of sediments which are deposited along the coast of a continent by its rivers, the solid material is forced down and the sub-crustal material is moved back towards the areas from which the sediments were derived. The outer shell, frequently called the earth's crust, rests on the interior material very much as a raft formed of logs rests upon a body of water. There is an equilibrium, established by the yielding to these loads of the outer shell of the earth, that is given the name of "Isostasy". This is a term derived from Greek words and it means "equal pressure", or "equal standing". The earth is in isostatic equilibrium, and whenever materials are moved over its surface by streams or rivers there is a tendency for the equilibrium to be restored. Of course, the earth's surface does not yield to very small loads - a few hundred or a thousand tons - or even to a few millions of tons, but after a river, like the Mississippi, has been sending solid material to the Gulf for a great many years, the crust near its mouth will be under such a strain that it will be pushed down to restore the balance.

Since the temperature of the earth increases with depth, it is certain that the crustal material, which is pushed down under heavy loads of sediments, reaches regions which are normally hotter than the regions previously occupied. Eventually this crustal material takes on new temperatures and that causes an expansion that forces the earth's surface upward. Here we have an explanation of the phenomena of earth's materials once below sea level, now lifted high up in the air.

Where erosion has been going on for thousands or millions of years, the earth's crust will be pushed up to restore the isostatic equilibrium. During this process the crustal material will be raised into colder regions and eventually it will be cooled down. This will cause a contraction and carry the earth's surface down, perhaps even below sea level.

It would seem, from what has been said, that we must have four distinct causes of earthquakes. First, is the breaking of the earth's rocks under the load of sediments; second, the breaking of the rock as the crustal material is pushed upward under the area of erosion; third, the expansion of crustal material which has been pushed down into hotter zones by the sediments; and fourth, the cooling and contraction of crustal material which has been pushed upward under areas of erosion.

It will be seen that we have been treating the earth as an engineering structure, such as a bridge or a building. We can follow through some of the processes that are common to the physical laboratory and in engineering field work in the moving of materials of the earth. There is no such thing as a rigid earth. It is a yielding structure and it will continue to be a yielding one as long as we have rain and sunshine. It is very fortunate that the earth is not composed of material of prodigious strength. If it were, forces would accumulate until they overcame the strength of the earth's materials and then there would be an earthquake which would be vastly more destructive than those we are accustomed to. Strange as it may seem, the more earthquakes we have the safer we are, because the more we have the smaller will be the intensity of any one of them.

We hear much about this or the other earthquake being more destructive than some other one, but we are very apt to rate an earthquake in accordance with the damage it does to human structures. An earthquake may occur in the center of a great desert and may create a great gap in the earth's surface, but may not destroy any human habitations because there are none near. Another earthquake of much less proportion may damage buildings and destroy human lives. Since we cannot prevent earthquakes, the earth's surface having been subject to them for hundreds of millions or a billion of years, we should apply our science and engineering to the problem of building our structures in such a way as to resist the shaking.

Earthquakes are caused by rock breaking and what is called the epicenter, or point at which the break occurs, must be within about sixty miles of the earth's surface. It is reasonably certain that most of the earthquakes occur within thirty miles of the earth's surface.

The earth will never collapse, but the mountains are not everlasting, and we will have earthquakes as long as the sun shines and we have evaporation and rainfall. Earthquakes will stop only when the sun no longer shines, but this probably will not occur for hundreds of millions of years. We must accept nature as it is, treat the earth as an engineering structure, and erect our buildings and other structures with a view to resisting those forces of nature which are constantly at work.

RATING OF PATENT LOGS

G. D. Gowie and M. A. Hecht, U. S. Coast & Geodetic Survey.

During the 1930 and 1931 field seasons on the Florida coast, logs were rated by the party on the LYDONIA over a course run on a sensitive range consisting of the two triangulation stations, NORTH MAST (wreck) and CAPE CANAVERAL LIGHTHOUSE. The length of the course was controlled by resection on third and fourth triangulation stations BEACHY and MIDWAY, so selected in relation to the course as to give rapidly changing angles with consequent accurate determination of distance. The maximum change in distance per change of one minute of resection angle was 2.1 meters.

Inverse position computations were made to obtain the azimuths and distances from NORTH MAST to BEACHY and MIDWAY. The course was divided into four equal sections; the north end was fixed by a resection angle of 90° between the range and MIDWAY; its full length was 2.665 nautical miles.

The ship steamed back and forth on the range. An observer with the computed resection angle set on his sextant marked the instant the ship was at each position, and both logs and revolution counter were read simultaneously. The logs were read to hundredths, great care being taken to obtain the second decimal place correctly. For each set of logs, two forward and two backward runs were made. The same dials were used on the starboard and port sides throughout the tests. Two rotors were rated with each dial and thereafter were used with the dial, and on the side of the ship, for which rated.

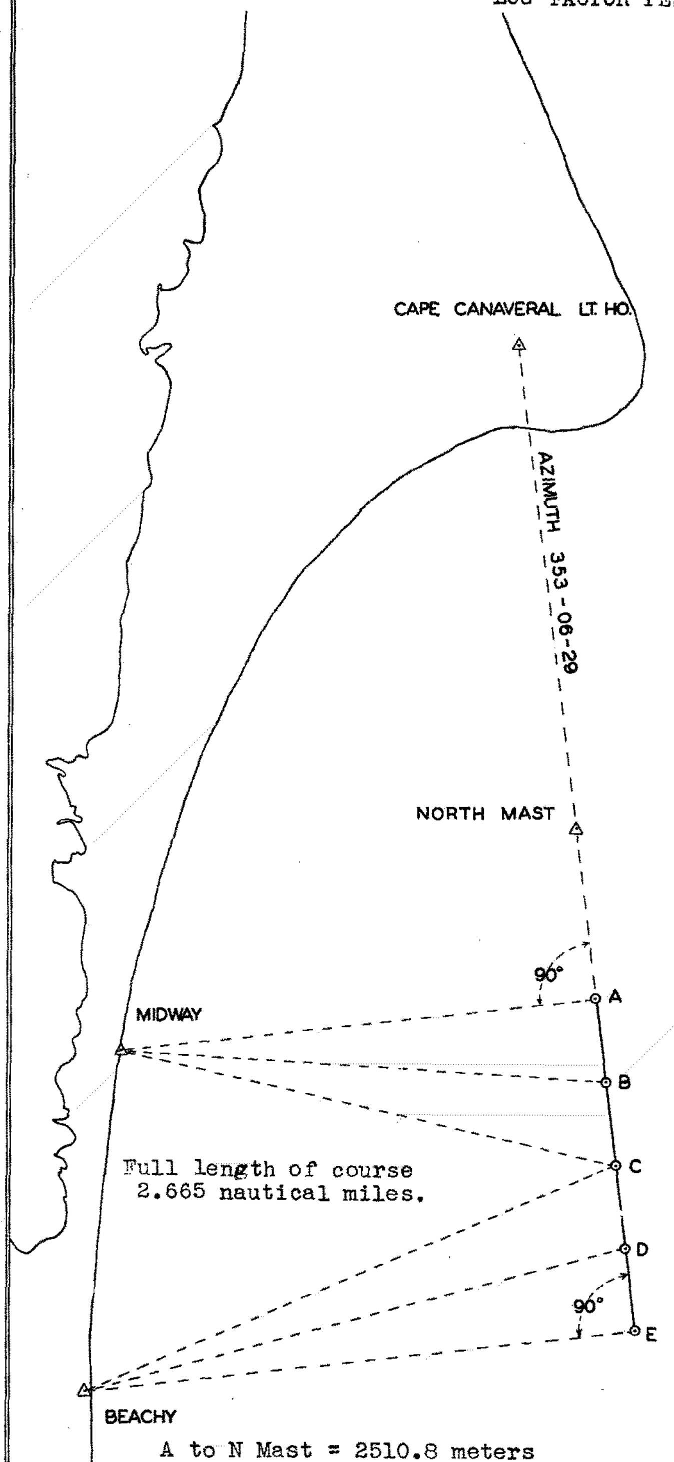
The course lies in Canaveral Bight as shown on the accompanying plate. It is slightly sheltered and has no cross currents. During the tests there was a light northeasterly breeze and a slight northerly chop. Simultaneous equations based on double runs were used to compute the log factors, thus eliminating the current.

An attempt was made to maintain a constant speed during the tests by maintaining a constant R.P.M. The average speed of the ship was 9.9 knots at an average of 103 R.P.M. A summary of the log factors and current values is shown on the attached plate.

In connection with the log tests, data were obtained from which the revolutions per nautical mile were obtained and the propeller slip computed. These results were particularly interesting because a new four-blade propeller had been installed during the 1930 repair period, primarily as an experiment to reduce the excessive vibration.

Since installing the new propeller, the vibration of the ship at full speed is barely perceptible. It is now possible to plot soundings and write on the bridge when running at cruising speed. This is 10 knots at 105 revolutions of the 4 blade propeller, which is equivalent to the old propellor making 118 R.P.M. At 125 revolutions the new propellor drives the ship at 12 knots, a considerable increase over old speed, at the same number of revolutions.

LOG FACTOR TESTS



A to N Mast = 2510.8 meters
E to N " = 7449.8 "
A to B " = 1234.75 "
B to C " = 1234.75 "
C to D " = 1234.75 "
D to E " = 1234.75 "

Results of Ratings computed by simultaneous equations using the formula: $Ry \pm Tx = D$ where R is the log reading, y the factor, T the time required for the run, x the current, and D the length of the course.

LOG #193-PORT ROTOR 191A		
No. of run	factor (y)	current (x)
1 & 2	1.015	0.085
3 & 4	1.032	0.131
2 & 3	1.028	0.210
1 & 4	1.024	0.019
mean	1.024	0.111

LOG #191-STBD. ROTOR 191		
No. of run	factor (y)	current (x)
1 & 2	0.983	0.084
3 & 4	0.995	0.036
2 & 3	0.986	0.156
1 & 4	0.989	0.000
mean	0.988	0.069

LOG #193-PORT ROTOR 193A		
No. of run	factor (y)	current (x)
1 & 2	1.088	0.084
3 & 4	1.082	0.042
2 & 3	1.078	0.072
1 & 4	1.082	0.132
mean	1.082	0.082

LOG #191-STBD. ROTOR 193		
No. of run	factor (y)	current (x)
1 & 2	0.970	0.120
3 & 4	0.978	0.000
2 & 3	0.968	0.096
1 & 4	0.980	0.024
mean	0.974	0.060

DETERMINATION OF SLIP OF PROPELLER

Total Revolutions = 11596

Actual miles run through water = 18.655

Pitch of Propeller = 11 feet

$$\text{Revolutions per nautical mile} = \frac{11596}{18.655} = 621.6$$

$$\text{Av. speed of ship} = \frac{21.320}{2.1451} = 9.939 \text{ knots}$$

$$\text{At av. No. of R.P.M.} = \frac{11596}{112.74} = 102.86$$

$$\text{Slip} = \frac{(11 \times 11596 \div 6080) - 18.655}{18.655}$$

$$= .1246 = 12.46\%$$

C.& G.S. Print (R-168)

NOTES ON CONTROL FOR AERIAL PHOTOGRAPHS

O. S. Reading, U. S. Coast and Geodetic Survey.

With the remarkable development of air photo mapping, it is becoming increasingly evident that the utility of control stations will be greatly enhanced wherever they can be so described as to be recoverable on aerial photographs without again visiting the stations on the ground. This may readily be done by a few measurements whenever a station is established near reasonably permanent detail of contrasting appearance such as cross roads, buildings, rocky points, or even corners of fields of differing culture. Such detail is usually noted in descriptions at present, but too often with estimated instead of measured distances. Measurements, not estimates, should be made to any definite points within 200 meters of the station. Enough measurements should be made to furnish a check wherever practicable.

Nothing is more aggravating to one trying to compile photographs than to find a description reading like this: "About a hundred meters east of a canal and about 30 meters from the bulkhead of a fill." Two simple measures instead of the estimates would save a special trip to the station.

To appear clearly in air photographs, particularly photographs on the small scales used for mapping, objects must have some contrast in color or shape from their surroundings. The more contrast the more clearly they will stand out, with the exception of small objects on white sand beach. The glare from white sand sometimes causes considerable halation, blurring the edges of dark objects in the photographs. Objects ten meters or more in diameter should be selected when practicable on white sand background, though smaller ones sometimes show well. The following objects suitable for referencing to control are listed in the order of their clarity of appearance and certainty of identification on aerial photographs: (1) Cross roads and railroads (measure to center of grade or pavement, (2) prominent buildings and bridges, (3) Canals and streams, (4) cliffs or bluffs, rock outcrops (particularly of different color or projecting shape), (5) waterlines generally (for sand beach or swamps take edge of drift or vegetation), (6) corners of cultivated fields, (7) points of woods or brush, lone trees, etc. In case of several measures or possible confusion of several buildings, etc., a sketch is invaluable.

The problem of locating the control stations on the photographs is usually considerably simplified if the photographs can be taken to the stations in the field. Nearly always when the locality of the station can be identified within 100 meters or so, there will be recognizable slight differences of light and shadow which can be identified with objects on the ground and the position either pricked through directly or determined by a few short measurements. In some cases it will be necessary to measure a quarter of a mile or so from some detail which can be positively identified to make certain of the identification of the spot. When the photographs are indistinct or when the photographs can not be taken to the site, it is always desirable to measure distances to adjacent streets if within 100 meters or so. Streets always show when not hidden by trees even in poor photographs, but other features are often not so discernible. Measurements to streets, including azimuths, should be taken to center of grade or pavement.

In areas of unvarying appearance, as a low mangrove shoreline, the simplest method may be to rod in with a plane table a sufficient part of the curve of the shoreline to fix the location of the station, when reduced to the scale of the photograph. If the work is not done on a regular projection, some sort of azimuth should be shown. Care must be taken not to sketch too much in this work lest slight discrepancies throw doubt on the position. Small irregularities of five or ten meters in size, if clear cut, can often be used for positive identification. In Florida on a straight sand beach with uniform palmetto vegetation, it was considered best to run a planetable traverse locating inshore hydrographic signals between third order traverse control stations and at the same time to locate buildings, cultivated fields and roads leading back from the beach for photo control. The high waterline, which was not well defined in the photographs, was also located by this traverse.

The accuracy of the photographic plot of course depends entirely on the care and accuracy with which the control is located on the photographs. If the control in spotted on the photographs by field parties, this must be done at the site of each station (some results where the control was spotted on the photographs aboard ship have been exceedingly unsatisfactory) . Each station need be spotted but once and the clearest photograph of the site should be used. The spotting of the station on the overlapping photographs is better done in the office. Should it be impracticable to prick the exact spot in the field, the general position of the station should be circled in pencil and the measurements to adjacent detail necessary to locate the station should be forwarded with the photograph for plotting in the office.

The amount of control required for plotting the photographs varies so greatly with the character of the photographs and the terrain, the scale of the map, and the permissible error that specific instructions will usually be required for each project. In general, a point near the center and one on each side of the area common to three overlapping photographs of a strip at intervals of about ten photographs along the strip is sufficient. If the photographs are much tilted or if the overlap is loss than 55 per cent, additional points will be required. With four or five lens cameras in good adjustment and with good flying, the control may be abridged somowhat.

When the control executed for a region consists of a traverse along the beach or triangulation across a broad bay which the pictures do not span, traverses along roads leading back from the shore may be used to get control points across the photo strip. It is desirable that such traverses be tied to triangulation stations, but when difficult ground, such as a mangrove swamp or a lagoon, intervenes, a quarter mile gap or so need not be measured but may be scaled from the photographs. Solar azimuths may be measured with theodolites whenever more convenient than geodetic azimuths from the triangulation. Distances may be measured with the 300-foot steel tape, angles with a small theodolite. The scale of the photographs will govern the accuracy of such spur traverses, only such precautions being taken as will serve to keep their error less than the draftsman can plot. It is desirable to note plusses to intersecting roads, corners of prominent buildings, or corners of fields of different culture about every half mile along such traverses.

As contours or form lines will not be drawn on the photo sheets except when the relief of the terrain is so conspicuous as to be used by navigators, vertical control will ordinarily not be required. Special instructions will be issued for the vertical control of each project for which it is required. It will consist of obtaining spot heights by leveling, null-reading aneroid barometers, or vertical angles from known stations according to the character of the terrain and the permissible error.

In addition to furnishing control, it may sometimes be necessary for a field party to make a field inspection with the photographs for the purpose of obtaining sufficient information to enable the draftsman, who is not familiar with the locality, to plot a conventional topographic sheet from the photographs. Notes showing the information may be written in soft pencil directly on the photographs or preferably a letter or symbol may be used and the note written on the card mount or in a separate notebook opposite the photograph number and a similar symbol. The following list of notes desired is intended as a general guide only and should be freely supplemented by any information useful in interpreting the photographs or calling attention to features which might otherwise be overlooked;

(a) Names of all towns, bays, rivers, canals, creeks, highways, landmarks and other features which should appear on the topographic sheet.

(b) Notes calling attention to all landmarks, buildings and other features which are recommended for charting. Aids to navigation, particularly beacons, require special treatment. The smaller aids do not usually show on photographs on mapping scales. The larger ones are usually located by triangulation when practicable. Special instructions will ordinarily be issued covering the location of aids to navigation. When necessary to use the photographs to locate the aids, signals should be spotted on unmistakable points and enough-measurements of angles or distances to furnish a check should be taken. When, because of the featureless character of the shore, it becomes impossible to accurately spot signals on the photographs, a planetable traverse should be run to tie the signals to features which can be positively identified or to characteristic curves of the shore as when locating control stations. Angles to tangents unidentified by signals should only be used by special permission and on reconnaissance surveys.

(c) The height of landmarks, character of bridges and roads, the number of tracks in railroad sidings and yards, with descriptions and sketches of any features which should be shown on the topographic sheets but for any reason are not clearly distinguishable in the photographs, should be noted. Among the latter are roads and streams obscured by overhanging trees and the high water line when obscured or indefinite. At times a slight difference in light and shade may be recognized and traced as the high water line in the field when it is too faint to be so recognized and used by the draftsman in the office. When the beach has the same slope and character, the high rater line may be interpolated between measurements taken at control stations for the photographs on any one sheet will all have been taken within a few minutes of each other.

(d) Each type of vegetation or culture should be noted on the photographs a sufficient number of times to make certain that the draftsman will interpret the photographs correctly in the office. The standard topographic symbols or a brief descriptive phrase may be used, such as mangrove, palms, mud flat, salt marsh, intermittant pond, canal with road on north bank, etc.

In general, the notes should be so copious as to leave no problem for the office except accurate drafting. The photo topographic sheets serve many purposes in addition to furnishing the topography shown on the charts, and, therefore, all the information plottable on the scale of the photographs should be obtained.

A FEW RECOMMENDED PAPERS ON AIR PHOTO TOPOGRAPHY.

"Aerial Photographic Mapping" by Captain Bruce C. Hill, C.E., Military Engineer, November-December, 1930, Vol. XXII, No. 2.

"Application of Stereoscopic Photography to Mapping" by Captain M. Hotine, R. E., Geographical Journal of Royal Geo. Soc, London, Vol. IXXV, No. 2, February, 1930.

"Aerial Photography Applied to Maps" by F. H. Peters, Canadian Engineer, Toronto, May 13, 1930, Vol. 58, No. 19.

"Aerial Photographic Mapping", U. S. Army Training Regulations 190-27, Superintendent of Documents, Washington, D. C, 15 cents.

British Air Survey Committee's "Report for 1923" and "Professional Papers", Nos. 1 to 6, London, His Majesty's Stationary Office. Prices range around $1.00 each.

Space prohibits listing these "Professional Papers" individually; also further items. The office has a bibliography available to those interested.

A recent paper of value is: "Photo Mapping Methods Used in Europe" by Lieut. Fredric A. Henney, C. E., Military Engineer, May-June, 1931, Vol. XXIII, No. 129.

PORTABLE R. A. R. STATIONS

Dr. Herbert Grove Dorsey
Senior Electrical Engineer, U.S. C. & G. Survey.

It is believed that the idea of a portable R.A.R. station started with the writer in the fall of 1926 while he was stationed on the LYDONIA during the early attempts to establish R.A.R. on the Atlantic Coast.

After definite failures of the shore stations on the North Carolina coast to receive the sound of bombs a sufficient distance to make the method practicable, experiments were started in which a hydrophone was suspended from a whaleboat, and with an amplifier, headphones and a notebook, an observer would listen while the ship carried out a pre-arranged schedule of operations. This generally occupied several hours during which the ship would fire bombs of TNT at regular intervals while running away from the whaleboat which would be anchored at some position which was deemed a possible location for a hydrophone station.

Since there was no method of communication between the whaleboat and ship, very often it would be found that after from two to six hours of running out and back by the ship, the whaleboat observer could only report that nothing was heard from the ship after the first ten minutes, although the ship had fired maybe 15 or 20 bombs after that and much time had been uselessly wasted. If communication could be had between the two, the total time could have been reduced to about 30 minutes.

Disregarding all advice and warnings of the ship's radio operator, the writer, after a few preliminary trials, made a transmitter of three coils of 9, 8 and 4 turns for plate, grid and antenna, respectively, some eleven centimeters in diameter. Each coil was covered with a layer of rubber tape and the three then taped together and fastened to an odd piece of bakelite on which was placed a tube socket and five binding posts.

There was no grid leak, tuning condensers, chokes; or bias; almost nothing one ordinarily sees in a transmitter. The radio operator declared it "would not and could not oscillate", and was dumbfounded when, with a UX 210 tube and 225 volt B battery, the lamp of a wave meter would light up when at a distance of ten inches. It was, of course, not efficient, but it was waterproof. Its wave length was about 60 meters and communication was possible at a distance of ten miles. While it was not used to automatically transmit a signal on receipt of the sound of the bomb, it so simplified the experiments that tests could be made with the whaleboat in a dozen different places in a single day. As soon as a test was completed in one location they would report "pick us up" and the ship would run back and tow the whaleboat to a new position. Eventually this simple device was worked to a distance of some 40 miles.

Naturally, a small transmitter in which the tuning is dependent to a considerable extent upon the capacity of the antenna system will have its frequency vary with every motion of the boat. A dash may be broken into dots and dots completely lost so that, except in a calm sea, communication is difficult. The next step in advance is to use an independent oscillating tube and let it feed a radio frequency amplifier which is coupled to the antenna. This form of transmitter is far superior in that it is much steadier and little affected by rolling of the boat. This type was successfully used on the ECHO in preliminary trials in the fall of 1929 and with the RANGER and the ECHO off Florida in the spring of 1930. These latter transmitters were the first practical attempts in using a thyratron instead of a relay to close the B battery circuit of the transmitter so that there is no lag in the sending of the initial dash. During the summer of 1930 on Georges Bank the transmitters on both the LYDONIA and OCEANOGRAPHER were changed to Quartz crystal control so that no bomb signals were lost duo to tuning itself, the frequency remaining absolutely steady so far as can be detected by the ordinary receiver.

During the fall of 1930 a report was sent in from the PIONEER that a launch had been temporarily equipped as a R.A.R. station and successfully used in determining distances between control buoys on an offshore bank. Discussion at the Washington office disclosed the usefulness of such methods and it was decided to build a compact arrangement for trial with the idea that it need not operate more than 10 or 15 miles to be extremely serviceable in many different cases of locating buoys, etc.

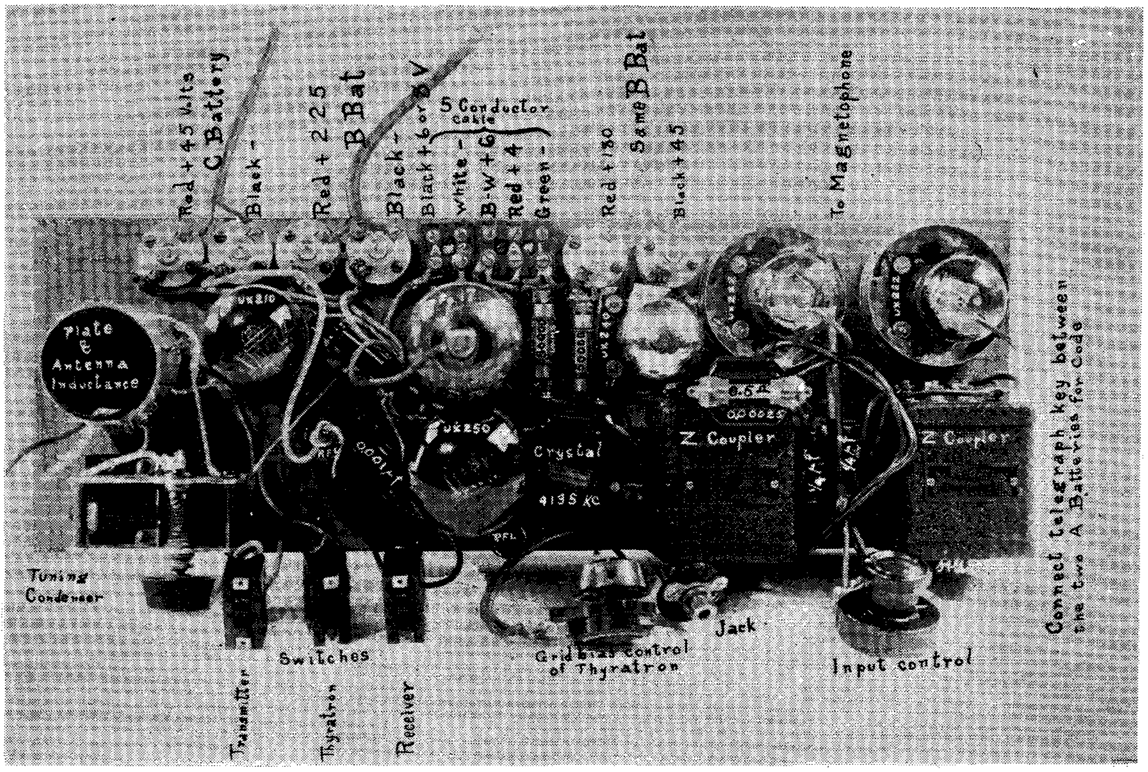
Before opportunity arrived for starting such an outfit, request came from the OCEANOGRAPHER for practically the apparatus which had been planned which was then built as quickly as possible during the press of regular work.

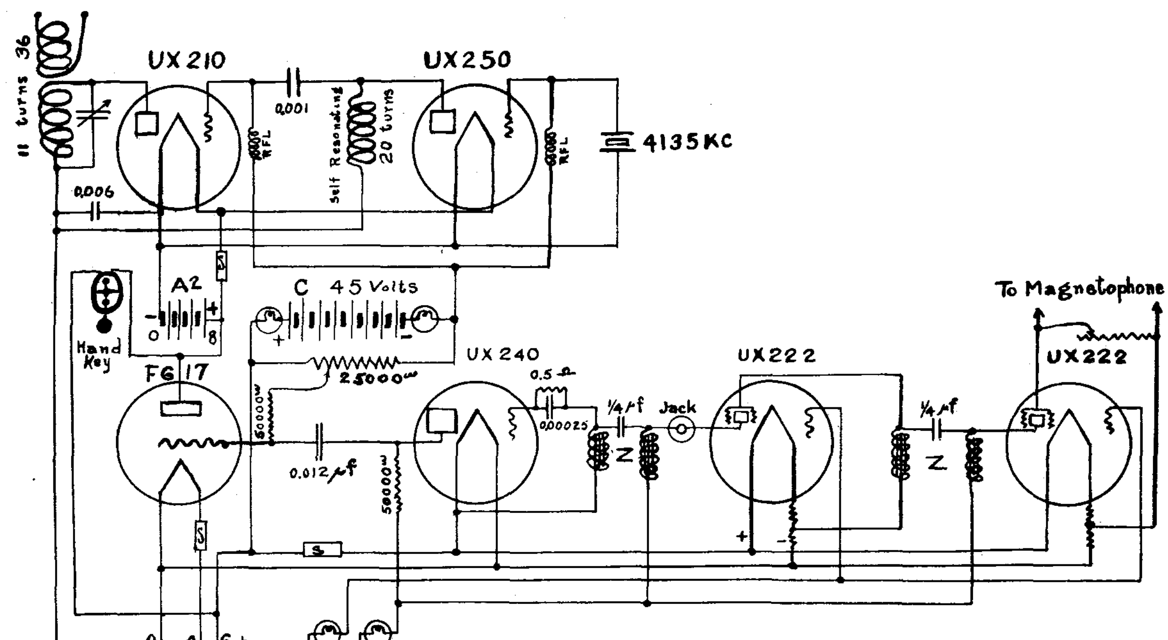
This apparatus is contained in a single cabinet of the same dimensions as the regular R.A.R. shore station amplifier (page 26, Special Publication No. 146) and it is only necessary for the ship to furnish two A batteries, one B battery, one C battery, magnetophone, hand telegraph key, and necessary antenna wire to be used in a launch or whaleboat or wherever it is desired to make the tests.

A short wave radio receiver is also to be supplied by the ship, but it may be operated from the B battery and A battery No. 1, used with the transmitter.

The illustrations show the arrangement of the apparatus when removed from the cabinet and give the values of voltage to be used and location of the different controls.

With the exception of the antenna binding posts on the upper left of the bakelite panel, all connections are made by means of cables passing through the back side of the box. A five conductor cable at the middle is connected to two A batteries, green to negative of No. 1 A battery, red to 4 volts positive, and black-white to 6 volts positive. No. 2 A battery may be 8 or 6 volts with white wire connected to the negative





PORTABLE R.A.R. SET

25 MARCH 1931

side and black connected to the positive terminal. The two A batteries are to be entirely separate and reasonably well insulated from each other by being placed on dry wood, for the difference in potential between them may be as high as the total B battery voltage.

A hand telegraph key should be connected between the positive terminals of the two A batteries and this key is to be used for regular telegraphic code between the boat and ship. Its operation will be to key the negative side of the B battery of the transmitter.

The B battery should consist of not less than 5 blocks of 45 volt dry batteries connected in series with negative end connected to the black wire in the cable next to No. 2 A battery, and positive wire to the red wire in this cable. Positive 45 volts and 180 volts of the B battery are to be connected to the black and red wires respectively in the cable next to No. 1 A battery terminals. A 45 volt C battery is to be connected to the left hand cable, negative to black and red to positive.

It will be noted that the B and C battery terminals are all connected to miniature lamp sockets which should contain miniature lamps of about 0.3 ampere, and voltage 3 to 6. These lamps serve as fuses to protect the tubes and also act as current indicators. Moderate glowing of the lamps minus and plus B only mean that current of the order of 100 milliamperes is flowing through the transmitter tubes. The other four lamps will not glow unless something is wrong.

The magnetophone is connected to the cable at the right. No battery is needed with the magnetophone as it is of the electromagnetic type of receiver generating its own electromotive force which is applied directly to the variable input control resistance and thence to the space charge grid and negative return of the first amplifying UX 222 tube which is connected to the second similar tube by impedance and condenser coupling. The screen grid voltage is 45 volts and the plate voltage is 180 and a ¼ microfarad condenser is used for coupling. Normally, these tubes and sockets are covered with aluminum shields, not shown in the photographs. In the plate circuit of the second tube a telephone jack is connected in which may be plugged ear phones for listening to amplified sounds.

The second tube is connected to a UX 240 tube through a grid leak and condenser, making it act as a rectifier. Its plate circuit is resistance coupled to a thyatron FG 17 and the grid return of the latter is connected to the arm of a 25000 ohm potentiometer connected across the C battery, the positive terminal of which is connected to No. 1 A battery. The plate of the thyratron is connected to positive terminal of A battery No. 2 so that the plate circuit of the thyratron is shunted across the telegraph key already mentioned.

In line with the thyratron is the oscillator tube inside a bakelite form on which is wound 20 turns of No. 18 wire serving as plate inductance for the oscillator. This inductance has sufficient distributed capacity so that the crystal oscillates freely without the use of a tuning condenser. The grid is connected to a radio frequency choke on which is impressed a negative bias of 45 volts by the C battery whenever the key or thyratron closes the circuit.

The oscillator tube may be a UX 171A or UX 250. Either of these with 220 volts on plate oscillated better than a 112 or UX 210. However, with only 2 volts on A battery No. 2, a UX 245 makes a good oscillator.

The oscillator plate is connected to the grid of the power amplifier through a 0.001 microfarad condenser, the grid being biased by minus 45 volts through a choke, the same as the oscillator tube. A UX 210 tube serves best as an amplifier, although a UX 171A will work and also a UX 245 with reduced voltage on the filament. The amplifier inductance of 11 turns of No. 12 wire is wound on a 2 3/16 inch bakeline form, mounted in a vertical position to the left of the amplifier. A 17 plate variable air condenser will tune this inductance to 4135 kilocycles, or to its second harmonic.

The antenna coil, of some 36 turns, is wound on the same bakelite form as the amplifier coil and the end terminals are connected to binding posts. In the laboratory two antennae wires about 10 feet long were connected to the binding posts and carried apart and slightly upwards to similate what might be had by using two oars as masts at the ends of a whale boat and connecting the antennae to their ends. A neon glow lamp gave indications of considerable voltage at their ends, but no actual tests were made. A flexible conductor is soldered near the middle of the coil, and taps are left at one end so that a ground wire may be tried, or different numbers of turns used to ascertain what may give best results in practice. With the close coupling between the antenna and plate coils, the condenser serves to tune both inductances.

In operation, the transmitter switch is closed and its circuits tuned until a good radio signal is received by the ship. This circuit is then opened and the receiver switch closed and input control adjusted so that the magnetophone seems quiet with no noise in the boat and the magnetophone hung about 6 fathoms deep. A slight pounding on the boat's side should be heard very plainly in the ear phones if all is working well. Next, the thyratron and transmitter switches should be closed and the potential of thyratron grid adjusted until the thyratron will not operate until some slight sound is produced in the water. The thyratron exhibits a blue glow when it operates and will not extinguish itself until its plate circuit or filament circuit is opened, or the filament circuit of the transmitter tubes. In the laboratory the amplifier was so sensitive to noises that the mere closing of the thyratron switch would cause sufficient noise to actuate itself and it was necessary to put an extra knife switch in the circuit but not mounted on the cabinet. This was connected between plus 4 volts of A battery No. 1 and the red wire. With this switch no trouble was experienced.

In practice, the thyratron will be used for only short intervals so that even though the filament requires 5 amperes, the A battery's charge will not be rapidly depleted. When the ship signals that the bomb has been dropped overboard, the circuit is closed through the thyratron and it should be opened again as soon as the noise of the bomb actuates the circuit which will send just one long dash. If the blue glow should persist in the thyratron as it sometimes does, due to the plate current heating the filament, it may be stopped by making a dot with the telegraph key which by shunting the thyratron plate circuit reduces its current to zero.

It should be noted that the signals made by the telegraph key will be slightly louder than those made by the thyratron, since the mercury vapor of the thyratron has an appreciable resistance. If this should make adjustment of the receiver and chronograph difficult, add a resistance of about 500 ohms in series with the key. This method is used on the GILBERT and the LYDONIA so that the thyratron signal is slightly louder than the key signal. This makes adjustment on the ship easy for the thyratron signal is always somewhat stronger.

If the two stages of audio amplification are considerably more than necessary, a change to one stage may be readily made by simply removing the two shields and space charge grid terminals and placing the terminal normally on first tube on the second tube cap and just neglecting the second terminal. In this case it may be desirable to place a piece of paper under the control rheostat movable arm so as to open its circuit.

* * * * * * * *

Since this portable set was built, experiments have been conducted with the new UX 232 screen grid tubes. These are far less micronophonic than the UX 222 tubes and give slightly greater amplification. Since they require only two volts on the filament and draw only about l/8 ampere, they are more suitable than even the UY 224 tube which requires 1-1/2 amperes.

If any more portable R.A.R. sets are built they should be planned for the UX 222 tube.

PORTABLE R.A.R. SET

O. W. Swainson, U. S. Coast and Geodetic Survey.

A cage aerial was stretched between two 2" x 3" poles 16 feet long rigged one at each end of the launch. The regular shore station equipment with A and B batteries used for power was installed in the boat.

Various methods were used for the hydrophone, all on the suspended type principle as the depth of water was usually about twenty fathoms. The first method was the regular suspended type with the lead-in wire running directly from the hydrophone anchor to the launch. The hydrophone was planted about two hundred feet from the launch, which in turn was made fast to one of the signal buoys. This was very satisfactory until the current became so strong as to drag the lead-in wire over the coral bottom and thus cut the insulation.

For distances up to 10 miles and with a wind not over force 3, and sea only moderate, a sixty pound weight {deep sea sounding shot) was fastened to the hydrophone and lowered over the side of the launch to a depth of twelve fathoms. In a comparatively smooth sea this worked fine, but when the launch pitched and rolled to any extent, the noise of the sea against the boat and the constant jerking of the hydrophone caused extraneous noises to interfere seriously. The trouble was lessened somewhat by a man acting as a shock-absorber by leaning over the side of the boat and holding the hydrophone cable in his hand.

In rough weather the suspended hydrophone was anchored near a signal buoy (within measurable distance), the wire run down the hydrophone anchor line, thence about two hundred feet along the ocean bottom to the anchor of a watch buoy, up this anchor to the watch buoy and then into the boat which was made fast to this buoy. A forty gallon oil drum made a good buoy for this purpose. The anchor line of the watch buoy was short, being about one and one-half times the depth of the water. This method gave good results. The gear could be left down for several shiftings of the buoys. It required the use of the ship, however, and took an hour to lay it or pick it up. The launch itself attended to the laying and picking up of the hydrophone in the other methods.

One or two percussion caps made good bombs for distances up to six miles. For distances of six to fifteen miles, gill milk bottles or 2-ounce condiment bottles filled with T.N.T. were used.

When everything was ready the ship was placed practically dead in the water close to the signal buoy - not over two hundred meters - the bomb was thrown over the stern, the distance from the ship to the point of its striking the water estimated, and at the signal of "over", the ship's heading and the bearing and vertical angle to the buoy measured. These measurements gave the relative position of the bomb to the ship's receiver (either the sounding hydrophone or oscillator diaphragm), the receiver to the observer on the bridge, and the observer to the signal buoy. The time recorded on the tape corrected for the distance of the bomb from the receiver gave the distance of the bomb to the launch hydrophone. The relative position of the launch hydrophone and the nearby tie-in buoy was measured by the launch. The bombs were dropped with the vessel under way when bombs larger than the 2-ounce bottles had to be used. With these data the distance between the buoys was determined graphically as it was easier than computing.

Five to fifteen determinations for each buoy distance were made, the ship being at different positions around the buoy at each determination in order to eliminate error in measuring distances and directions of the various component parts of the operation.

For short distances, less than four miles, the oscillator was used instead of bombs. This expedited the work considerably as the vessel could steam slowly around the buoy, obtaining a distance determination as frequently as desired, as the launch receiver would be left on continuously and no reports were made after each determination.

Usually the maximum discrepancy in a series of distance determinations was less than sixty meters, and the average residual about ten meters. The maximum distance determined was thirty miles. Seldom were "jumps" noticed on sounding lines when passing from one side of the line of buoys to the other or when changing fixes.

Azimuths were determined by placing the vessel on range between two buoys when the sun was low or on the horizon and measuring the sun's inclined angle to the horizon over the distant signal and the vertical angle of the sun. Sometimes only one azimuth was measured this way and then the azimuth carried forward by placing the stem of the ship against a buoy and measuring the angle between the buoys, a marker buoy having been placed off to one side to aid in measuring the large angle if necessary.

The set was left in the launch continuously. It came in quite handy one night when the launch had to be sent after dark to the assistance of the sounding launch which had broken down among the breakers and reefs at More Reef. Constant communication with the ship was maintained and thus much anxiety and suspense avoided while the dangerous rescue was being accomplished.

USE OF AIR TOPOGRAPHIC SHEETS FOR HYDROGRAPHIC CONTROL.

B. H, Rigg, U. S, Coast and Geodetic Survey.

In the early part of 1930 a hydrographic survey was made on the west coast of Florida in the passages that form the Ten Thousand Islands. Practically all of this region consists of mangrove swamps, terminating at the coast in a complicated mass of swampy islands. Innumerable rivers, creeks and slues flow from a system of bays, lakes and large lagoons in the interior to the coast. The depth of the water in the hays varies from three to five feet; the rivers range in depth from two and one-half to thirteen feet. To complicate matters still more, practically all of the rivers have a mass of oyster bars and shoals at their mouths and there are no artificial aids to navigation. However, through this maze of inland waterways there exist navigable passages which are used considerably by small craft. The purpose of the survey was to determine the more important of these and obtain the field data necessary to chart them.

On account of the prohibitive cost of extending triangulation through the region, it was not possible to employ the usual methods of control. The entire area, however, had been photographed from the air and the photographs reduced to 1:20,000 scale topographic sheets. Copies of these sheets, of which there were 13 (sections of 2 shown on attached plate), were furnished the party to serve as a basis of control. In addition to the topographic sheets, the original photographs were available for the use of the party.

Control

For simplicity, the control employed will be divided into three classes:

1. Approaches and entrances to the river mouths on the Gulf Coast where signals were located by sextant cuts (see accompanying plate).
2. In the rivers where sextant fixes could not be plotted. (See accompanying plate).
3. In lakes and lagoons, (see insert on accompanying plate).

No. 1. Special care had to be taken in these areas due to the possibility of changes in the shoreline resulting from a severe storm that had occurred after the photographs were taken. Locations for signals were selected on the topographic sheet and identified on the shoreline. Signals consisting of a square of white cloth with a strong cord at each corner tied over a number of mangrove branches bunched together were placed at each location. The directions obtained included those to all prominent tangents and objects. The sounding launch was then anchored at various positions offshore and additional cuts taken and recorded.

In the field these cuts served to check the location of the signals on the boat sheet. For smooth sheet plotting they were used as follows: The cuts taken at each signal and at each anchored boat position were plotted on separate sheets of tracing paper. These sets of cuts were


RODGERS RIVER
mangrove
mangrove
SECTION SHEET T4431
N.W. END OF CHOKOLOSKEE BAY
mangrove
FERGUSON RIVER
RUSSELL KEY
shell mound
29'
28'
11'
27'
81°10'
RUS
LUM
BEG
TEL
RAT
FLAG
POD
OUTER
SUB
SAN
WES
PEA
RU
LAN
FEB
GRO
PEP
PT
MIB
OLE
DAM
DEN
KIT
COP
RUM
FAT
ET
WEST COAST OF FLORIDA
1930
SKETCH SHOWING HYDROGRAPHIC
SIGNALS LOCATED FROM DETAIL
SHOWN ON AIR TOPOGRAPHIC SHEET
B.H. RIGG
CHIEF OF PARTY
HYDROGRAPHIC SIGNALS
ANCHORED BOAT POSITIONS

fitted to the topographic sheet by laying one over another and shifting slightly until all cuts gave good intersections. To start with, one tangent or object had to be held fixed; something that was well defined on the photograph and had not been changed by storms. In several cases, houses on the beach were used as fixed points. If nothing of this nature was available, a coral rock or a small island would be used. The accompanying sketch shows a section of the topographic sheet at the mouth of Broad River plotted in this manner. After the signals were plotted, hydrography was controlled with three point sextant fixes in the usual manner.

No. 2. In the narrow rivers and creeks, the time and cost of locating signals rendered this method impracticable. In the wider passages, three lines were run, one in the center and one at a definite distance from each bank. Usually the center line was run first. Definite topographic features that could be located on the sheet were used as the basis of control; a bearing was taken to the point and the distance measured with the range-finder. In doing this, the range-finder was used by the chief of party while the course of the launch and the bearing of the object were determined by another officer using a large boat compass (equipped with a pelorus attachment) located in the stern of the boat. The same topographic features were used for the several lines run in the same locality. Where distances on a sounding line between topographic features were great, additional control of the line could be obtained by comparing the actual measured distance to the shoreline at any instant with the corresponding distance indicated on the sheet between the shoreline and the dead reckoning position of the launch at that instant. The topographic features were designated with a dot and a letter, A, B, C, etc.

In narrow channels obstructed by bars, the knowledge of a local guide was relied on and a single line delineating the best water was run. At times conditions were such that definite points or tangents were so far away that bearings and distances could not be obtained; in these cases the channel was sketched by the hydrographer. Many bars were located with range-finder distances and bearings, but the observations could not be recorded due to the difficulty in definitely describing, in the sounding record, the exact point observed upon.

The following method was used in the bays where the depths were more or less uniform and the points were well defined: Lines were run from point to point; each point was given a name and considered an object. A bearing and distance were recorded in the record to that particular object.

No. 3. In areas such as Whitewater Bay where there were numerous islands and well defined points and where long lines could be run, three point fixes were used with the tangents to the islands as objects. This area was more or less protected and had undergone practically no change from the storms that had occurred subsequent to the taking of the photographs. To simplify the recording, the various islands used were given names and the tangents defined as N, Ne, etc.

Suggestions

After discussion in the Chart Division, following the review of the smooth sheets, the following suggestions are made for this class of work:

That signals located by plane table be designated by a red circle
" " " " sextant cuts " " " " blue "
That points and tangents to which sextant angles were taken be designated by a green circle.

It was sometimes necessary to use several different tangents of the same island. To simplify matters, the island should be given a hydrographic name indicated in red.

Changes found in the topography shown on the sheet should be in black ink with a conspicuous note. If many corrections are made, it is desirable to submit an overlay sheet of tracing cloth with the sheet. This overlay should be of the same size as the hydrographic sheet.

Now place names should be added in pencil and noted in the descriptive report.

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STEERING ON SHIP OCEANOGRAPHER

F. L. Peacock

(Abstract)

The report gives the results of analysis and study made of compass and steering data obtained on the OCEANOGRAPHER during 1930 season on Georges Bank to determine the actual courses steered and the reliability of the steering. The results are based on comparison between 667 courses as set on the steering compass with corresponding courses actually steered as determined from the mean of readings taken every 50 seconds on standard compass. The average difference between the courses set and those steered was l.°2. Thirty per cent of the differences were less than 0.°5, 50 per cent less than one degree and 14 per cent more than two degrees. The wind effect was considered. The tendency to steer into the wind was found in a less degree than anticipated. As regards direction of the wind, it was found the vessel steers easiest with wind within four points of dead aft and is hardest to control with the wind two to four points forward or abaft the beam.

SOME SUPPLEMENTAL USES OF AIR PHOTO TOPOGRAPHIC SHEETS

E. H. Bernstein, U. S. Coast and Geodetic Survey.

On my recent trip with the Launch ELSIE, while making a field revision of the Inside Route Pilot, New York to Key West, it was a revelation to me to learn the extent to which the United States Engineers of the Jacksonville district are using our photo topographic sheets of the coast of Florida. I found in the Jacksonville office enthusiastic praise for the sheets, and it is noteworthy what a fundamental role they are playing in the extensive survey and dredging operations connected with the Intracoastal Waterways program.

Not only have the sheets been found to be accurate, but also of great value because of the wealth of detail shown thereon, Among other uses, the Jacksonville office utilizes the sheets for plotting field notes, center lines, etc. The various local offices also make extensive use of the sheets which fall within their districts.

In several places it was evident that the location party had been guided in laying out new channel routes by information shown on the sheets. This fact, coupled with my interpretation of conditions on the ground as revealed by the sheets, furnished a remarkable aid in following newly dredged channels which had not yet been marked by the Lighthouse Service.

At first I doubted whether the air photo sheets would be of much use. for the coast pilot party, but I soon found that they were the most valuable charts I had for that region. I very often found that, guided by them, I could follow the labyrinth of canals, creeks and dredged channels without hesitation. They furnished a means of letting me know exactly where the launch was at any time, because of their minutely detailed representation of topographic features.

The sheets show no hydrography, but because of the representation of spoil banks and outline of shoal areas, they furnished valuable information in several open water areas where the regular charts were useless. I tried to impress the captains of the two Lighthouse tenders, engaged at present in marking the newly completed stretches of the route, with the remarkable help these sheets would be in determining accurate positions of their new aids, but they were reluctant to use them because soundings are not shown.

The United States Engineers at Wilmington, North Carolina, are at present compiling sheets from recent air photographs taken by an Army plane of the coast between the Cape Fear River and Winyah Bay. The sheets will be used in connection with the construction of the new Intracoastal Waterway through that region.

THE MUTINY OF THE SCHOONER "EWING"

R. R. Lukens, U. S. Coast and Geodetic Survey.

The first hydrographic work on the Pacific Coast by the Coast Survey was undertaken by Lieut. Commanding Wm. P. McArthur in 1849. Under date of October 27, 1848, Superintendent A. D. Bache directed McArthur to make preparations for starting the hydrographic survey of the Pacific coast of the United States. The Schooner Ewing of the Revenue Service was selected for the duty and she was transferred to the Coast Survey, then a bureau of the Treasury Department. After extensive repairs (which exceeded the estimate by $800) the Ewing sailed from New York on January 10, 1849, and after a rather eventful voyage, arrived in San Francisco Bay on August 1, 1849.

Lieut. Commanding McArthur, at the direction of the Superintendent, went to the Pacific Coast via the Ismuth of Panama, and after long delays, finally joined his vessel in San Francisco early in September, 1849. He made the trip to Panama in one of the new Aspinwall steamers, sailing from New York, and upon arrival at Panama, found some 2500 men on the beach awaiting transportation to San Francisco. The steamer that should have taken them was lying helpless at San Francisco without a crew and with no coal.

In an official letter dated Panama, New Granada, April 20, 1849, McArthur states that he had visited Col. Hughes who was making surveys for a railroad across the Isthmus. This railroad was soon built and proved to be a great success financially. The following is quoted from the same letter: "The citizens behave generally very well, but occasionally they indulge in a fracas and on more than one occasion I have been instrumental in maintaining place and I am in continual fear of some serious difficulty. There are so many good people amongst the immigrants however, that law and reason will be observed. I have indulged quite extensively in speaking the Spanish language since I have been here continuously called upon to interpret for the natives and immigrants and have recently been dignified with the euphonious title of Judge!" Judging from McArthur's private correspondence, his letter to Superintent Bache was rather modest, for he was really at the head of a vigilante committee and some rather stern justice was dealt out to the bad men of the crowd.

After a long delay at Panama, a company of men chartered the ship Humboldt, and McArthur accepted the offer to take command of her and navigate her to California. The ship had a passenger list of nearly 400 men with little in the way of accommodations, but McArthur's navy discipline prevailed and the ship arrived in San Francisco without any serious disorders.

Upon arrival at San Francisco, McArthur found the gold excitement at white heat with wages ashore ranging from 8 to 12 dollars per day. He had no authority to pay prevailing wages and the situation he faced was certainly a dismal one. Ships were being wrecked right and left and the need for charts was a crying one while McArthur was held practically helpless for lack of a crew sufficiently large for surveying purposes.

Shortly after he joined the Ewing, a very serious mutiny occurred. The following is a report from Passed Midshipman William Gibson who was in charge of the boat crew which mutinied:

U. S. Schooner Swing,
Bay of San Francisco,
September 21, 1849.

Sir:

I respectfully report to you a mutiny and attempt on my life made by the boat's crew belonging to this vessel and under my charge at the time, on Thursday the 13th inst., and the circumstances connected therewith.

Between the hours of nine and ten, p.m., of the day stated, I landed some visitors to the schooner on the wharf at the foot of Clay St. in the town of San Francisco, and shoved off to return to the vessel. The boat had been pulled I judge about 300 yards from the wharf, I steering, when I saw the after oarsman start to his feet, muttering something not distinguishable, and, before I could move, he threw himself upon me where I was sitting, clasping me by the arms. I struggled to my feet and succeeded in getting hold of one of my pistols (which unfortunately were both in my pockets) but, in the act of drawing it out, I was surrounded and my arms held to my sides by, I believe, every man in the boat. One man said, "Overboard with him - damn him", and I felt them trying to throw me from the boat. With a sudden effort, I freed my arms, seized two of them, and, still holding them, was forced into the water, the boat nearly capsizing. Here, believing the cartridges of my pistols not yet wet, I again endeavored to draw one, but, while making the effort, I was once or twice pushed under, and was obliged to swim off clear of the boat and men in the water. Turning one moment to see what was being done with the boat, I was hailed by the man who first attached me with "What will you give us to save your life?" Those of the boats crew who had been overboard were now in her, and they commenced pulling off.

Further exertions, except those for self-preservation, were now useless, so I swam for the shore slowly, for I had pistols in my pockets, heavy clothes on, and my strength was much exhausted by previous struggles. When about 50 yards from the wharf, I called for aid; I heard the alarm given and boats hurrying to my assistance. That assistance came not a moment too soon; for so nearly had I fallen a victim to the violence of these deserters that I can remember but the sensations of drowning, and, for hours afterwards, but a vague feeling that many people were about me; many hours was it before medical skill awakened me to full consciousness of the life which it had literally restored to me.

The name of the man who first seized me (the one who pulled the after oat) is John Black.

Who it was who first spoke of throwing me overboard, I do not know. I did not recognize the voice. I do not think, however, that there were any leaders in the affair, as everything seems to have been done in concert, without hesitation or inaction on the part of any one.

I am, sir,

Very Respectfully,
Your obdt. Serv't.,
William Bigson, Pass'd Mid'm.

Lieut. Comd'g.
Wm. P. McArthur,
U. S. Schooner Ewing.

McArthur took vigorous means to apprehend the culprits and offered a reward of $500 each for the criminals. On September 16, they were returned to the schooner, then lying in Suisun Bay, by a mining company who had taken them. They were transferred to the Flagship Savannah where they were confined awaiting court-martial. Although the Ewing was a Coast Survey ship, the crew was under Navy articles.

The results of this court-martial are detailed in the following letter:

U. S. Schooner Ewing,
San Pablo Bay,
October 27, 1849.

Dear Sir:

* * * * * * * *

In my last letter I informed you of an outrage committed by five seamen belonging to this vessel. Charges were brought against them for mutiny, desertion, running away with a boat, the property of the United States. A Naval general court-martial was directed to convene by Commodore Jones (13 in number); and, after a patient and deliberate trial, the accused having the benefit of the most able counsel which could be procured, they were all found guilty of "mutiny and desertion", and John Black was further found guilty of "mutiny, etc., with attempt to kill" ana adjudged each and every one of the aforesaid seamen to suffer "Death, by hanging until they are dead at the yard arms of such vessels in the service of the United States, and at such times and in such waters as the commander of the United States Squadron on the Pacific Ocean may think proper to direct."

The sentence of the court was approved by the Commodore, and two of the mutineers (John Black and Peter Black) were executed, one on board the Flagship Savannah, and one on board the Ewing. The sentence of the remaining three was commuted to corporal punishment and confinement.

Thus have I passed through an ordeal as repugnant as it was necessary. These men had signed the usual shipping articles used in the service of the United States; they had served several months in a very proper and quiet manner; they had not only <u>never been punished</u> but had never even been spoken harshly to. Their immediate commanding officer, in his proper uniform, was seized and thrown from the boat, and left to drown. I felt convinced that I had not power to punish so outrageous an offense, and reported it to the commander in chief of the U. S. Naval forces in the Pacific; ana the law has taken its course.

The effect which this solemn affair has had, so far as can be perceived, is highly beneficial and I feel convinced that I shall have no more trouble.

During the past month I did nothing except to attend the court-martial as a witness; except that we took occasion to overhaul and paint up the schooner, in order that we might be prepared for the rainy season.

* * * * * * * *

I remain, truly respectfully,
Yours, etc.,
Wm. P. McArthur
Lt. Comdg. & Asst., U. S. Coast Survey.

Professor A. D. Bache,
Superintendent,
U. S. Coast. Survey,
Washington, D. C.

After overcoming one difficulty after another, some of which seemed insurmountable at the time, Lieut. Commanding McArthur succeeded in making a valuable reconnaissance of the coast from San Francisco to the Columbia River. This work was considered of such importance that the three sheets were engraved, printed and published in 20 working days from the time the drawings were received in the Washington office.

After a year on the coast, McArthur received the welcome orders to return to Washington, and sailed from San Francisco December 1 on the Steamer Oregon. When shortly out of San Francisco, he developed an acute attack of dysentery and died on December 23, 1850, just as the Oregon was entering Panama Harbor. He was buried on Taboga Island, but in 1867 his remains were removed to the Mare Island Navy Yard where he had made his first surveys.

In 1876 the steamer McArthur was built at Mare Island and named in honor of William Pope McArthur. The McArthur was in service on the Pacific Coast and Alaska until 1916 and is well remembered by all the older officers of the Service.

THE ORIGIN OF THE SUBMARINE VALLEYS ALONG THE SOUTHERN EDGE OF GEORGES BANK

(I) N. H. Heck, U. S. Coast and Geodetic Survey
Chief, Division of Terrestial Magnetism & Seismology.

With reference to remarks about the mysterious nature of submarine valleys and other structures on Georges Bank appearing in a recent bulletin of Field Engineers, I would like to call attention to the fact that in a recent book, "The Sons of the Earth" by Prof. Hartley Mather of Harvard, the great ice sheet is shown as extending off to Georges Bank. It is therefore probable that this was terminal moraine. It would seem, however, that if streams were to be gouged out, the area must have been above water at the time. I have never seen any statements about the condition of this area. I understand that it is generally held that much of the continent was depressed under the load and that the otherwise unexplainable earthquakes of the region are related to readjustment. Recent activity as shown by the Grand Banks Earthquake of November 18, 1929, might indicate that a process of adjustment is still going on.

(II) F. P. Shepard
Professor of Geology, University of Illinois.

Shortly after the occurrence of the Grand Banks earthquake of November 18, 1929, Captain Bone of the Steamship Transylvania reported that he had found deep water in a position which, according to the chart, should have been well within the margin of Georges Bank. He came to the conclusion that the earthquake had altered the sea bottom at this point. However, the position was about 500 miles from the epicentre of the earthquake and 340 miles from the nearest cable break, which naturally led one to doubt whether there was any connection between the earthquake and the supposed change in the shelf margin.

During the summer of 1930 the United States Coast Survey started operations in a resurvey of Georges Bank. Crossing the vicinity where the change of depth had been reported, they found a submarine valley penetrating the shelf edge for about seven miles (see plate). Since this valley lies across one of the approaches to Nantucket Lightship from Europe, it assumes considerable significance from the point of view of navigation.

The discovery of the valley did not prove that there had been a recent displacement of the edge of the shelf. Examination of the old soundings made by the Coast Survey about 1874 showed that the soundings were so far apart that the valley might easily have been missed. On the other hand, vessels coming in from Europe have been taking soundings in this general vicinity for years, so that it seems a little strange that it was not till after the earthquake that the depression was suspected. Captain N. Johnson, as commander of the North German Lloyd Steamer Columbus, had taken a particularly large number of soundings across this area. The Columbus is equipped with the Fathometer echo sounding device, and this was regularly set in operation as the edge of the shelf was approached. As a result, Captain Johnson became so familiar with the topography that he could tell his position very accurately in approaching Nantucket Lightship. In the Marine Review for June, 1928, some of his soundings are plotted on a chart and curves have been drawn to show the topography. Several of the lines of soundings on this chart cross the valley area, but there is no indication that such a valley existed. Accordingly, it seems to the writer that there is some reason to believe that the valley developed at the time of the earthquake.

If we assume for the sake of argument the contemporaneity of valley formation and the earthquake, we must look for some explanation of the feature in terms of the earthquake. If a block of the earth's crust at this place had dropped suddenly to the extent of about 2,000 feet (the depth of the valley), there should have been at least two important observable effects. In the first place, the shaking of the crust should have made a record on the various seismographs of the vicinity showing epicentres nearer than that of the Grand Banks disturbance. Secondly, a large tidal wave (tsunamis) should have swept the adjacent coasts. Since there is no evidence of either of these features, this explanation appears to be unlikely. On the other hand, it has been observed that landslides are a frequent accompaniment of earthquakes, even when the shocks originated at considerable distances. Such phenomena accompanied the San Francisco and the Yukatat Bay earthquakes, for example. Also, many of the changes in Sagimi Bay found after the great Japanese earthquake are probably a result of submarine landslides. Some of the cables which were broken at the time of the Grand Banks earthquake were found buried deeply in sediment showing the effect of landsliding. Since this earthquake was felt as far west as Albany, it probably produced very appreciable shaking in the outer part of Georges Bank. When conditions are favorable for landsliding, a small shock is often the trigger effect which sets the slide in motion. Since slides do not commonly produce any record on seismographs, the objection to the down faulting suggestion cited above does not apply to landsliding. Also, if the slide moved rather slowly, as do many slides on land, it would not have produced surface waves perceptible at any distance from the center of disturbance.

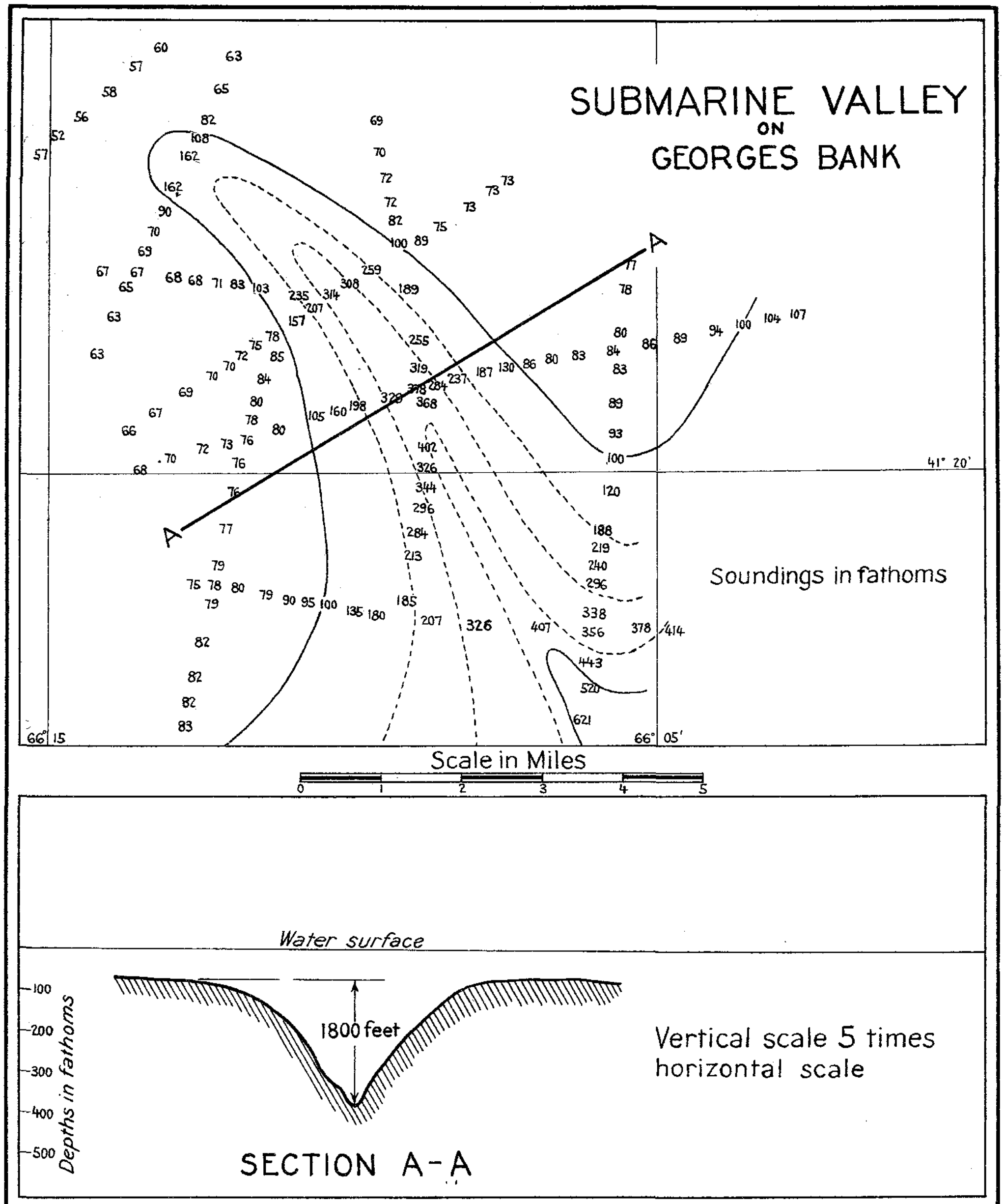
If we assume, on the other hand, that the valley was not developed at the time of the earthquake, the possibility that it was due to an earlier landslide may still be entertained. If it is a landslide excavation, one might find a hummocky zone beyond the mouth of the depression, such as usually occurs where a mass of alluvium has slid out of a gully. As only four lines of soundings cross the valley, there are not sufficient soundings to show such topography. However, the outermost line has what appears to be a hill along its course. This might have been caused by a landslide. Such hills are found in association with many of the landslides of the west. A more detailed survey would probably make it possible to test this landslide suggestion.

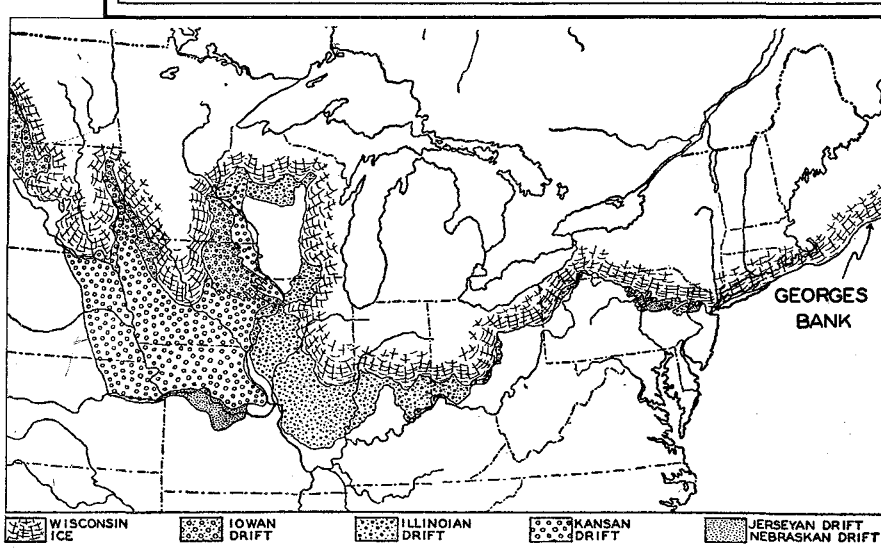
One might ask why a landslide should leave a depression which is so suggestive of a river valley in shape. Speculation as to the earlier history of the continental shelf in this area may serve as an answer to this question. In the first place, there are many reasons for believing that the continental shelf here, as off many other coasts of the world, has been elevated at some time during the past allowing deep entrenching by rivers. Many submarine valleys, such as that off the Hudson, are still found on the shelves and are too long and narrow to appear to be explainable by landsliding. Possibly one of these valleys was cut in the region under discussion. We can assume in turn that it was submerged at a later period. Still later came the development of the great continental ice sheets. It happens that Georges Bank is in line of continuation with the terminal moraine of the ice sheet which extends north and east through part of Cape Cod and the Island of Nantucket. Also the topography of the inner portion of Georges Bank is suggestive of a moraine with its hummocky character. The finding of various igneous rock fragments on the surface of the bank is also corroborative evidence that the bank is in part a moraine. This would indicate that the front of the Great Glacier stood on the bank. As a result, great quantities of debris should have been washed out from the melting ice onto the outer part of the continental shelf. The sediments distributed in this way should have filled preexistant depressions in the outer shelf. It is quite likely that the deeper part of the valleys would have received muddy sediments which would in turn have been covered with coarser debris. After the glaciers had retreated, conditions would have become quite ideal for slides. Outside was the steep continental slope, inside a valley filled with loose sediment and plastic mud at the base. Given a shaking of the ground, and it is easy to understand how a great stream of sediment might have glided out of the filled valley accumulating on the continental slope below.

Hundreds of submarine valleys have been found cutting the continental shelves of the world. Many of these are clearly of a different character from the one under discussion. Some of the valleys, for example, are broad troughs of great length like the St. Lawrence trough and the valley heading into the Bay of Fundy. Others of these valleys appear to be quite similar to the Georges Bank valley. Unfortunately, the position of the soundings in most of these cases can not be relied upon since they were made before the adoption of radio acoustic means of location. The recent surveys along the west coast of the United States have shown that there are a considerable number of valley-like indentations in the shelf margin. The valley outside of the Columbia River is quite comparable with the Georges Bank example. Directly beyond this valley is an elevation which might perhaps be interpreted as a result of the sliding of material out of the valley and accumulating as a ridge beyond.

III. Kirtley F. Mather
Professor of Geology, Harvard University.

There are several equally plausible explanations for the presence of these submarine valleys, and in the present state of our knowledge, I do not think any definite decision can be made concerning the matter. It is therefore extremely desirable to keep our theories decidedly in the category of tentative suggestions. There are, however, several things which incline me to believe that these valleys have some genetic relationship to





During the Pleistocene Period the northeastern states were invaded by five successive ice sheets. The last of these, the Wisconsin ice sheet, is represented here as being at its maximum extent. The areas covered with drift of the preceding glacial states are also shown. (Based on maps prepared by Ernst; Antevs in 1929)

From SONS OF THE EARTH by Dr. Kirtley F. Mather published by W. W. Norton & Company.

the glaciation during the Pleistocene period. The gravel and pebbles on the surface of Georges Bank are not necessarily proof that the ice reached that far across the Gulf of Maine, but they are in perfect harmony with that idea. The glacial deposits on Cape Cod seem to indicate quite unmistakably that a large lobe of ice must have stood east of the arm of the Cape. If the ice from the Labrador center extended to points south of Cape Cod and southeast of the southern end of Nova Scotia, it seems necessary to believe that it would also have crossed the Gulf of Maine and reached at least the northwestern margin of Georges Bank.

We have at present no accurate basis for determining the amount of peripheral uplifting of the earth's crust just beyond the margin of the ice sheet, but it seems very likely that isostatic depression beneath the ice lobe must have been compensated in part by a peripheral up-bulge. If so, this might put the southeast margin of Georges Bank far above sea level for a short time, geologically speaking.

All available information concerning the topography of the southeast slope of Georges Bank is indicative of extremely youthful erosion by running water. These short, steep-sided, deep valleys, trenching the slope of this submerged plateau, could have been eroded only by streams working on a land mass. They could not have been gouged, by glacial ice nor eroded by marine currents. Their form seems also to deny the possibility that they themselves are rifts in the earth's crust due to any known type of crustal disturbance. Their form, number, and the smoothness of the plateau surface and slopes between the valleys all combine to suggest a comparatively brief interval of stream erosion during which the plateau front was locally trenched by swift streams.

Withdrawal of water to provide the ice of the wide-spread continental ice sheets would have lowered sea level in the vicinity of Georges Bank by 200 to 250 feet; possibly this one factor alone would expose the bank down to the 50 fathom curve. Something more must be required to lower relatively the sea level below what is now the 700 or 800 fathom curve. It is barely possible that peripheral uplift due to isostatic depression beneath the ice lobe might accomplish that result, but I have no way of checking this factor quantitatively.

IV. F. P. Shepard
Professor of Geology, University of Illinois.

I am glad to see that Professor Mather has the same idea about the great glacier having extended across the northern margin of Georges Bank. I am not sure that I should agree with his suggestion about the peripheral bulge outside of the ice sheet as a cause of the valley. This idea was suggested some time ago by Daly to explain the submarine valley off the Hudson. I can see several difficulties concerning it. In the first place, I note that the charts show that the continental shelf off Antarctica, instead of building up above sea level, is actually very deep, as if it had been depressed by the weight of the adjacent ice. Also, if the outer part of the Bank had bulged up as Professor Mather suggests, it seems to me that it would have reversed the drainage so that streams would have flowed towards the glacier rather than away from it. Also the submarine valleys of this type appear to be more common off non-glaciated areas than off glaciated areas.

HYDROGRAPHIC SIGNAL WITH TRIANGULAR CROSS-SECTION

H. A. Paton and W. F. Deane, U. S. Coast and Geodetic Survey.

While considering the type of hydrographic signal to be constructed for the survey of the entrance to Port Royal Sound, S. C, by the party on the NATOMA, C. A. Egner, Commanding, it was found that a tower with a triangular cross-section could be built with a great economy of labor, material and time, and, at the same time, add appreciably to the visibility.

By using a right triangle cross-section and orienting it so the bisectrix of the right angle pointed through the center of the working grounds, the visibility was greatly aided. With targets on the equal sides of the triangle, the tower had more value as a left hand or right hand object for sextant fixes without appreciably reducing the size of the target visible for a center object. The width of the target when used as left hand or right hand object was eight feet or more, and when used as a center object, eight feet to eleven feet, three inches.

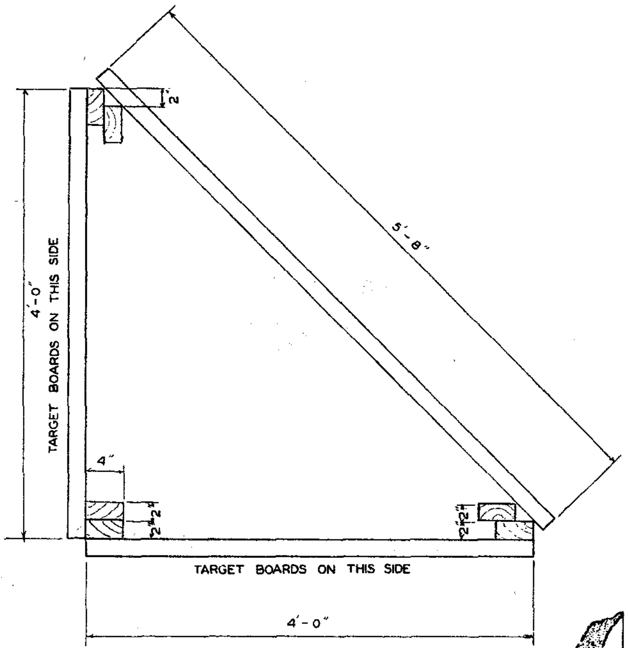
As shown by the accompanying drawing, the cross-section is a right triangle with sides of 4, 4, and 5,66 feet. Here the utmost economy is realized for the usual stock lengths of material are easily divisible without waste. For example: 4 4-foot girders, or 2 5.66-foot girders and 1 4-foot girder could be cut from a 16-foot 2" x 4" board; 3 5.66-foot girders from an 18-foot 2" x 4", and 1 5.66-foot and 2 4-foot girders from a 14-foot length.

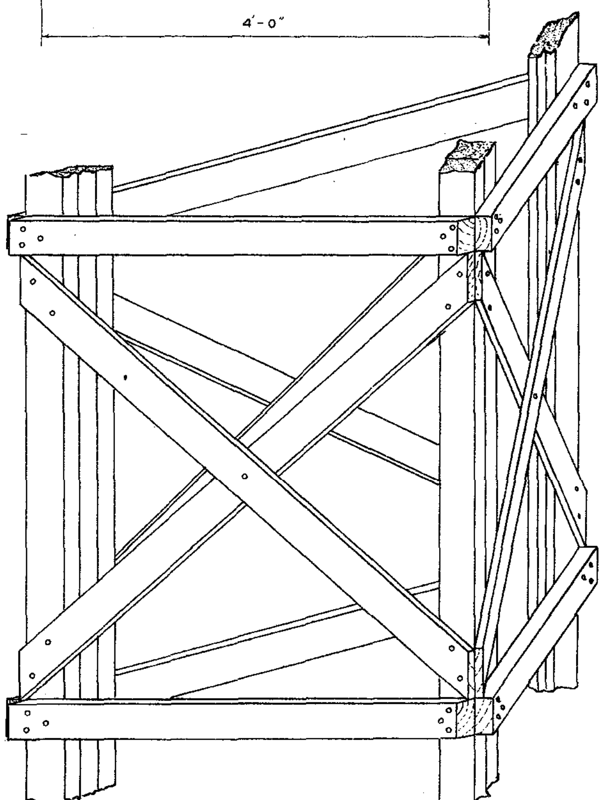
The length between girders, top to bottom, is 4 feet. Thus the diagonals can also be cut economically from stock lengths of 1" x 4" lumber. For example: 3 5.66-foot diagonals could be cut from an 18-foot 1" x 4" piece, 2 6.95-foot diagonals from a 14-foot length, and 1 6.95-foot and 2 5.66-foot diagonals from an 18-foot length.

The legs or uprights are framed to accommodate the nailing on of girders and diagonals with the maximum strength possible. One leg, at the right angle, is made in the usual manner by nailing 2 2" x 4" pieces together to make a 4" x 4" section. The other two legs are built up by nailing 2 2" x 4" boards together in such manner as to have a 2" overlap. This overlap gives an even surface to nail to and if nails be driven into both pieces, the connection will be strong. All legs are framed with a 2 - 2" x 4" section with an initial 8-foot piece of material to allow for a sufficient overlap. The length of the splices used was 3 feet, or, in cases where odd lengths of 2" x 4" boards were used, the splices were smaller. 1" x 4" boards are recommended for splices in all cases as the joints are then sound enough.

Double diagonals were used for each bent for 4 bents, then single diagonals were used.

By reference to the drawing, it will be noticed that the lower 6 feet of the signal were buried in the ground with the footing used as shown.





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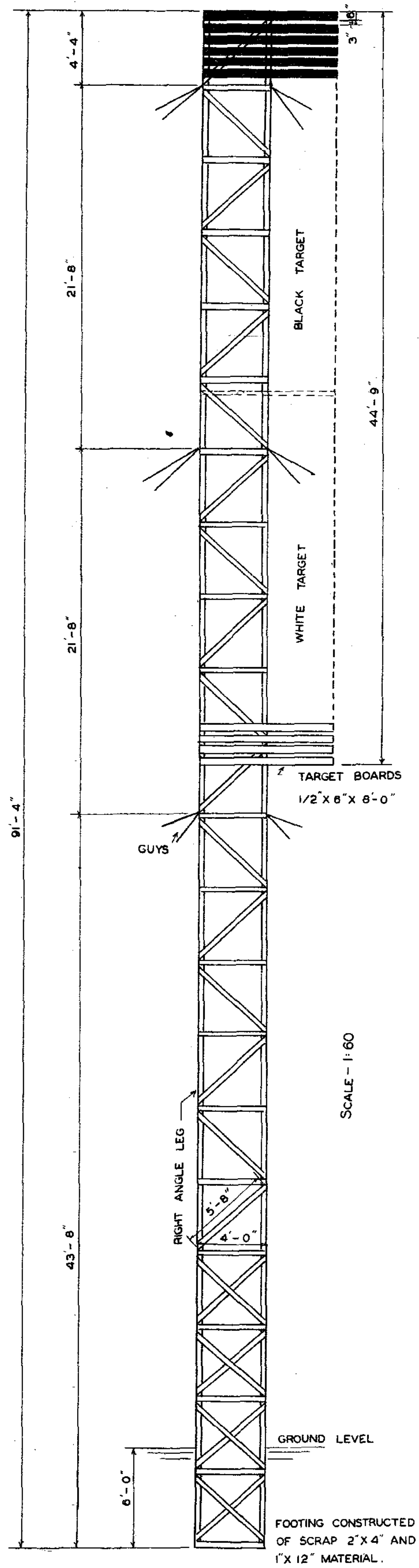


HYDROGRAPHIC SIGNAL

TRIANGULAR CROSS-SECTION

USED BY THE NATOMA SEASON 1931

C.& G.S. Print (R-171)

This footing of 1" x 12" boards on 2" x 4" "boards is recommended, as no danger is introduced because of lack of perpendicularity.

Twenty 8-gauge guy wires were used and found satisfactory. Some issue might be taken to the large number of guys, but from the experience derived from the building of this signal, the additional amount of wire insures a greater stability than a lesser amount within economic limits. By having a 45 angle or greater between the ground and the guy, the resultant force caused by wind putting tension on the guy was more successfully coped with. Four guys were used at the juncture of the tenth and eleventh bents, 8 at the fifteenth and sixteenth, and 8 at the twentieth and twenty-first. It is desirable that the guys be made fast to the tower and led out in such fashion as to be perpendicular to a side of the cross-section. The customary "deadmen" were used for anchor where trees were not available.

In usual practice, the target boards, 60 - ½" x 6" x 16', would be nailed to the long side or hypotenuse of the triangle. However, in this case, to insure the visibility heretofore discussed, the targets were cut into two pieces of 8 feet and nailed on the 4-foot sides of the tower. This also eliminates the use of wings as braces.

A total of 97 man hours was required to construct this latter type of signal. The lack of experienced men probably lengthened the time, and, in addition, these man hours covered transportation of lumber and marking of station in addition to actual building.

The simplicity of the design lends itself to adaptation to signals of any height up to a maximum of about 100 feet. An additional advantage is realized in using the triangular cross-section in preference to the rectangular, because of the smaller amount of twist in the former.

Bill of Material.

Lumber, class 2.

60	½"x6"x16'	at .09	$ 5.40
4	1"x12"x16'	.24	.96
43	2"x4"x16'	.21	9.03
7	2"x4"x18'	.24	1.68
3	2"x4"x14'	.18	.54
13	1"x4"x14'	.09	1.17
17	1"x4"x18'	.11	1.87
5	1"x4"x18'	.10	.50
		total for lumber	$ 21.15

Wire, 8-gauge, approximate length of
1320 feet. 1 1/2 coils at $3.65 — 5.47

Nails, various sizes.
25 pounds at .05 — 1.25

Grand total of materials $ 27.87

WRINKLES IN FIELD AND OFFICE WORK

LONGER RED LIGHT SIGNAL
O. W. Swainson

The method of obtaining a longer signal for the red light of the fathometer, as mentioned by Captain Adams on page 59 of the December Field Association Bulletin, has been adopted with success on the PIONEER. Formerly we carried the red light to 300 or 400 fathoms. Now we carry it to 500 or 600 with equal ease.

It was necessary to install a push-pull switch by which, when desired, we could shunt the resistance that was automatically thrown in to slow the motor during the changing of gears when the shifting wheel was turned far enough to shift the cams. Otherwise, the motor decreased speed when the longer contact cam was shifted to the contact wheel.

USE OF ALUMINUM SHEETS
C. A. Egner with Comments by A. M. Sobieralski.

A method has been followed in the plotting of our Florida hydrographic smooth sheet #7 which may, or may not, be original. This sheet combines both fixed position hydrography and P.D.R. and extends from the beach to the 100-fathom curve. It is on a scale of 1:40,000.

Wishing to rush this sheet to completion, we hit upon the idea of having two officers work on it at the same time in the following manner: One to plot all fixed position hydrography on the sheet itself and another to plot the buoys and P.D.R. on aluminum, later transferring them by tracing to the smooth sheet, or by DMs and DPs.

Aside from speeding up the plotting, this had the following advantages:

(1) A projection being made on the aluminum covering the area with shore signals plotted on it, the buoys' positions determined by sextant fixes remain true in relation to the shore and to each other. This is also true in the case of those buoys located by full speed double runs.

(2) The scale of the aluminum does not change with temperature as in the case of paper. Therefore, distances will be true on the aluminum, whereas on paper one may be transferring distances from a metal scale to the paper, the relation of which changes as the work progresses. Carrying these measurements over a considerable distance leads to error in the latitude and longitude of the points plotted.

(3) Aluminum presents a smoother, flatter, surface for working with parallel rulers and, consequently, greater accuracy is possible.

(4) Transferring the work to the smooth sheet is done by making a tracing of the work on aluminum, then pricking the points through, shifting the squares of latitude and longitude to agree with the smooth sheet. This re-

duces the work to a proper relation with the fixed position plotting. If it is felt greater accuracy in transferring the work is required, all points can be transferred by DMs and DPs.

(5) As only short sections of the construction lines need be transferred, there is no necessity of drawing on and erasing these lines on the smooth sheet. This reduces wear and tear on the sheet, preserves a good surface for plotting and soundings, and keeps the sheet clean.

Comment — A. M. Sobieralski.

The use of aluminum plates for plotting is increasing. An aluminum plate 38" x 50" costs about $2.50; graining costs $.60.

Several parties have inquired whether plates should be returned to the office. As they are liable to be warped from use or in transportation, and considering the cost of packing, transportation, re-graining, etc., there would probably be no saving in returning them.

The grained surface of an aluminum plate will take pencil or ink.

Pencil marks made with a soft pencil can be removed with art gum. A hard eraser will remove the grain and once the grain has been removed, neither pencil nor ink will take. The surface can be roughened with a lithographic pencil and water.

Ink can be removed with water or a dilute solution of oxalic acid (one ounce oxalic acid crystals to 15 ounces water). A slight stain will remain which can be removed with a lithographic pencil.

The lithographic pencil removes the grain but roughens the surface sufficiently to take ink or pencil. Each of the spots where the lithographic pencil has been used shows smoother and brighter than the rest of the plate.

"ACCURACY AND MORE ACCURACY - K.T.A."
A "wrinkle" for taking the guess work out of right angle turns in P. D. R. work
E. W. Eickelberg.

When P. D. R. work is done on scales in which a change in course of 90 can be shown, the following method was used to determine ship's position after turn was completed:

A large paper carton or wooden box was thrown overboard at the beginning of the turn, one officer following it with pelorus for obtaining a bearing when on, or nearly on, the new course and one officer taking a dip angle with sextant. This gives a bearing and distance from last known point for going ahead. On the LYDONIA where work was being done on a 1:40,000 scale, the turns were being shown as 90° arcs, but after a few trials of this method in calm weather, it was shown that the vessel traveled ahead on her old course twice as far as on the new in making the turn, i.e., 0.2 mile ahead, 0.1 mile on new course. The total distance was usually loss than a third of a mile with the LYDONIA. Of course, these results are altered by wind and to some extent by current, both of which also affect the object thrown over.

I have talked with another officer who says he had found the same to be true on hydrography controlled by fixes, that is, that the ship travels twice as far on the old course as on the new.

AUTO HELIO BEACON
(From "Australian Surveyor", Vol. 2, No. 1, 1930)

We have received from Messrs. Cooke, Troughton and Sims, Ltd., particulars of an instrument which is intended to take the place of the ordinary heliograph in topographical survey in order to reduce the expense and inconvenience of having to keep helio parties in the field during the observations of a triangulation.

This instrument has been designed by this firm at the instigation of Mr. Frank Debenham, Reader in Geography to Cambridge University, and may be briefly described as a dome of mirrors mounted on a tilted axis-spindle which is supported on a gimbal-mounted ball-bearing. A pinion at the lower end of the spindle engages with a circular rack so that when the dome is rotated by the wind acting on vane-arms attached to it, the axis sweeps out a conical path and gives a circular rocking motion to the dome.

The mirrors on the dome and its motion are arranged to give intermittent flashes to all points around it for almost all positions of the sun, and the maximum possible error for any distance over 10 miles will be within 1 second of arc.

The apparatus aroused great interest when demonstrated before the International Geographical Congress at Cambridge during 1928.

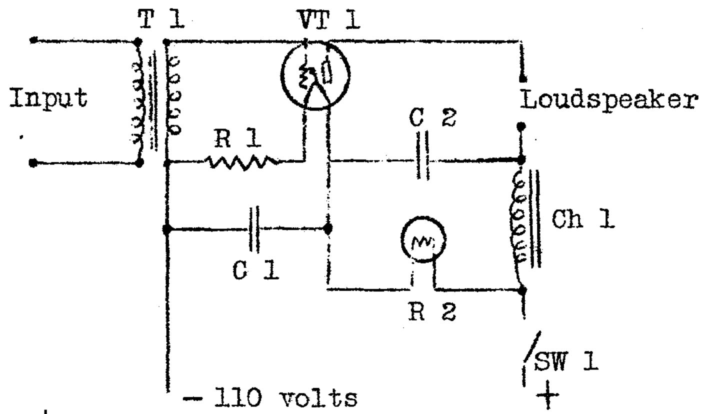
IMPROVEMENTS FOR FATHOMETER
O. W. Swainson

On the Ship PIONEER a loudspeaker with amplifier was connected up with the fathometer so that the outgoing sound and the echo could be heard from the loudspeaker, or over the headphones, as the operator desired.

The loudspeaker is especially good when the red light times six method is used. The echo can readily be distinguished from the stray noises by its particularly sharp thud sound. Hearing the echo enables the operator to distinguish the correct red flash that is the sounding from strays that might be flashing at various places on the dial of the fathometer.

On the PIONEER the loudspeaker is left on all the time when sounding as the sound aids the eye in reading the soundings. When using the red light method, the operator can tell by the length of time between the outgoing sound and the echo whether the sounding is 25, 125 or 225 fathoms. The officer on watch can tell at all times the approximate depth of water the ship is in from the sound without asking or looking at the fathometer.

Diagram of Loud Speaker Amplifier.



List of Parts Used.

T1 - Six to one ratio audio transformer.
R1 - Twenty ohm resistance for 201a tube. Sixty ohms for 171a tube.
VT1 - Either 201a or 171a depending on the value of R1 which gives the proper grid bias for the tube by means of the voltage drop across the resistance.
C1 - Two microfarad bypass condenser.
C2 - Two microfarad bypass condenser.
R2 - Twenty five watt, one hundred ten volt lamp. The voltage drop across this lamp is used for the "B" voltage.
CH1 - Thirty henry B eliminator choke.
SW1 - On and off switch.

The hook-up to the fathometer is as follows: The headphones were removed from the binding posts on the fathometer and a pair of leads connected to the two outside contacts of a double circuit telephone jack substituted. The two inner contact leads are connected across the primary of the transformer in the amplifier. When the headphones are plugged into this jack, the amplifier is automatically disconnected from the circuit. When the headphones are removed the amplifier is connected and it is only necessary to throw the on-off switch to on position if circuit is not already closed to enable the operator to hear the outgoing sound and incoming echo on the loudspeaker.

Another convenient addition on the PIONEER'S fathometer is a pointer in front of the fathometer dial. This pointer was constructed by securing a narrow brass strip about 1/4" wide and 1/8" thick across the diameter of the coincident method circle. A hole was drilled in the brass strip so as to be in center of dial. A pin was put through the hole with the pointer secured on the inner end and a knob on the outer end so that the pointer can be turned by turning the knob. One end of the pointer points to the red light circle of graduations, while the other end to the white light circle of graduations.

This pointer is very convenient for the red light times six method. Since the outer circle is six times the scale of the inner circle of graduations and the zero of the one circle is 180° from the other. When the pointer points at the red light, the sounding may be read directly from the other end of the pointer on the outer circle of graduations. The use of the pointer eliminates the necessity of multiplying the red light sounding by six, or the need of tables. It is also an aid in following the red light when the depth is changing rapidly.

IMPROVISED ERASING MACHINE
F. B. T. Siems

Occasional use is found aboard ship for an erasing machine. A simple one was devised and used with success aboard the SURVEYOR.

A small, light, high speed electric drill, such as are used by radio mechanics, was fitted with a 5 to 6-inch shaft, constructed of l/4 inch brass stock and with threads cut on one end a distance of an inch; the circular eraser used being secured between suitable washers and nuts. By using erasers of various thicknesses, it was found almost any line, etc., could be quickly and neatly erased.

(Erasing machines with flexible shaft are on the market and are used extensively in the office).

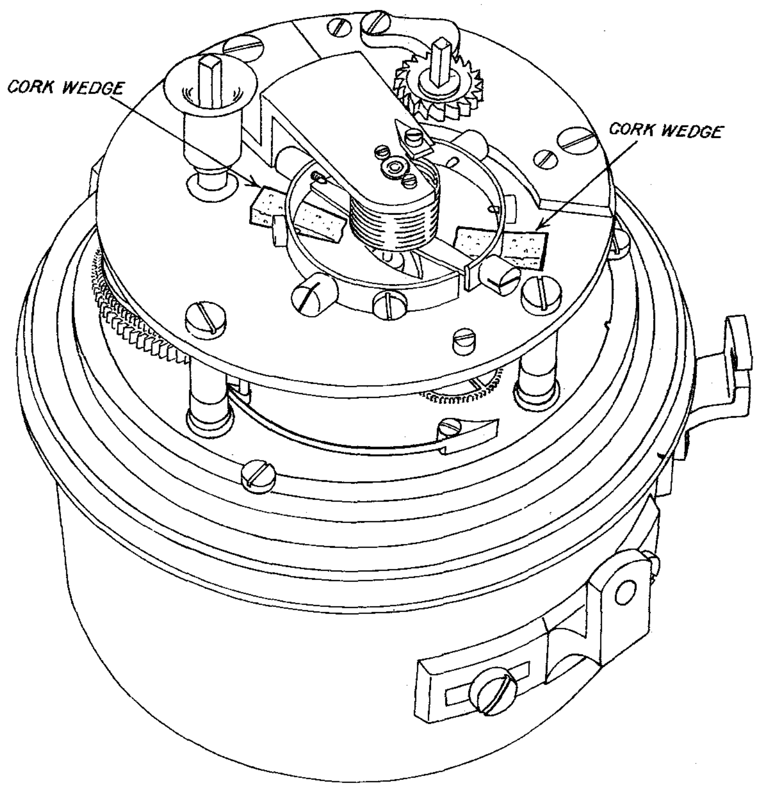
NEW DESIGN FOR LAUNCH SOUNDING CHAIR
G. C. Jones.

Have a little wrinkle in field work for the Bulletin, namely, the use of a 50-gallon oil drum for a launch sounding chair. Installation of such a drum on a launch gunwale is so simple and easy that no detailed description is necessary. It wasn't originated hero, but was brought from L. C. Johnson's party by one of his men. Johnson isn't sure where the idea originated. Leadsman like it much better than pipe or wood frame and canvas.

KEEPING ON THE SOUNDING LINE
W. D. Patterson

One of the offshore shoals was developed by the launch party using the method illustrated on page 88 of the Hydrographic Manual. By running lines parallel to one of the angle arcs, the launch can be kept on course by the left angleman watching the constant angle. This method is as good as ranges for running straight lines and was especially useful on account of the strong currents in the locality. This method of developing offshore shoals is a great convenience. I have met few officers who are acquainted with this method, even though it is described in the Hydrographic Manual. It is recommended that attention be drawn to it in the Bulletin.

To pack Chronometers for shipment.



There are several precautions to be observed in the preparation of a chronometer for shipment if it is to reach its destination without damage.

1. The balance wheel should first be stopped by allowing it to strike against a small piece of writing paper until motion ceases. Never use the fingers or any rigid body for this purpose. As the balance wheel is very heavy as compared to its supporting pivots, it is necessary to carefully lock it to prevent motion during shipment, causing breakage of the delicate pivots. This is done by inserting soft cork wedges, as shown in the diagram. These must be placed as nearly opposite the spokes of the wheel as possible and both should be carefully pressed in at the same time to avoid a sideways pressure on the pivots. They should never under any circumstances come in contact with any of the adjusting screws in the balance wheel. The wedges should be only pressed in with sufficient firmness to insure their remaining in place, and should never be forced. Cork wedges will be issued with most chronometers, but should none of these be available, care should be exercised in the selection of this material to insure that it is soft and resilient.

2. After the wedges are inserted, the chronometer should be replaced in its case and the cover screwed tightly in place. If a gimbal case is used, the chronometer should be removed from the gimbal rings and packed in the case with paper, securely wedged with this material so that it cannot move.

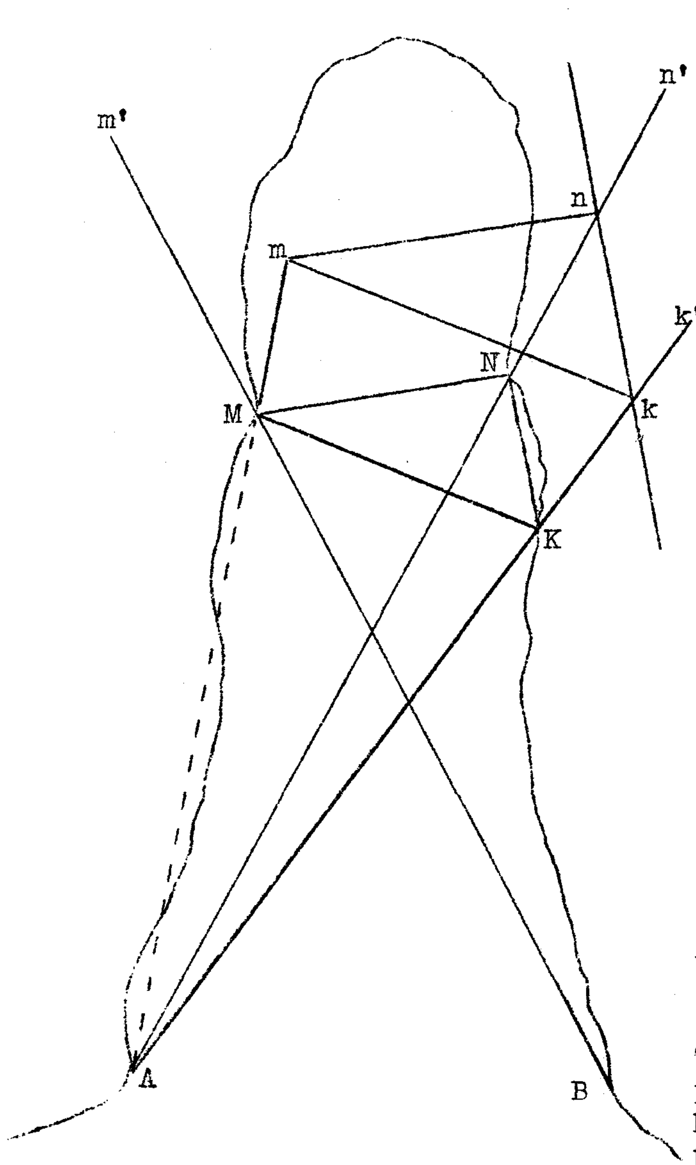
3. In packing in an outer shipping case, it is advisable to wrap the chronometer case with paper to prevent infiltration of dust and to use paper as a cushioning material in the packing box. EXCELSIOR SHOULD NEVER BE USED as it is dusty and the fine powder will sift through exceedingly small openings. (R-92)

A HINT TO TOPOGRAPHERS

Earl F. Church

The problem consists of the location of three unknown points with a chock from two given points, by means of orienting lines only and without any intersections from the known points. I believe the following discussion, together with the accompanying diagram, is sufficient explanation:

Conditions: The instance where the problem was almost invaluable was in running into a bay in which there were no triangulation stations for control. Referring to the figure, A and B are two points located upon the plane-table sheet from triangulation or traversing outside the bay. The point A will see the right-hand side of the bay and B will see the left side, but no intersections can be obtained on points on either side. Traversing into the bay from A or B is difficult or perhaps impossible on account of the steep rocky shore line.



Method of Procedure: Let the rodman put a flag at each of three points favorable for setting up the plane-table back in the bay. Two of these points, which we call N and K, are on the right-hand side of the bay, for instance, and are visible from A. The other, called M, is on the left side and is visible from B. Set up the plane-table at A and draw orienting lines An' and Ak' toward the points N and K respectively. Then set up at B and draw orienting line Bm' toward M.

Next set the table up at the flag K, orienting on A. Then draw a long orienting line toward the flag N at any convenient place as kn. It must be kept in mind that the intersections k and n of this line with Ak' and An' are not the actual points K and N on the sheet, for K, the place of set-up, has not been located.

Next set up the table at the flag M, orienting on B. Resect upon the flags N and K, using the arbitrary points n and k as the corresponding points on the sheet. This gives a location of M at some point, as m, not on the line Bm'. But, as a matter of fact, the point M really lies on the line Bm'

Now with the fiducial edge, draw a line from A to the arbitrary point m. (This is not an observed line for A and M are not inter-visible). The point M, where Am cuts Bm', gives the true location of M upon the plane-table sheet.

Next sight upon N and K, locating them by intersections with An' and Ak' from the point M; the check, then, is the parallelism of the line EN with the orienting line kn. Or, locate N by an intersection from M with the line An'; construct NK parallel to the orienting line nk, locating K by its intersection with Ak'; then check by a resection upon K from M. The geometric proof is obvious.

AUXILIARY SWITCH USED ON MOTOR TRUCK, EMPLOYED IN ERECTING STEEL TOWERS, TO PREVENT ACCIDENTS.

H. W. Hemple.

That the Bilby steel tower can be erected to a height of 103 feet (including the digging of the anchor holes) by a party of five men in five hours is due not only to coordination of effort on the part of the men but also the employment of the motor equipment to hoist the steel members. A small "niggerhead" about six inches in diameter and eight inches wide is bolted into place on one of the rear wheels of the truck. This wheel is then jacked up and the engine thrown into gear; the hauling rope is then wrapped around the "niggerhead" to hoist the various steel members. By surging the rope, the hoisted members can be stopped at the height where they are needed. In practice, four men are on the tower, one on each corner of the tripod, and the other at the tackle to handle the equipment as it arrives; the fifth man is on the ground hoisting the steel. With only one man on the ground, accidents may occur, and have, should this man suddenly become incapacitated and unable to stop the motor. To take care of such an emergency, Lieut. Gallen's party has placed an auxiliary switch on the flare board near the rear wheel, within easy reach of the operator, and by throwing this out of mesh, the engine can be stopped.

DRAWING R.A.R. DISTANCE CIRCLES OF LONG RADII.

F. B. T. Siems.

I. With Beam Compass.

Circles of long radii, limited by space available aboard ship, have been drawn on R.A.R. sheets by means of a beam compass. A beam as long as eight feet, made of wood in the form of a two-inch T in cross section, has been used and found to have the required amount of rigidity and lightness.

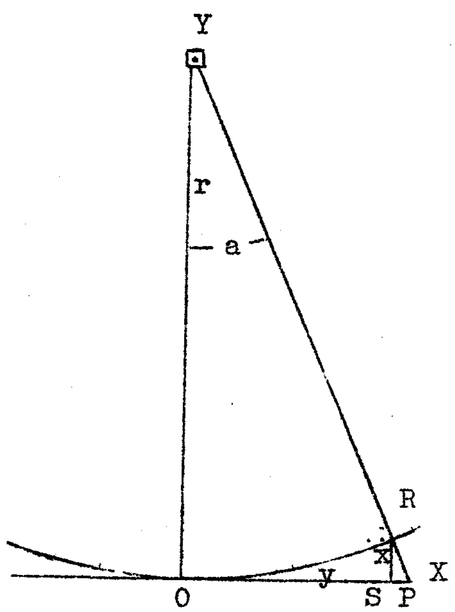
In the use of a long beam compass, circles most accurately drawn result when applying light pressure for movement at the fixture directly over the pen,the other fixture being lightly held in place at the circle center. Pressure applied at any other part of the compass may cause variable flexure of the beam while drawing the arcs. Celluloid is excellent material for maintaining the circle center against the tendency of wear occasioned by the pivotal point of the compass.

The position of the hydrophone if it falls comparatively far outside the limits of the sheet is located, for swinging in the arcs, by a distance and direction from a geographic position on the projection, the geographic position of the hydrophone being known.

II. By Computation.

Circles involving radii too long to permit the use of a beam compass were constructed in the following manner: The geographic position of the point of intersection of two distance circles falling on a convenient part of the projection was computed and plotted. This required the solution of the triangle, formed by the two hydrophones and the point of intersection of the two distance circles, in which the three triangle sides are known. Azimuths from the point of intersection of the distance circles to the respective hydrophones are also computed in connection with the position computation, the geographic positions of the hydrophones being known which provide the distance and azimuth between them.

The azimuth lines loading to the respective hydrophones arc plotted trigonometrically, rather than by means of a protractor, through the point of intersection of the two distance circles. Lines normal to each azimuth line are drawn through the point of intersection and through points at distances therefrom along each azimuth line corresponding to the adopted interval between concentric arcs.



Considering an azimuth line as the Y axis and a normal line as the X axis, the rectilinear coordinates of points on the circle passing through the origin of the system were derived as follows:

Referring to Fig. 1, lot OY represent the azimuth line to hydrophone Y and the radius r of the circular arc OR, OP the normal line, OS and SR the y and x coordinates of the point R, RP an extension of radius YR, and a the angle RYO or PRS.

In this particular problem, only small angular values of a are involved and the ratio OS with respect to r is practically the same as the ratio of OP with respect to r.

For small values of the angle a it may be considered then that:

$$\tan a = \frac{y}{r}$$

$$\cos a = \frac{r - x}{r} \qquad \text{or} \qquad x = r - r \cos a$$

Assigned values of y are entered in the above formula and corresponding values of x are solved by logarithm. It is not necessary to find the angular value of a, but simply to find the value of the cosine corresponding to the tangent of the angle.

It is considered that the method of deriving the coordinates trigonometrically is simpler than <u>employing</u> the formula

$$y = 2 r x - x^2$$

as values of x corresponding to assigned values of y are desired; the solutions must be made by trial on account of the two powers of x in this equation.

The formula first given may be modified to cover cases of larger angular values of a, as follows:

$$\tan a = \frac{OP}{r} = m$$

$$X = r - T \cos a$$

$$y = OP - SP = OP - x\,m.$$

Assigned values of OP are entered in the above formula and the corresponding coordinates x and y are solved.

<u>COMMENTS ON PREVIOUS ARTICLES</u>

ON COMMANDER GARNER'S ARTICLE ON REFRACTION
O. W. Swainson

I experienced a similar horizontal refraction in the triangulation north of Luzon in 1923. The wind was offshore during the morning and onshore during the afternoon. This caused the angle at West Base between Fuga and East Base to differ as much as five seconds in the morning from the afternoon observation. Fuga was about fifty miles distant, the line passing close to the surface of the water.

ON THE ARTICLES BY K. T. ADAMS AND G. D. COWIE ON STAR FIXES.
O. W. Swainson.

Both of these articles were very interesting and instructive. Lieut. Comdr. Adams brought cut many valuable points to observe in taking star sights, but I believe, with Lieut. Comdr. Cowie, that he is in error in assuming that the correct height of eye is so important when a round of sights is taken.

The four hundred sights taken by the officers on the PIONEER last year have made me believe that in most cases weighting the observations does not improve the accuracy of the results.

I prefer Lieut. Comdr. Adams' method of determining the final position to the Sumner bisectrix method used by Lieut. Comdr. Cowie.

ON BUOY CONTROL
(From Season's Report, G. D. Cowie, Florida Coast, 1931)

Part of the control consisted of a closed loop of buoys about 32 miles in circuit. Sun azimuths, or angles, between buoys were taken around the circuit and double log runs made between each pair of buoys. This circuit was computed mathematically and the closing error distributed. The azimuth closed less than one minute and the distance about 150 meters. This closure is a good example of what can be done by the sun azimuth-double log run buoy control method. It is believed that sun azimuths observed under good conditions are seldom over 2 minutes in error, and log distances can be measured with errors not greater than 0.02 miles per mile.

Fixed position control was used out to the 30-fathom curve (approximately 30 miles offshore).

ON TRANSMISSION OP SOUND THROUGH SEA WATER

O. W. Swainson

I was very much interested in Dr. Dorsey's article on the transmission of sound through sea water. I think his theory of "velocity energy integral" comes closer to the facts than that of any other theory about which I have read. If the sound traveled along the bottom, as Mr. Shalowitz's investigations sended to show, then why would not the depth of water be a function of time required for the sound of a bomb to reach a hydrophone? The sound wave would have to go to the bottom and thence to the hydrophone, hence the deeper the water, the longer would be the time before the wave got started horizontally.

Dr. Dorsey stated that he does not think there is a difference in velocity due to strength of explosion and attributed my observations, where a less depth was obtained with bombs than with the oscillator, to the action of the relays. This might be partially true but not entirely so, as in that case the difference between the bomb depth and oscillator depth would be constant irrespective of the depth. This was not the case; the deeper the water the greater was the discrepancy. In fact, we found that by using a velocity of 1530 for bomb explosions and 1480 for the oscillator the two depths chocked each other. There also was a difference between the explosion and the first echo from that between the first and second echoes or third and fourth echoes.

My observations were that there was no difference due to different sizes of explosions - a detonator giving the same result as a pint bomb - but the bomb gave a different depth than the oscillator, showing that it was the kind of sound and not the volume that made the difference Captain Maher suggested that this discrepancy may be due to the explosive effect of bombs. I never did think that sound had more than one velocity in a given medium at constant conditions, but this has me guessing.

I have made some more experiments along this line and, as soon as my large oscillator is repaired, will continue thorn. So far I have both disproved and proved my former findings. It would be interesting to compare a long R.A.R. distance as determined by the sound of the oscillator with that obtained by a bomb, and also a short distance.

COMMENTS ON THE PRECEDING
A. L. Shalowitz

If I understand Commandor Swainson correctly, he is saying that if the bottom theory of propogation is correct, then the time required for the sound to reach the hydrophone should be a function of the depth and the deeper the water the longer would be the measured time interval. In other words, velocity tests made in deep water, other things being equal, should yield a velocity value less than tests made in shoal water. Would not my general theory bear that out, since temperature of water decreases with depth? And haven't experiments also proved this to be the case? (See page 49 of my report quoting a statement by Commander Strains on to the effect that "The net velocity between hydrophone and bomb was less when the bomb was fired in deep water than in shallow water").

COMMENTS ON STAR SIGHTS AT BUOYS
O. W. Swainson

I was very much interested in Lieut. Hubbard's valuable report on star fixes, but I disagree with a few of his conclusions.

The mean intercepts of star sights of three observers on the PIONEER, 1930, at buoys are: O. W. Swainson, mean of five sets, 0.10 from; C. K. Green, mean of ten sets, 0.19 from; E. O. Heaton, mean of ten sets, 0.04 from. The average intercept for all buoys was 0.11 mile, and the greatest difference of any observer's mean intercepts from this average intercept was 0.08 of a mile.

In the Hawaiian Islands the water and air are so nearly the same temperature that no information regarding the effects from their differing can be obtained. Few water temperatures were taken at the time for star sights and hence the data are insufficient to draw any reliable conclusions therefrom. As the error would be a constant, applicable to all angles, it would have no effect on the selection of the position from any figure of more than two sides. If there are but two sumner lines, the true position is guess work anyway. No doubt there is an error dues to appreciable difference in temperatures of the water and air, and the application of this error would reduce the size of the figure, but it would be unnecessary to apply it except to isolated sumner lines such as noon latitude sights.

As I have stated before, I do not agree that any system of weighting other than that of following an officer's normal type of figure should be used. Lieut. Hubbard's suggestion that weights be given sumner lines depending upon the differences of observed rate of change of altitude from the theoretical is interesting, but, in my opinion, hardly feasible. There are so many elements entering into the observing of an angle of a star that to fix the true position relative to a summer line proportional to the difference of the observed rate of altitude change from the computed change is just as apt to increase as to decrease the error.

SUGGESTIONS

FATHOMETER CORRECTIONS
O. W. Swainson

Why is it necessary, except as a scientific principle, to make the theoretical corrections to fathometer soundings under 300 fathoms? Why not take a series of comparisons in different depths with vertical casts and use these results to correct the soundings? I believe we would get just as accurate corrections and certainly eliminate a great amount of work.

(Believe Swainson should have said "except to obtain scientific data" rather than "as a scientific principle".-Ed.)

TUBES FOR MAILING SHEETS
O. A. Egner

In connection with mailing smooth sheets to the office, it has occurred to us that the present method is quite a makeshift. Certainly too much dependence is put on the care exercised in wrapping these valuable sheets in protecting them from possible damage from rain, etc., while in transit.

It is now possible to have made suitable waterproof containers in the shape of tubes, similar to our present chart tubes, which would be both light and inexpensive. Concerns manufacturing food containers in many of the well known forms could be approached by the office with satisfactory results, it is believed.

SMALLER AND OFTENER.
O. W. Swainson

The December bulletin was a fine piece of work; in fact, I think it was too good. There was so much material that the readers were apt to skip much that they would have read if there had been a fewer number of articles. This is especially true of the younger officers. I suggest that the bulletin be published more often, say quarterly, and be made smaller. (The cost of the bulletin is governed by the number of issues rather than by the size. Twice the number of issues of half the size would be considerably more expensive.-Ed.)

LARGER STATION MARKS REQUIRED IN TEXAS
(From Season's Report of W. Mussetter, Gulf Coast - Mobile to Corpus Christi - Reconnaissance)

"A peculiarity of the Texas black lands is their cracking and swelling qualities, resulting in a heavy action similar to severe frost action. During the dry season, deep cracks will form and when rain falls, the consequent swelling results in both vertical and horizontal displacement. Some of the old marks were found badly disturbed from this cause and State Highway Engineers reported disturbance to bench marks. It is suggested that marks in this area be made especially deep. Probably the same amount of concrete made into a long slender post, with its upper surfaces smooth, will give a more permanent mark than a shorter, thicker mark."

MORE SPEED
W. D. Patterson

The strong currents encountered on the working grounds were our greatest handicap. On large tides the currents attained a velocity of 4 to 6 knots over all parts of the working grounds. There have been times when the ship was sounding against the current and running full speed when we made no progress between four minute positions. This indicated a current of over seven knots for short periods of time. On one day the ship drifted with the current for one hour and it required two hours full speed run to cover the same distance against the current.

The past season has demonstrated the need for designing Coast Survey ships of greater speed. A seven knot ship running against a six knot current will make one knot. An eight knot ship will make twice the speed. Of course, it is very seldom that Coast Survey ships will have occasion to operate in such strong currents, but since the fathometer has been adopted as a surveying instrument, more speed is desirable. With the old methods of sounding, a sounding speed of five knots was seldom exceeded. With the fathometer, a ship making seven and one-half knots can accomplish only one-half as much as a ship making fifteen knots.

HOW SHALL WE DISTINGUISH FOURTH ORDER TRIANGULATION STATIONS?
(I) F. B. T. Siems.

It is suggested that signals located by fourth order triangulation or traverse, if computed, be indicated by blue triangles on topographic and hydrographic sheets, and that this symbol be also used for intersection stations when the object is not well defined, as in the case of some peaks, or when the intersecting angle is less than 20°.

(II) A. M. Sobieralski

There is little advantage to be gained by classifying triangulation stations on hydrographic and topographic sheets, or even on progress sketches. The proper place to indicate the classification is on the lists of geographic positions. The only reason for indicating the classification is for the guidance of persons using the triangulation stations in the future, and there is no assurance that they will see either the survey sheets or the progress sketches.

The official adoption of a new symbol is attended by considerable difficulty, not the least of which is approval by the Federal Board of Maps and Surveys. It is mandatory by executive order to use the symbols adopted by the Board on all maps published by the Federal Government.

While it might be said that these sheets are not published, the symbol should be adopted officially or else it would fall into disuse and the interpretation of the symbol would be difficult in the future.

The use of various colored inks for different symbols is objectionable because the field parties and the public usually see only photographic copies of the sheets. Blue is particularly objectionable because it will not photograph.

I therefore consider it unnecessary to show triangulation stations of different order by different symbols on the hydrographic and topographic sheets. If the stations should be classified on the lists of geographic positions, then a separate symbol should be adopted for each order, the symbols to be different in shape, not in color. A system of abbreviations or notations would probably be simpler.

(III) P. A. Smith

In view of the past trouble resulting from use of supplementary points as control for additional triangulation, it is suggested that intersection points which have been determined with accuracy less than third order, and, in particular, points which have no check position, be published in the list of Geographic Positions, omitting the azimuths, back azimuths and distances to adjoining stations. Such explanatory notes should also be made as would leave no doubt concerning the inadequacy of the points for triangulation control.

(IV) F. S. Borden

Some means of distinguishing between fourth order control points and those intersection points which have, or could be given, third order strength seems very desirable. I agree with Commander Sobieralski, however, that little would be gained by attempting to distinguish between them on topographic or hydrographic sheets. A chief of party will seldom fail to locate a triangulation intersection station as closely as it can be plotted on the scale of the sheet he is using and as a point on that sheet it is usually entirely satisfactory. The trouble begins when a future surveying party, either within or without the Service, utilizes the station for something more than a control point, such as the end of a line for extending triangulation.

In any locality the stations which are to be cut in by intersection can generally be divided into two groups: First, those on which definite pointings can be made and which are so situated with relation to the main scheme stations from which located that they form strong figures; in other words, those that would serve as unoccupied points in a supplemental scheme of triangulation. Examples of these are church spires, lightning rods on chimneys or tanks, spires on tops of cupolas, etc. Second, those on which definite pointings can not be made and which would not be suitable for use as unoccupied points in a supplemental scheme. Examples of these are peaks, pinnacle rocks, trees, houses, broad cross-section tanks or chimneys, etc.

For the first group, it is my opinion that we should treat the stations as though included in a supplemental third order scheme of triangulation, observe angles accordingly and list them as at present giving azimuths, back azimuths and distances. For the second group, I believe we should treat them simply as points and list only the positions as suggested by Lieutenant P. A. Smith. Such a procedure would be a definite indication that they were only of fourth order accuracy and should under no consideration be used except as points.

STAGGER THE C.O's AND EXECS.

W. D. Patterson

During the past few years it has so happened that both the Commanding and Executive Officers of each Coast Survey ship in the Philippines have been relieved at the same time. It is believed to be much more efficient and desirable to stagger their assignments so that one will be relieved one year and the other the following year, thus keeping an experienced officer on the ship at all times. This is especially desirable on the two ships operated by the Philippine Government where conditions are entirely different from those in the States, where the U. S. regulations do not apply, and where there are no published regulations, except circular letters, to guide the Commanding and Executive Officers in the preparation of their accounts, the purchase of supplies, and the care and disposition of Philippine property.

RANGE FINDERS AND BALLOONS

C. A. Egner

On pages 67-72 of the December Bulletin you go extensively into applications of your pet "Buoy Control". You will remember we tried to get approval of a small range finder for measuring distances to the buoys. It was said that there was no suitable instrument like that on the market.

It seems that some have been developed since that time. I have seen two advertised in a recent copy of the International Hydrographic Review. It appears to me that one or the other of these is just what we need for buoy control and should be sufficiently accurate for our purpose far beyond the range of present methods. This would mean a great saving in time in taking departures from and in tying onto the buoys.

With this in mind, why not mount it on a pelorus pedestal or provide some similar method of reading it in azimuth (referred to the compass, of course) and thus give at one and the same time both bearing and distance? I believe that this would make it entirely feasible to do hydrography close to the buoys using this instrument alone for control, if mounted high enough as to give unobstructed vision. (LYDONIA was recently equipped with a Barr and Stroud range finder. No report as yet.-Ed.)

Here is another. May be nebulous, but I'll chance that.

For years, Chief Silva has been a bug on this one and it may have merit. If so, he gets the credit. He wonders incessantly why balloons couldn't be used offshore in place of buoys. We all know that Goodyear makes gas bags of various descriptions. Could a series of these small ones be anchored offshore in the same way that we anchor buoys, double or triple anchors, maybe, to hold them in place? I'll admit I have not gone into the mechanical side at all, but you see, here we get elevated signals in the same way we have them elevated on shore, and I'm sure a twelve-foot diameter gas bag could be seen fifteen or eighteen miles. A hundred-foot elevation would be simple.

GENERAL

From Season's Report, F.H. Hardy, Commanding SURVEYOR
Southwest Alaska, 1930.

Resuming command of the SURVEYOR after a period of a decade was one of my pleasantest experiences in over twenty-six years of service. After launching, the SURVEYOR had been widely advertised as the most modern survey ship afloat. Whereas, this was perhaps true as far as the ship structurally was concerned, it was far from true as to the condition of her surveying equipment in 1930. It was a great satisfaction in 1930 to find her surveying equipment equalled by few, if any, surveying vessels. Under Captains Maher, Sobieralski and Lukens this equipment had been built up to such a high point of efficiency that after a year's service, I find that I have contributed nothing to it and only hope that in transferring the command to Captain Siems I have maintained it at as high a point of efficiency as when transferred to me by Captain Lukens.

In this part of "Rip Van Winkle", one of/the most startling changes noticed was the improvement in the crew. The unsettled labor conditions of 1919 and 1920 gave way in the early twenties to more stable conditions. Full advantage of this change was taken by Captain Sobieralski in building up a petty officer complement which in capability and, more important, in the interest and pride in the work of the Survey it would be hard to improve upon. Comparatively few changes were made by Captain Lukens among this personnel, but all of these changes added materially to the efficiency of the complement. Chief Engineer, Mr. Johanson, had built up a most efficient engine room force. With these petty officers as a nucleus, Mr. Meaney and Chief Johanson selected the additional men necessary to fill out the complement for a surveying season with rare judgment. The result was that during a season of approximately five months spent on the working grounds in a most uninteresting country with only three days in the small town of Kodiak as a relief during the entire season, there were no complaints nor kicks which came to the attention of the Commanding Officer. There was a pride and interest shown by the crew in the work being done which ten years ago would have been considered ideal, but impossible of accomplishment. During the season there was no trouble on account of liquor and before leaving Kodiak, after three days having been spent there around the Fourth of July, several persons came to me and said that they had never had any Government vessel come to that port with such a fine crowd of officers and men. The fact that the ration allowance is ample to provide a good table is an essential factor in the keeping of desirable men and their contentment.

As at present organized, the Coast Survey offers little future to the members of the crews of our vessels. This condition is one that I know has received a great deal of attention from all chiefs of parties who have been fortunate enough to have had men who, by the faithful service they have rendered, have warranted consideration for their future welfare. After a certain age, the men begin to slip, and as at present organized, it places the chief of party in an embarrassing position because, on the one hand, he hesitates to deprive any man of a livelihood who has given the best years of his life to the Service, and, on the other hand, he knows that a younger, more active man would be better for the party. Without enlistment, I can see very little hope of obtaining retirement pay for the men, and for our work I am very much opposed to an enlisted personnel, as you would not get as capable men or have the same flexibility in the organization as you do by hiring men as we do at present.

* * * * * *

In regard to the pay of officers and men, I would suggest for consideration increasing the pay of the chief writer after he has served for a period of six years to $150 per month. As every chief of party is aware, a good chief writer adds materially to the efficiency of the party, both from the accounting and surveying side, and his pay should at least equal that of the electrician, whose duties are extremely light, although they carry responsibility in regard to the care of explosives.

* * * * * *

The Launches WILDCAT and HELIANTHUS, capable of accommodating detached parties, together with the launches on the ship, make an almost ideal equipment for the execution of the work called for in the instructions. The operation of these larger launches under the direction of one chief of party in the field leads to economy in the execution of the work.

* * * * * *

The N & S reversing gear on the WILDCAT and the electric sounding machine were given a very severe test in the survey of Sitkinak Strait. It was often necessary to back up full speed every 30 or 40 seconds when running with the current. It is doubtful if any clutch could have stood up under such heroic treatment. The only trouble given by the gear was not the fault of the mechanism, but through insufficient lubrication. The WILDCAT with the same engine and clutch which proved unsatisfactory for hydrographic work has, since the installation of the N & S reversing propeller, been a satisfactory survey launch.

The Motor Sailer equipped with reversing propeller proved an extremely economical hydrographic unit. Mr. Sipe, in charge of the Motor Sailer, working between Low Cape and Cape Alitak, in eight hours and seven minutes work accomplished 47.9 miles of hydrography, obtaining 258 soundings with the sounding machine and 441 with the hand lead, 250 positions being taken. This was, as far as I can find out, the record for that launch and certainly speaks for its efficiency as a survey unit. Approximately 1200 miles of sounding lines were run with the Motor Sailer and at no time during the season was there any delay caused by engine trouble.

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There seems to be a tendency among some of the officers to feel that when the general system of lines called for in the instructions is completed the area is entirely surveyed, apparently the development of indications obtained on the regular system being considered by them as unnecessary work.

LOYALTY

(Array and Navy Register, April 18, 1951)

Loyalty to one's superiors, loyalty to one's self, and the ability to inspire loyalty on the part of others are the qualities that are most essential in the makeup of the really valuable officer of the uniformed services -- the leader of men. It means a true, willing, practical, and unfailing devotion to a cause.

The strong-minded man likes to have things his own way, and for this he can not be blamed. It is a trait of human nature in which there has been little change through the ages.

The "yes, yes" officer never amounts to much, nor does he get far in the service. The contentious individual goes even less. There is a proper time and a proper way for an officer to express his own ideas when they do not agree with those of his superiors. The efficient man will sense both the time and method; the laggard will pout it out within his own soul.

Once a problem has been solved, a decision arrived at and announced, an officer's duty is apparent. He must set aside his own ideas and endeavor, with all of his might, to carry out the plan which it is his duty to follow. Failing this he can not be counted as loyal to his superiors.

Included in the efficiency replies which officers are required to render periodically on their subordinates is a question about this matter of loyalty to which an answer must be supplied: "K. Proper authority having decided on the methods and procedure to accomplish a certain end, does he render willing and generous support regardless of his personal views in the matter?"

Consider that you are preparing an efficiency report. The report is on you yourself. What answer would you make to this leading question. If, down deep in your innermost heart, you can not answer "Yes" to it, then you are lacking in one of the prime qualifications of an officer, and you will do well to brush up on this subject of loyalty.

If we will examine closely into ourselves we shall find only too often a tendency to inquire too closely into the orders and directions of our superiors. If they agree with our own ideas, well and good; we can be intensely loyal. If they do not, perhaps we take them with bad grace. Our loyalty rings true when it is convenient and when we are in agreement. He is an unreliable subordinate who can be depended upon to carry out loyally only those plans which he himself approves.

Let an officer be ever so brilliant, ever so brainy, ever so ambitious, if his superiors have reason to doubt his loyalty through and through, they will not for a moment consider him for positions of real trust and responsibility.

True loyalty does not mean merely passive compliance with the letter of the law or the decision of a superior. It means a true and honest effort to carry out the intent as well.

The loyal officer is prepared, if emergency arises, to sacrifice hiS own comfort, even his own interests. He puts the good of the service ahead of his own convenience. He does his duty intelligently, with enthusiasm, with zest and with a will. Nor will the truly loyal officer be content to shield himself by claiming ignorance of his orders, if it is possible to obtain more information about the desires of his superiors.

"To thine ownself be true, and it must follow as the night the day thou canst then be false to any man." In these immortal words the Bard of Avon summed up the idea of loyalty.

TRANSLATION OF TRIANGULATION MANUAL

A translation in Polish of Major Hodgson's Manual of First Order Triangulation has been published as one of a series of books on surveying and related subjects by the Geographic Section of the Societies of Military Science in Warsaw, Poland.

The translation was made by Apolonjusz Zarychta, Captain, Corps of Geographers, and Feliks Kopczynski, Lieutenant, Corps of Geographers. In the translation, the original text was carefully followed. Most of the illustrations were reproduced.

The following excerpt is from the translators' preface:

"Polish technical literature does not contain to date a systematically worked out manual of triangulation. We do not need to underline (emphasize) the importance of this science and technical practice for the needs of the country and preparation of the defenses of the country. Major Hodgson's book enlightens us in detail with the triangulation methods adopted by the U. S. A. Particularly valuable appear to us the chapters dealing with organization of the work, methods of economy applied in the noblest sense of this work, in which the Americans lead the world and to which they owe so many records and triumphs of their engineers.

"We believe that the Manual will establish valuable material as a standard for our undeveloped surveying practice."

STORIES NEEDED.

The editor is collecting a file of human interest stories apropos of Coast Survey work and would like to have field officers send in any such stories as come to their notice. This file will be available to officers preparing popular articles for publication. These stories will also make good material for magazine and newspaper writers who frequently visit the office in search of stories. Lieut. Comdr. Lukeons makes the following contribution:

A local trapper and fisherman at Dutch Harbor, Alaska, took a notion that he would sail his little schooner down to San Francisco and take a vacation in the States. On hearing about the trip, the Coast Guard boarded the little craft to see if it was properly equipped with navigation instruments, life saving gear, etc., and much to their amazement, they found that the navigating equipment consisted of one small compass of doubtful value. "How", they asked, "do you expect to find San Francisco without a chart, sextant or chronometer?" "Well", the old fellow said, "the goose get there all right and I guess I've got as much sense as a goose."

ON FORWARDING MAIL

It is suggested that if you would print a notice similar to the following in your Bulletin, it would result in benefits to the members of your Association:

"The attention of the field personnel is called to Coast and Gaodetic Survey Circular No. 9-1928, dated September 11, 1928, entitled, "Forwarding of Mail to Dependents of Field Personnel'. This circular states that the Post Office Department has informed the Bureau that mail, other than first-class, can not be forwarded to wives or dependents of commissioned or other field personnel of this Bureau without being subject to additional postage.

"It is suggested that subscriptions for magazines and papers be placed in the officer's name and not in the name of the dependent. It is also suggested that, as far as possible, mail orders specify that the material be addressed to the officer so that additional postage will not be necessary if the package has to be forwarded."

AN APPEAL FOR PHOTOGRAPHS.

The photographic files of the office are badly in need of "new blood". The few good pictures on hand have been used a good many times in articles and publications and we are in need of new material.

Field parties are urged to take and send in more pictures. The following subjects are especially desirable:

- Unusual planetable set-ups.
- Theodolite set-up on sharp peaks.
- Ships, with high mountains in background.
- Mountain climbing expeditions.
- Wrecks and strandings.
- Fathometer views, with an officer attending it.
- Sounding machines in operation.
- Planting buoys.
- Queer or unusual pinnacle rock formations (close up).
- Heavy surf breaking on a coast or rocks.
- Animal pictures, such as sea lions, whales, reindeer, etc.

For purposes of reproduction, prints should have plenty of contrast and should be taken as close up as possible.

The Coast Pilot Section desires good views of headlands, capes, islands, lighthouses, etc., suitable for publication in the various pilot volumes. These should be taken as close up as possible and the bearing and distance of the subject should be given.

Officers may send in films, either developed or undeveloped. If desired, the films will be returned after copies are made here. Even a small snapshot can sometimes be enlarged to make a very interesting picture.

NO INDICATION OF DEPRESSION HERE.

Demand for charts (issue and condemnation) was large. While May, 1931, was not a record month, only two prior months exceeded it. It is interesting to analyze and compare item by item sources of demand for those three months, for which purpose the following table is presented:

Issued	April, 1917	January, 1919	May, 1931
Sales Agents	6203	8965	13566
Manila Field Station	1025	356	28
Sales Section	55	26	142
Sales, Office	76	89	352
Coast Survey	1277	424	913
Hydrographic Office	21031	23849	8509
Lighthouses	706	160	333
Shipping Board		1377	
Coast Guard			5628
Other Executive Depts.	1083	456	1026
Congressional	142	146	481
Foreign Govts.	18	82	351
Miscellaneous	63	18	169
	31679	35948	31498
Condemned	2978	860	2393
Issued and condemned	34657	36808	33891
Issue Manila			231
	34657	36808	34122

Sales, Free Issue, Condemnation

	April, 1917	January, 1919	May, 1931
Sales	6334	9080	14291
Free Issue	25345	26868	17438
Condemnation	2978	860	2393
	34657	36808	34122

Percentages

	April, 1917	January, 1919	May, 1931
Sales	18.3	24.7	41.9
Free issue	73.1	73.0	51.1
Condemnation	8.6	2.3	7.0
	100.0	100.0	100.0

USE OF BILBY STEEL TOWER ABROAD

Extract from paper entitled "The Progress of Geodesy, Topography and Cartography during the Last Half-Century", by General G. Perrier, Member of the French Institute and Professor at the Polytechnic School (Paris), published in the November, 1930, number of the Journal "Le Genie Civil", on its fiftieth anniversary.

"Since 1927, steel signals of the type called Bilby Tower, designed by Engineer Bilby of the Coast and Geodetic Survey of the United States, have been constantly used by that Service and they offer the invaluable advantages of stability, rapidity of erection, and of economy. Wooden signals, 20 to 30 meters high, which were used on the new meridian of France, were composed of two independent structures (one for the instrument, the other for the observer). A Bilby tower, which can be erected to a height of 40 meters, also consists of two independent structures; it is taken down and transported on automobile trucks; in 13 hours, four men can take down a 23-meter Bilby tower, transport it 112 kms. and re-erect it."

Gen. Perrier informed this office that he refers to the excellent results obtained with the Bilby Tower when he is delivering lectures in his course at the Polytechnic School and in his articles in other technical journals. At his request, the Director furnished him with a complete set of photos of the Bilby Tower and a description of it, and also sent the same information to the Director of the Geographic Service of the French Army. Both expressed great interest in the data.

It is of interest to note that the Geodetic Institute of Denmark purchased one of the Bilby towers from the Aermotor Company of Chicago and is using it as a model for the construction of similar steel towers for use on its triangulation.

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CAN YOU EQUAL IT

C. A, Egner, U. S. Coast and Geodetic Survey.

Perhaps Adams started something in his "Can You Beat It" section. I would suggest that this section be altered to include such items as would more properly be incorporated in "Believe It or Not" (Ripley).

For instance, you might include in your next number the following:

(1) There is now in the enlisted personnel of the NATOMA in the capacity of night watchman a man by the name of W. G. Hill. He was at one stage of his life one of the real checker experts of the country, being classed among the first ton. His name is quoted in chess and checker publications and he is still regarded with corresponding respect by those in a position to know about such things.

Contrary to the usual conception of checkers as merely a barber shop pastime, this game offers unlimited opportunities for a type of pure science and is rated by same experts as on a par with chess. Needless to say, Mr. Hill isn't defeated by the usual run of checker players. This has been true to my knowledge over a four-year period wherever he has gone, be it Florida, New York or Norfolk. Incidentally, he has the material on hand for an exhaustive publication on checkers, illustrating the various lines of attack and defense gleaned from over 15,000 cases of expert play.

Would anybody in the Coast Survey like to take him on?

(2) Mr. Paton claims to have taken a sextant angle on a shore object at a greater distance than anybody else who has done offshore hydrography on the southeast Atlantic coast. His 200 pounds perched astride the yardarm on the foremast of the NATOMA, he used Δ Golf, a water tank four miles south of Jupiter Inlet, a distance of 20.7 nautical miles. Position 49, Y day, May 20, 1930.

(3) In precise leveling in 1920 when we used to mount the "gun" on a Buda side-drive speeder, the following three days of leveling are matters of record:

(a) In January, 1920, near Guadelupe, Cal., in a day of 7 hrs. 40 min. of "shooting" - - - - 21.5 miles of single line.
(b) On Feb. 27, 1920, in the vicinity of Florence, Cal., in 7 hrs. 10 min. of leveling - - 21.2 miles of single line.
(c) On Mar. 11, 1920, in the vicinity of Anaheim, Cal., in exactly 8 hrs. of leveling——————- 25.7 miles of single line.

These are three of the four largest days of which there are definite records, the fourth being a day by T. J. Morris, a foreman hand in Mr. Lutz's party, in which he covered 22 miles in one day of unknown length. Lieut. Commander Peters did 20.3 miles in one day of seven hours.

On the day of 25.7 miles, 178 set-ups were made averaging 24 rails, or 12 rails on back and foresights. The writer has made 116 set-ups in four hours, on shots of shorter length.

Also, I wonder if the long-legged boys like Thomas have beaten 15.2 miles on foot, carrying the 28-pound tripod himself, which the writer did out of Pana, Illinois, in November, 1921.

In this connection, I might say that in California in 1920 I had a rodman named Curran Butler who ran the mile in high school in 4:44 and who could, on occasion, rod all day at a steady pace.

PERSONAL

Announcements

Lieut. Comdr. and Mrs. E. W. Eickelberg announce the arrival on January 9, 1931, at Seattle, Washington, of a son, Ernest W. Eickelberg, Jr.; weight, 7 pounds, 6 ounces.

Mrs. John A. McGhee announces the marriage of her daughter, Mary Myrtle, to Mr. John Clarence Mathisson on Saturday, January the thirty-first, nineteen hundred and thirty-one, Birmingham, Alabama.

Lieutenant and Mrs. B. H. Rigg announce the arrival on May 3, 1931, at Oneonta, New York, of a son, Kent Rigg; weight, 8 pounds, 7 ounces.

Lieut. Comdr. and Mrs. G. C. Mattison announce the arrival on May 4, 1931, at Manila, P. I., of a son, George Carl, Jr.

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An unlimited master's license was granted to Lieutenant W. M. Scaife on May 26, 1931, at Jacksonville, Florida.

A license as chief mate, unlimited, was granted to Lieutenant L. S. Hubbard on March 16, 1931, at Jacksonville, Florida.

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ROSTER
ATLANTIC COAST

HYDROGRAPHER - Georges Bank, coast of New England.
(4) W. E. Parker, Commanding (41) R. D. Horne, Executive Officer
(64) E. B. Roberts (139) F. A. Riddell (148) J. C. Tribble, Jr.
(102) E. H. Kirsch (142) F. Natalla (150) J. C. Tison, Jr.
W. E. Greer, Chief Engineer

OCEANOGRAPHER - Georges Bank, coast of New England.
(11) L. O. Colbert, Commanding (57) R. A. Studds, Executive Officer
(59) B. H. Rigg (68) T. B. Reed (108) C. A. Bannister
(61) L. C. Wilder, Training Officer (69) J. C. Sammons (145) E. B. Brown, Jr.
D. H. Konichek, D. O. J. K. Holloway, D. O.
J. E. Waugh, D. O. J. L. McIver, Chief Engr.

LYDONIA - Georges Bank, coast of New England.
(24) G. D. Cowie, Commanding (56) W. M. Scaife, Executive Officer
(78) L. S. Hubbard (83) W. H. Bainbridge (143) J. S. Morton
C. N. Conover, Chief Engineer R. C. Overton, Mate

GILBERT - Georges Bank, coast of New England.
(36) Charles Shaw, Commanding (75) K. C. Crosby (156) J.T. Jarman

NATOMA - I. Pollock Rip Channel, Mass.
II. Port Jefferson, Long Island Sound, New York.
(37) C. A. Egner, Commanding (82) H. A. Paton, Executive Officer
(97) G. R. Shelton (157) W. F. Deane (159) E. J. Hicks, Jr.
A. Silva, Chief Engineer.

OGDEN and MARINDIN - Wire drag, Long Island Sound.
(65) H. E. Finnegan, Chief of Party (147) M. A. Hecht F. E. Okeson,
(86) S. B. Grenell (152) C. R. Reed Mate.

MITCHELL, ELSIE, ECHO, RODGERS - Current survey, Buzzards Bay.
(76) G. E. Boothe, Chief of Party (149) 0. B. Hartzog
(74) I. Rittenburg P. Taylor, D. O.

Shore Party - Combined surveys, Galveston Bay to Houston, Texas.
(52)) J. A. Bond, Chief of Party (153) E. L. Jones

Shore Party - Control Surveys, New York Harbor and vicinity.
(60) R. W. Woodworth, Chief of Party

MIKAWE - Combined surveys, Wicomico River, Maryland.
(46) E. H. Bernstein, Chief of Party C. F. Chenworth, D. O.

PACIFIC COAST

SURVEYOR - Tenders: WILDCAT and HELIANTHUS - South Coast of Kodiak Island, Southwest Alaska.
(17) F. B. T. Siems, Commanding (50) R. R. Moore, Executive Officer
(70) R. W. Knox (117) E. C. Baum (144) R. A. Marshall
(92) A. C. Thorson (129) G. M. Marchand (163) C. J. Beyma
(10E) W. J. Chovan (131) R. A. Earle G. E. Johanson, Chief Engr.
(116) G. W. Lovesee (136) M. G.Ricketts R. W. Healy, Mate
F. J. Soule, Surgeon

PIONEER - Laysan and Lisianski Islands, Hawaii
(22) O. W. Swainson, Commanding (42) C. K. Green, Executive Officer
(55) E. O. Heaton (125) C. J. Wagner C. R. Jones, Chief Engr.
(109) P. L. Bernstein (135) R. A. Gilmore D. R. Kruger, Surgeon
(111) V. M. Gibbens . (146) J. C. Ellerbe, Jr.

DISCOVERER - Tender: WESTDAHL - Kenai Peninsula to Afognak Island, Southwest Alaska.
(28) H. B. Campbell, Commanding (43) G. L. Bean, Executive Officer
(71) H. A. Karo (106) G. A. Nelson (137) G. C. Mast
(85) R. J. Sipe (118) L. W. Swanson (140) I. R. Rubottom
(101) F. B. Quinn (132) H. F. Garber (141) M. E. Wennermark
A. N. Loken, Chief Engineer
WESTDAHL
(39) L. D. Graham, In Charge

GUIDE - I. Approaches to and Strait of Juan de Fuca, Washington
II. North of Point Reyes, California.

(29) K. T. Adams, Commanding (51) II. Odessey, Executive Officer.
(72) G. L. Anderson (122) J. C. Mathisson (161) E. H. Sheridan
(93) J. C. Partington (127) A. N. Stewart F. Seymour, Chief Engr.
(103) H. J. Healy (130) J. N. Jones

EXPLORER - Tender: SCANDANAVIA - Behm Canal, Southeast Alaska

(30) E. W. Eickelberg, Commanding (58) H. C. Warwick, Executive Officer
(66) C. M. Thomas (115) H. O. Fortin F. L. Chamberlin, Chief Engr.
(81) R. C. Rowse (151) K. S. Ulm W. Weidlich, Mate

Shore Party - Combined Operations - San Francisco Bay.

(35) G. C. Jones, Chief of Party (155) H. C. Applequist
(38) L. P. Raynor H. G. Conerly, D. O.

Shore Party - Combined Operations - I. Bodega Bay to Point Reyes, Cal.
II. Halfmoon Bay, southward, Cal.

(94) L. C. Johnson, Chief of Party (121) E. B. Lewey
(133) K. B. Jeffers

PHILIPPINE ISLANDS

(16) J. H. Hawley, Director of Coast Surveys

PATHFINDER - North coast of Luzon Island.

(27) G. C. Mattison, Commanding (48) C. M. Durgin, Executive Officer
(40) M. O. Witherbee (80) J. C. Bose A. Hunnycutt, Chief Writer
(62) J. M. Smook E. C. Zimmerman, Chief Engr.
J. W. Wetzel, Surgeon

FATHOMER - East coast of Luzon Island

(33) J. Senior, Commanding (54) A. P. Ratti, Executive Officer
(77) E. A. Deily (100) E. R. McCarthy (126) R. C. Bolstad
G. W. Hutchison, Chief Engineer W. J. Leary, Surgeon

MARINDUQUE - Sulu Archipelago

(34) R. P. Eyman, Commanding (79) P. C. Doran, Executive Officer
(120) F. R. Gossett J. Wyer, Chief Engineer
(128) C. A. George M. F. Froyd, Surgeon

Reduction of Aerial Photographs

(45) 0. S. Reading, In Charge (99) B. G, Jones
(138) M. H. Reese

Coast Pilot - Alaska

(44) W. D. Patterson

GEODETIC PARTIES

First-order Triangulation - Wyoming and Colorado

(84) C. I. Aslakson, Chief of Party (98) I. T. Sanders
(87) W. F. Malnate (107) W. R. Porter

First-order Triangulation - Illinois, Iowa and Minnesota

(47) H. W. Hemple, Chief of Party
(53) C. D. Meaney, to relieve Lieut. Hemple late in season
(113) J. P. Lushene
(154) W. C. Russell

First-order Triangulation - California and Nevada

(96) John Bowie, Jr., Chief of Party
(89) F. G. Johnson

Signal Building in Iowa and Minnesota

J. S. Bilby, Chief of Party

Reconnaissance

Mid-west and South - Wm. Mussetter, Chief of Party
(91) R. L. Pfau
Washington, Idaho and Montana - (95) E. B. Latham, Chief of Party
Western United States - (112) C. A. Schanck, Chief of Party

Washington Office and Reconnaissance

(49) F. L. Gallen

Leveling

State of Washington
(67) Charles Pierce, Chief of Party
(162) R. H. Tryon
Minnesota and Iowa
(63) A. J. Hoskinson, Chief of Party
J. C. Bull, Junior Engineer
Maryland, Pennsylvania and New York
(90) W. M. Gibson, Chief of Party
Montana
(110) J. D. Thurmond, Chief of Party
(158) T. M. Price, Jr.
Southeastern Oregon and Nevada
(114) Curtis LeFever, Chief of Party
(134) John Laskowski
South Dakota
(119) G. R. Fish, Chief of Party
(160) A. L. Wardwell
Western Oregon
(123) H. J. Oliver, Chief of Party
(164) E. E. Stohsner

FIELD STATIONS

(9) F. H. Hardy, Seattle
(10) T. J. Maher, San Francisco
(13) R. F. Luce, Boston
(20) J. H. Peters, Honolulu
(21) E. R. Hand, Porto Rico
(25) H. A. Cotton, New York
(32) R. L. Schoppe, New Orleans