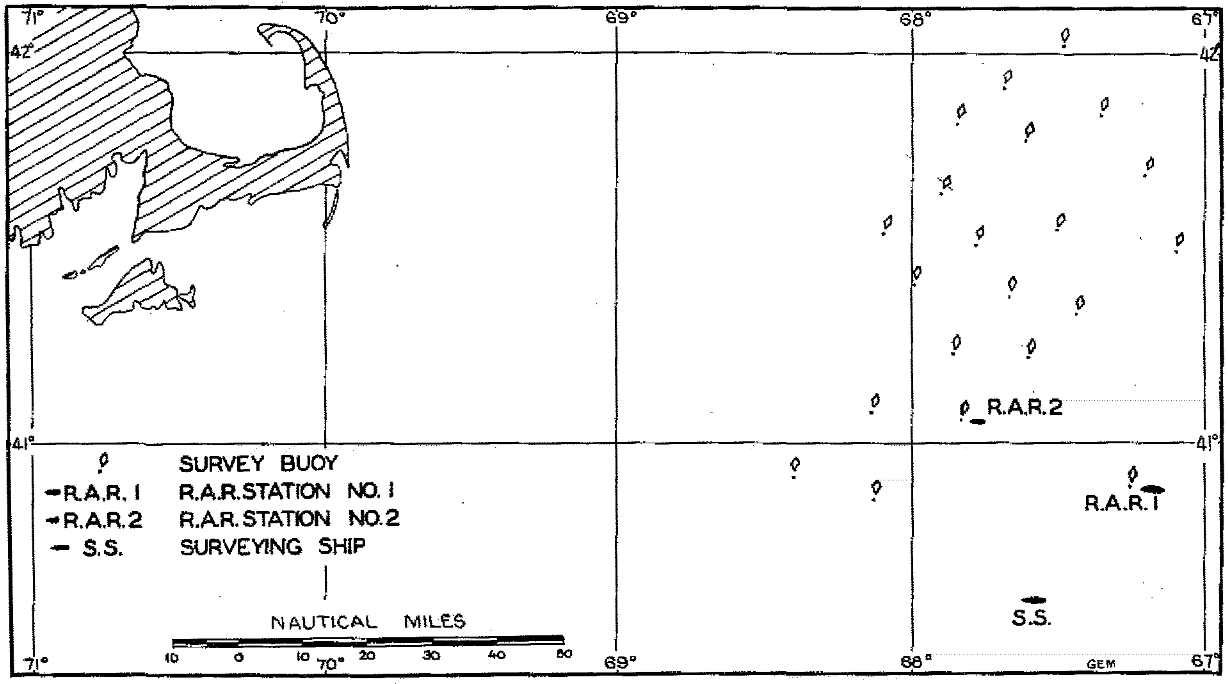
ASSOCIATION
OF
FIELD ENGINEERS

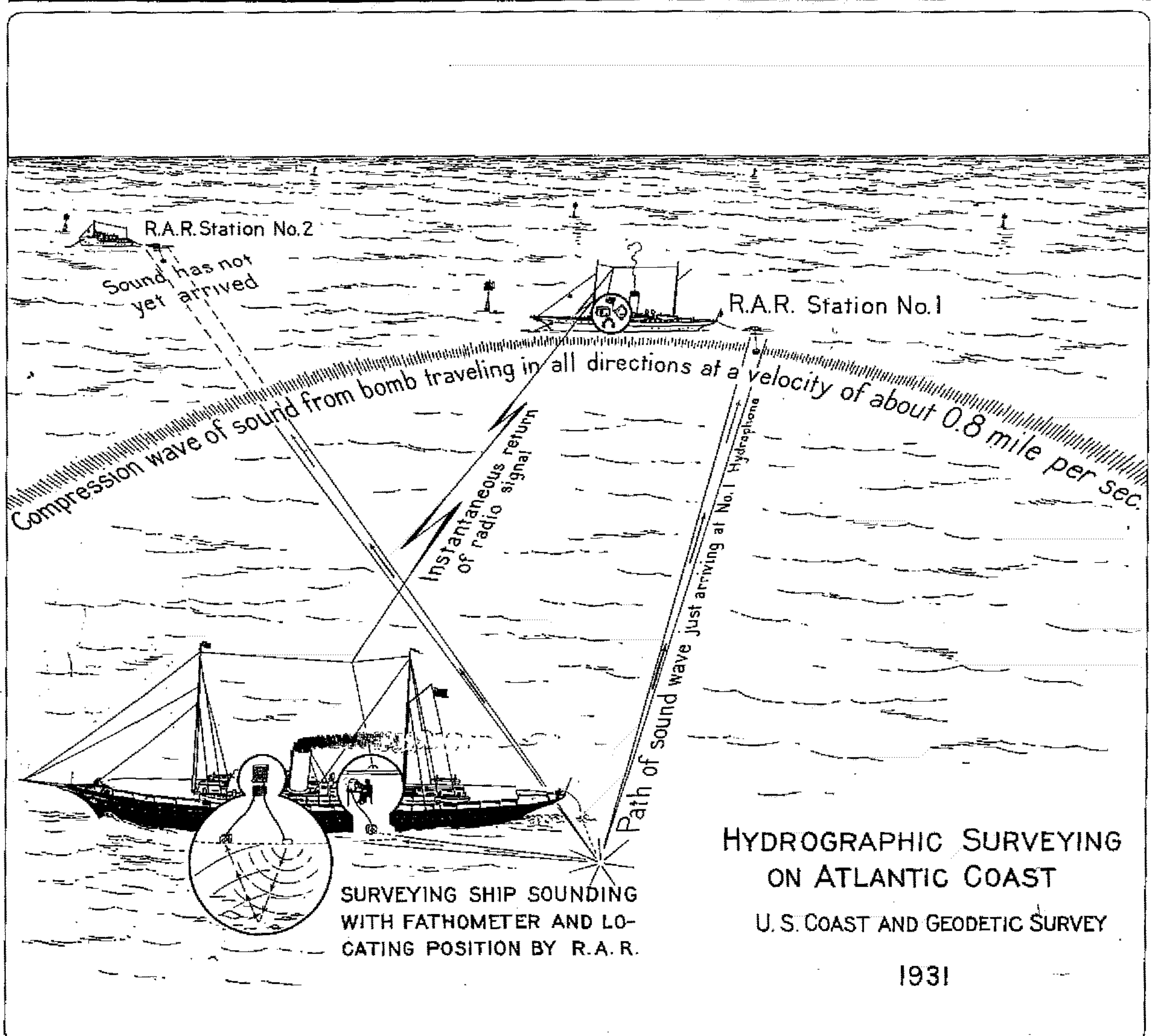
U.S. COAST & GEODETIC SURVEY

BULLETIN

DECEMBER 1931

No. 4


71°
70°
69°
68°
67°
42°
41°
R.A.R.2
R.A.R.1
S.S.
SURVEY BUOY
R.A.R. 1 R.A.R. STATION NO. 1
R.A.R. 2 R.A.R. STATION NO. 2
S.S. SURVEYING SHIP
NAUTICAL MILES
10 0 10 20 30 40 50
GEM


R.A.R. Station No. 2
Sound has not yet arrived
R.A.R. Station No. 1
Compression wave of sound from bomb traveling in all directions at a velocity of about 0.8 mile per sec.
Instantaneous return of radio signal
Path of sound wave just arriving at No. 1 Hydrophone
SURVEYING SHIP SOUNDING WITH FATHOMETER AND LOCATING POSITION BY R.A.R.
HYDROGRAPHIC SURVEYING ON ATLANTIC COAST
U. S. COAST AND GEODETIC SURVEY
1931

C.&G.S. 419

THIS BULLETIN CONTAINS

THE FIRST HUNDRED AND FIFTEEN YEARS

R. S. Patton
Director, U. S. Coast and Geodetic Surrey
(Extract from the Director's Annual Report to the Secretary of Commerce for the fiscal year 1931)

The submission of its one hundredth annual report must be an interesting event in the career of any organization. Actually, the Coast and Geodetic Survey is more than a century old; its centennial was celebrated in 1916. The present anniversary therefore can be only of passing interest. It does, however, justify a brief backward glance, if for no other purpose than to determine what guidance for the future can be drawn from the experiences of the past.

During the past century the Coast and Geodetic Survey has had its vicissitudes. Adequate performance of the main task assigned to it has been rendered difficult by the fact that over the greater part of the period this Nation as a whole has not been ship minded. With the passing of the clipper-ship era, and the subsequent concentration of the Nation's energies on the development of our great interior domain, the national vision of the American flag upon the high seas, of American commerce carried in American bottoms, became obscured to an extent from which recovery is not yet complete.

This popular attitude made the bureau's task an up-hill struggle in which progress was usually less than the situation required. Our territorial waters contain far too many rocks and shoals named for unfortunate vessels which were wrecked on them, because this bureau had not gone there earlier with the surveys which would have located them in a far more orderly and economical manner. Fortunately, the past decade has witnessed a marked improvement in this respect, and the situation to-day is better than at any time during the latter half of the century.

As we study the Coast and Geodetic Survey itself, we note two characteristics which have been outstanding over the whole period of its existence.

The first relates to the high concept of fidelity and integrity adopted as the initial standard for its work, and which has since been scrupulously adhered to through all vicissitudes. In that distant period when the Coast Survey was being launched on its mission of public service, surveying in this country was a crude art, limited almost entirely to the delineation of property boundaries. Land was plentiful and money scarce, and the property owners of that day could not afford to pay the cost of accurate surveys even had methods of making them been available. Surveying, therefore, was little more than a formality to give a rough approximation of the area of a tract of land, and to aid in the recovery of certain physical marks on the ground so long as those marks remained intact; but too crude to serve in reestablishing the marks if they became totally obliterated.

When we recall this then prevailing attitude toward surveying, we realise how remarkable it was that the first Superintendent of the Coast Survey, Ferdinand Hassler, could have conceived of the unprecedented program which he proposed, and above all that he could have brought about its adoption. That program was for a survey of the entire coast; to be executed piecemeal, it is true, but executed with such accuracy, continuity, and fidelity, and with the whole held fixed by a precise framework of geodetic control, so that every part would fit accurately into each adjacent part. It was to be a survey of such breadth of conception and fidelity of execution that in appropriate parts it would serve not merely the limited purposes of the immediate present, but also the broader and more exacting needs of a distant future. It embodied an ideal of service which would stand the test of time.

Throughout the years the bureau has held steadfastly to that ideal. That which has been done at all has been done thoroughly. If sacrifices have been required, they have been made in the volume of results accomplished, not in the quality of that which was done. On the other hand, in the practical, day-by-day application of an ideal which might be carried to extremes, the bureau has kept its standards sane and reasonable. It has realized the distinctions between, the superaccuracy and refinement which are theoretically possible and the more reasonable attainments which are economically justifiable. It has endeavored to be alert and progressive without being radical.

The second outstanding characteristic is a corollary to the first. That which has just been described can be summarized by the statement that the Coast and Geodetic Survey has at all times attempted to maintain its work on a firm scientific basis. Naturally, therefore, it has also attempted to maintain a proper relationship to those branches of science upon which its work impinges. Through that relationship it has both contributed to science and received from science.

The bureau's contributions to science have been mostly incidental by-products. There seems to be an unwritten law to the effect that the Federal Government shall not engage broadly and avowedly in scientific research. Such research is undertaken from time to time, but it always has as its objective some definite, limited, utilitarian purpose. The bureau's penetrations into scientific fields have been of this character, and the resulting benefits to science have been of two kinds: (1) Accumulations of precise data made available to scientists outside the Federal service for studios which have opened the door to new truths; and (2) occasional studies of such data by bureau personnel, through which similar scientific progress has been attained. For example, the Coast and Geodetic Survey has devoted years to observing the rise and fall of the tides at hundreds of points along our coasts in order that the mariner may make practical use of the data thus obtained, yet the same data have been studied in the Survey office and from them have been derived the now generally accepted theories explaining the tidal phenomena. The bureau has studied terrestrial magnetism in order that the mariner and the surveyor may have knowledge of the extent to which from time to time, and from place to place, the compass needle deviates from true north. The data collected as a basis far these studies have proved invaluable to scientists is the great research laboratories of the Nation studying problems of radio transmission and related matters. The geodetic data obtained in the course of the Survey's work have contributed much to the better determination of the size and shape of the earth, The Survey measures the force of gravity at hundreds of points throughout the country as a necessary part of the triangulation by which it gives to the engineer accurate distances between points on the earth's surface, yet the gravity determinations have had important additional values in enabling geophysicists to arrive at a better knowledge of the constitution of the earth. To serve the mariner the bureau has measured the depths of the coastal waters and studied their circulations. The precise and detailed information thus accumulated is of material value to the broad science of oceanography.

The principle underlying this relationship to science has been a constant realisation by the Coast and Geodetic Survey that the results of its labors had important collateral values additional to those inherent in their primary purpose, and the bureau has always been zealous that these additional values be utilized to the fullest possible extent. This zeal has had an important reaction which along has fully justified the relationship. By reason of the resulting close contact with scientific progress the bureau through the years had adapted to its own purposes a long series of scientific achievements which enabled it to do more and better work at steadily decreasing unit costs. Much of the work accomplished to-day is done at unit costs undreamed of 30 years ago, in spite of the great increase in the cost of labor and materials. The men in the service to-day probably are no more industrious and faithful than were their predecessors of the earlier period. If they accomplish more, it is principally because they have better facilities with which to work; facilities which they could not have had to the same extent had they failed in appreciation of this scientific relationship.

Finally, this relationship is in part the cause and in part the effect of a high service morale which has been of untold practical value. In a service charged with the execution of tasks requiring many years for their accomplishment, there is always danger that the personnel will dig themselves into a narrow rut in which performance becomes stereotyped and perfunctory, methods and processes ossify to a seriously inefficient obsolescence, and the service becomes unresponsive to changing public needs. Therefore, within reason, any influence which widens the horizon, inspires alertness and enthusiasm, and helps to keep the service in step with national progress is to be welcomed.

The Survey's contacts with science have had that effect. While it is true in part that the contacts have existed because of the existence within the service of the desirable characteristics named, it is equally true that the contacts have been a powerful factor in sustaining and strengthening those characteristics. Action and reaction are equal here, as elsewhere, and can be dismissed as such. The important fact is that without this mutually beneficial relationship the Survey could not have attained to the position of useful service which it now occupies, and the Nation, not the bureau or science, would have been the principal loser.

The profit to be derived from this review is obvious. The Coast and Geodetic Survey, in spite of its age, is young and vigorous to-day because throughout the years it has kept before its mind's eye a vision of useful service to be performed; a vision so inspiring as to exact from one generation after another the best which each could give, Preservation of that vision undimmed is essential to equal usefulness in the years to come.

# #

UNITID STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

September 1, 1951,

The Director,
U. S. Coast and Geodetic Survey.

Dear Sir:

The Geological Survey acknowledged, with thanks, receipt of your letter of August 22, File No. 60-BJ, in which you state that a satisfactory plan has now been worked out whereby the U. S. Coast and Geodetic Survey engineers in charge of field work may know specifically what connections between work of this Survey and that of the U. S. Coast and Geodetic Survey will best meet the needs of the topographic branch. These ties to Geological Survey work will obviously reduce the cost of field work of this Survey and will make it possible to advance the work of topographic mapping with much greater rapidity.

The cooperation of the U.S. Coast and Geodetic Survey in the past has proved of inestimable value to the Geological Survey, I trust the execution of the aforementioned plan will not interfere materially with the present field practice of the U. S. Coast and Geodetic Survey. Your courtesy in this matter is appreciated.

Yours very truly,

(Signed) Julian D. Sears
Acting Director,

LEVELING COOPERATION IN OREGON

Lewis A. McArthur
Secretary, Oregon Geographic Board

Officers of the U. S. Coast and Geodetic Survey may be interested in what is being done in the state of Oregon toward improving the type and frequency of bench marks, elevations of which are established by spirit leveling. During the field seasons of 1930 and 1931 a great deal of this work was carried on in such a way as to dovetail with the leveling operations of the Coast and Geodetic Survey in Oregon, and as a result of these activities, the first-order level net of the state will not only be intensified in so far as mileage is concerned, but the newer work will be so much better than the older work from the point of density of marks that comparison would almost be odious.

As most of the officers know, the leveling itself is but a means to an end. The bench marks are the only tangible results that are left for the use of the public, and unless these bench marks are of a permanent character and placed in positions where they will be of greatest use to the public, the work falls short of the ideal.

About ten years ago the writer became interested in the matter of developing the level net of the state. He enlisted the interest of certain members of the Oregon State Highway Department and also of the engineering departments of a number of railroads. Representatives of various power companies also became interested in the problem, as well as some city and county officers. One of the first tangible results of the work was the adoption by two of the largest power companies in the state, to wit, Portland Electric Power Company and Pacific Power and Light Company, of a standard type of bronze bench mark disk similar to that used by the governmental bureaus. The Oregon State Highway Department shortly thereafter adopted a standard bronze disk bench mark, and this act was followed by a similar one on the part of the State Engineer. State Engineer bench marks are primarily intended to be installed in permanent locations near stream gauging stations so that in cases where a gauge is disturbed it is possible to replace the staff at the original elevation.

Other organizations in Oregon which have adopted permanent disk type bench marks include the U. S. Forest Service, the U. S. Bureau of Public Roads, the U. S. Engineers, Clackamas County Roadmaster, and the city of Portland. As a result of all this activity on the part of various organizations it becomes apparent that when leveling is to be carried on in Oregon it is of great importance to get a complete list of all bench marks that may have been established adjacent to the proposed level lines. The results of first-order levels are so valuable that it is to the interest of all organizations to have their bench marks turned on during the course of the work. It is obviously a great advantage to have elevations established for all marks which may previously have been set, where the work of connecting does not involve running more than a few hundred feet from the main route of travel.

The Oregon State Highway Department has set a large number of permanent bench marks. Its standard specifications call for at least one bench mark in every substantial concrete structure, and in the case of long bridges, bench marks are generally set in both ends. These marks are used by the bridge engineer's division as a basis for taking the cross section of the channel of the stream each year to see to what extent piers and abutments may be threatened or undermined, OSHD bench marks are also used to a great extent by resident engineers in connection with addition and betterments to existing highways, and also in designing new highways, particularly county market roads.

Modern transmission line construction requires in many cases that profiles be prepared before supporting structures can be located and designed. Accurate levels are almost a necessity for good transmission lines, especially in rough territory. Besides this, federal and state regulations require accurate determinations of dam and powerhouse elevations. The two power companies mentioned above have adopted as standard practice a requirement that all permanent structures be provided with bench marks, even though it may not be possible to provide sea level datum elevations for the marks at the present time.

Various governmental bureaus, such as the Forest Service and the Geological Survey, of course, require benchmarks for mapping purposes. The Bureau of Public Roads has found it necessary to monument many of its highway projects with concrete posts, which serve as alignment and right-of-way monuments as well as bench marks.

The existence of a considerable number of permanent marks previously established by other organizations adjacent to proposed new level routes is,of course, something which should be called to the attention of the U. S. Coast and Geodetic Survey officers who are in charge of the new work. Obviously, it would be a difficult matter for the Washington office to got in touch with all the various organizations in the field to determine in advance where marks have been installed. The Oregon Geographic Board has, therefore, made it a practice of keeping a file on all the old work so that when a new Coast and Geodetic Survey line is in contemplation a list of existing marks may be made up and turned over to the proper officer.

Besides all this there are many cases where local organizations in Oregon have found it desirable to install additional disks along proposed Coast and Geodetic Survey routes. Some of these organizations may be planning work to be carried on in the next two or three years, and by securing the establishment of an elevation near the starting point much future labor will be saved. During the past two or three years the Oregon State Highway Department and the U. S. Forest Service have set permanent bench marks along proposed Coast and Geodetic Survey routes without determining their elevations. These marks have been installed as the basis of future operations. The net result of these activities has been that the Coast and Geodetic Survey level circuits in this state on which the field work has been done in 1930 and 1931 show a much higher frequency of bench marks than is the case in the older work. An example may he cited by way of comparison of the U. S. Coast and Geodetic Survey line extended from Klamath Falls to Ontario in 1920. This line is approximately 439 miles long and it determines the elevations of 177 permanent bench marks, most of which were set at the time the line was run, although a few older marks are included in the total. This provides a frequency of .4 bench mark to the mile, or, putting it the other way around, there is a bench mark every 3.5 miles.

In 1930 four different lines were run in this state, with an average mileage per permanent bench mark of .93, 95, .98, and 1.03 or, for all practical purposes, a bench mark for each mile of line. A comparison between this work and the 1920 work needs no comment. Further, it should be said that the character of the marks on the new work is much more substantial, so that not only has the frequency been increased to about two and one-half times that of the older line, but also the marks on the new work will, in all probability, have a much longer life.

Officers of the Coast and Geodetic Survey may be interested in some notes that the writer has made in respect of suitable locations for bench marks. Among the suggestions that occur are the following:

Situations near hotels are desirable from a point of view of advertising and public policy. It is frequently possible to put a disk at the entrance of an important hotel without much extra work. A large percentage of the traveling public now goes by automobile and does not have an opportunity of seeing bench marks at railroad stations. Generally speaking, modern hotels have suitable locations for the installation of disks.

The same suggestion may be made in respect of post offices, even when they are in rented structures. Here again a suitably installed disk is an excellent type of advertising.

The writer feels that perhaps more attention should be given to the matter of junction points with old lines. It is believed that in cases where the older work antedates the new work by as much as ten years, one new permanent mark should be installed, irrespective of the conditions of the older marks. In many cases the most suitable new location is in the most modern and up-to-date building in the community. It is obvious that if a new line is started from old work where two marks are already installed in old structures, certainly these should be fortified with one new mark in a modern building. The old marks can not have the expectancy of life a new mark will have, especially since the art of concrete construction has developed so rapidly during the last decade and has to a great extent supplanted brick and stone.

In the western states bench marks in bedrock certainly have a long expectancy of life. Experience in Oregon indicates that the bedrock bench marks have much less mortality than any other type, and in most of the Western states, bedrock is frequently available.

Iron post bench marks should be reinforced wherever possible by casting about the post a quantity of concrete, approximately equal to the bulk of one of the new type concrete posts used by the Coast and Geodetic Survey. If an old mark is worth redetermination, it is certainly worth perpetuation. In this section of the United States it is apparent that iron posts that have been in the ground upward of 25 years can not have much expectancy of life.

The old type iron post did not present sufficient cross section to withstand severe treatment from heavy truck wheels, especially when the ground is soft from winter rains. A heavy truck will knock an iron post out of plumb with but slight impact. A substantial concrete jacket will convert an old iron post mark into a permanent installation, especially since the iron will provide a substantial reinforcement. The concrete jacket should extend below the frost line. Incidentally, the appearance of the old iron post above the ground line is no indication of actual conditions below the surface. Frequently the tops look fine, but further inspection will disclose almost complete corrosion a couple of feet below.

There is an ever-present tendency to widen existing highways, If possible, posts should not be set on the insides of curves, nor in localities where it is obvious that material will be borrowed to widen the roadbed. Furthermore, the posts should not, as a general thing, be established in the vicinity of crossroads or other places where subsequent improvement will call for enlargement of curve connections to crossroads. The enlargement of crossroad connections is apparently increasing. Besides this, the establishment of filling stations at important intersections has destroyed many bench marks. It is suggested that permanent marks should not be instilled in roadside posts within 500 feet of important intersections.

The tremendous educational value of bench marks in schools certainly should not be overlooked. Principals and teachers are beginning to know much more about bench mark disks and these marks are frequently discussed in geography and physical geography classes. It is often possible to utilize a school bench mark as a basis for a short talk to school children about the importance of such marks in general and call attention to the fact that they should never be disturbed or destroyed.

The Boy Scout movement has an important bearing on bench marks. The writer has been able to utilize Boy Scout troops on several occasions in the work of checking up descriptions of bench marks set many years ago. Very frequently a troop of Boy Scouts can run down and redescribe these marks in less time than it would take an adult to do it. Since a great many Boy Scout meetings are held in schools, this furnishes an additional incentive to, establish bench marks in school buildings.

Another thought in connection with bench marks in the arid parts of the west comes to mind after inspecting a series of marks set very close to the banks of a small stream. It probably did not occur to the bench mark setter who installed these marks in a dry summer that the stream might ever get out of its banks. In this particular section there was native rock available for the entire distance which could have been reached with probably one extra set-up at each post. Besides winter floods, many sections of the western states have cloudbursts, and posts set near creek bottoms will not last long under these conditions. In addition, frost is much worse in these low, moist sections.

The writer suggests the installation of marks in pairs, say, not more than .25 mile apart. Engineers are urged to start from two marks, yet there are many cases where this is impracticable. An engineer doing a small amount of leveling can not ordinarily be expected to run back three miles to a check point. If the Coast and Geodetic Survey's standard installation could provide for standard marks approximately once every two miles with these marks installed in pairs, it would, in the opinion of the writer, greatly increase the usefulness of the marks, and also make possible the future rehabilitation of destroyed marks with much less work.

It is the belief of the writer that the cooperative plan now being utilised in Oregon might be put into effect in other states in the Union with great benefit to all concerned. It seems probable that the Coast and Geodetic Survey could get in touch with interested persons in many communities who would be only too glad to correlate the various agencies that should be so vitally interested in this important work.

# #

CONTRACT SIGHED FOE SURVEY VESSEL

From Pacific Marine Review, July, 1931

Formal contract was recently signed by the Canadian government and the Collingwood Shipyards, Ltd., Collingwood, Ontario, for the construction of a hydrographic survey vessel to be 214 feet between perpendiculars, 36 feet beam. She will have twin screws propelled by triple expansion steam engines developing 1200 indicated horsepower. Steam will be supplied by two Scotch boilers. The vessel will have a speed of 12 knots loaded.

(We are glad to learn that this fine new ship is to be fully equipped for R.A.R. work)

SOME RESULTS OBTAINED IN THE READJUSTMENT OF THE TRIANGULATION IN THE EASTERN HALF OF THE UNITED STATES

Dr. O. S. Adams
Senior Mathematician, Division of Geodesy,

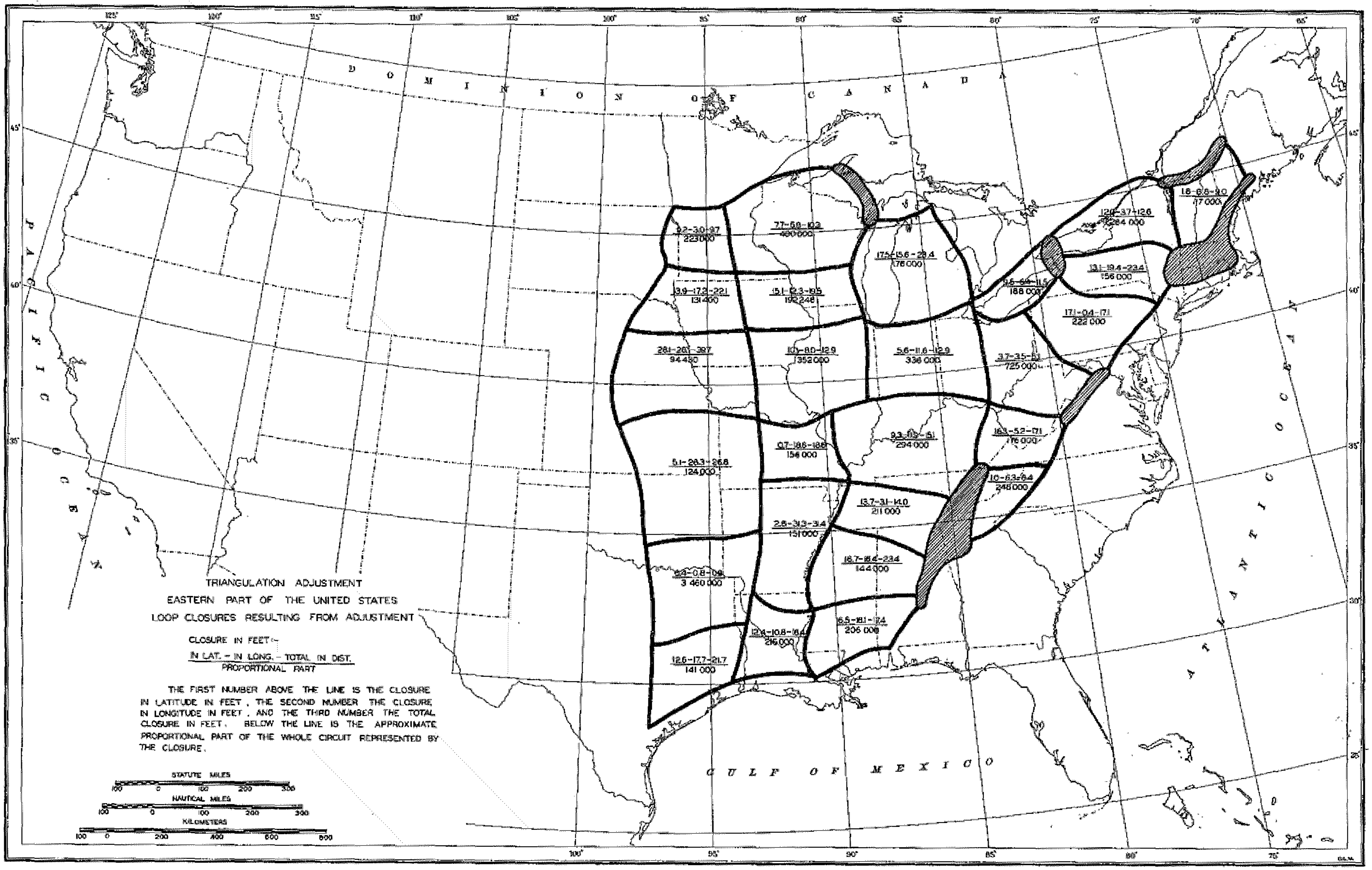
The readjustment of the triangulation in the western half of the United States by the Bowie method was completed in 1929. Plans were at once made for the application of the same method to the first order work lying east of the 98th meridian arc. It was planned to hold this arc as fixed in the western adjustment. The complete scheme includes arcs of the U. S. Lake Survey and an arc of triangulation of the Geodetic Survey of Canada extending from Lake St. Clair to the northwestern boundary of Maine.

In this comprehensive network of arcs it was necessary to establish 29 junction figures and 55 sections of arcs. In New England and also in the southeastern states it was necessary to adopt rather extensive junction figures due to the complicated nature of the triangulation in those regions. The arcs of this adjustment form a network that consists of 36 closed loops. The figure shows the closures that were found in these loops after the preliminary adjustments.

The work on the preliminary adjustments has been in progress during the past two years with varying number of men assigned to the sections. In a number of the arcs the field work was in progress and these could not be adjusted until the final records were obtained in the office. The field work on the last of these arcs was completed about July 1 of this year. In the first week in October the preliminary adjustments were finished and the positions in the junction points were determined.

In the figure are shown, expressed in feet, the loop closures in latitude and in longitude, with the total closure and the proportional part of the length of the circuit that this closure represents. The resulting closures are not quite as good as those found in the western net but there are two reasons why this should be so. In the first place, the circuits are smaller and hence the chance for balancing of errors is not as great. In the second place, those circuits with one side on the 98th meridian arc had to have the closure adjusted into the remaining sides since this arc is held fixed.

Field work is now in progress for a first order arc extending from Massachusetts and Rhode Island down the Atlantic Coast to Florida and thence-westward to Mobile. In addition, a number of cross arcs from this new work to join the oblique arc at various places will be observed. This new work will then be adjusted into the network as determined by the present adjustment. It is expected that this work will be completed within the next two or three years. This will give excellent control for the second and third order triangulation that is already in existence in the immediate neighborhood of the coast.


TRIANGULATION ADJUSTMENT
EASTERN PART OF THE UNITED STATES
LOOP CLOSURES RESULTING FROM ADJUSTMENT
CLOSURE IN FEET:-
IN LAT. - IN LONG. - TOTAL IN DIST.
PROPORTIONAL PART
THE FIRST NUMBER ABOVE THE LINE IS THE CLOSURE IN LATITUDE IN FEET, THE SECOND NUMBER THE CLOSURE IN LONGITUDE IN FEET, AND THE THIRD NUMBER THE TOTAL CLOSURE IN FEET. BELOW THE LINE IS THE APPROXIMATE PROPORTIONAL PART OF THE WHOLE CIRCUIT REPRESENTED BY THE CLOSURE.
STATUTE MILES
NAUTICAL MILES
KILOMETERS
DOMINION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO

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In the eastern adjustment is included a continuous arc of triangulation along the Mississippi River from New Orleans to Cairo, Illinois. Then from that point to St. Paul, Minnesota, a new first order arc has been completed just recently and this work is being adjusted to fit into the network as given by this present adjustment. This means that for the first time adequate first order control will be found throughout the total length of the Mississippi River, To this control the second and third order work along the River will be adjusted so that all of the control will be on one datum and everything will be perfectly consistent.

In deference to the wishes of the International Boundary Commission, United States and Canada, and to the Geodetic Survey of Canada, an agreement has been reached to hold fixed the Buffalo-Trenton arc and to make a supplementary adjustment of junction positions in New England including the Canadian arcs to the northward and eastward. This will be done in cooperation with the Geodetic Survey of Canada and will result in a completely coordinated net with the inclusion of all the Canadian first order arcs that are completed in that section. The Canadian arcs joining on the western half of the country have already been coordinated in the Worth American Datum of 1927 and this present work will put the two countries on a completely unified system. This is a most satisfactory condition for both countries and is one that is absolutely needed for the Boundary Commission. A unified datum is the only solution where it is necessary to use control from different arcs, and this has to be done in fixing the boundary between the United States and Canada.

# #

Extract from "Surveying and Mapping Methods" by Lenvik Ylvisakeor, Engineer, U. S. Engineer Office, St. Louis. CIVIL ENGINEERING, December, 1931.

* * * * detailed requirements as to the accuracy and presentation of the map sheets were stated in the specifications as follows:

"Map sheets shall be prepared on a polyconic projection at a scale of 1:12,000'.* * * * The horizontal positions of all features shall be shown on the North American datum and all elevations referred to Gulf level.* * * * All features shown on the maps shall be located with such accuracy that no error is measurable to the scale of the map."

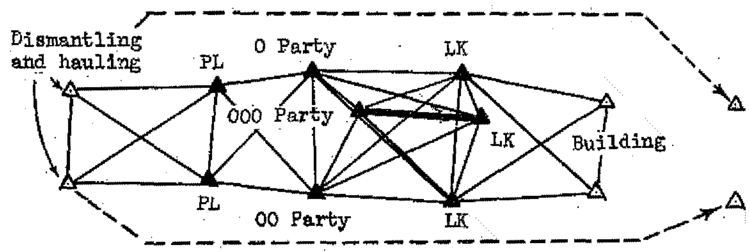
One successful feature of the winter work was sounding through the ice, using ice augers to drill holes for the sounding lines, * * * * Aerial photography was utilized by the contractor as a basis for all mapping. Cultural features were transferred from the photograph to field boards and topography was sketched in the field by the plane table method. The triangulation stations along the river, established by the Mississippi River Commission, were used for primary horizontal control. * * * * A significant fact developed was the inability of the contractor to economically utilize the charts of the former survey in reducing the amount of field work.

FIRST ORDER TRIANGULATION

P A R T Y   O P E R A T I O N S

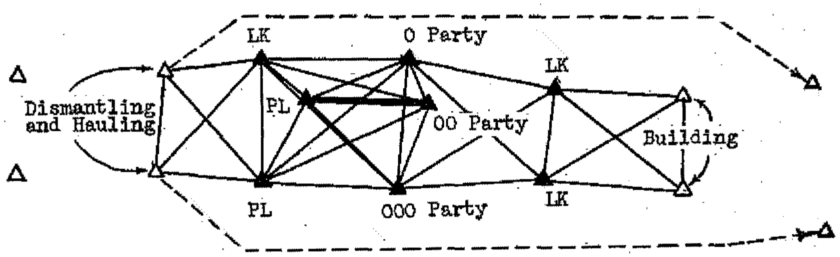
Double Units

Operations Completed March 10th



Approximate distance: 50 miles

Operations Completed March 11th



These diagrams show the daily movements of all units of a double first order triangulation party using steel towers. They also show how the use of a third observing party (000 Party) will save a day in such figures as the base net, and central points.

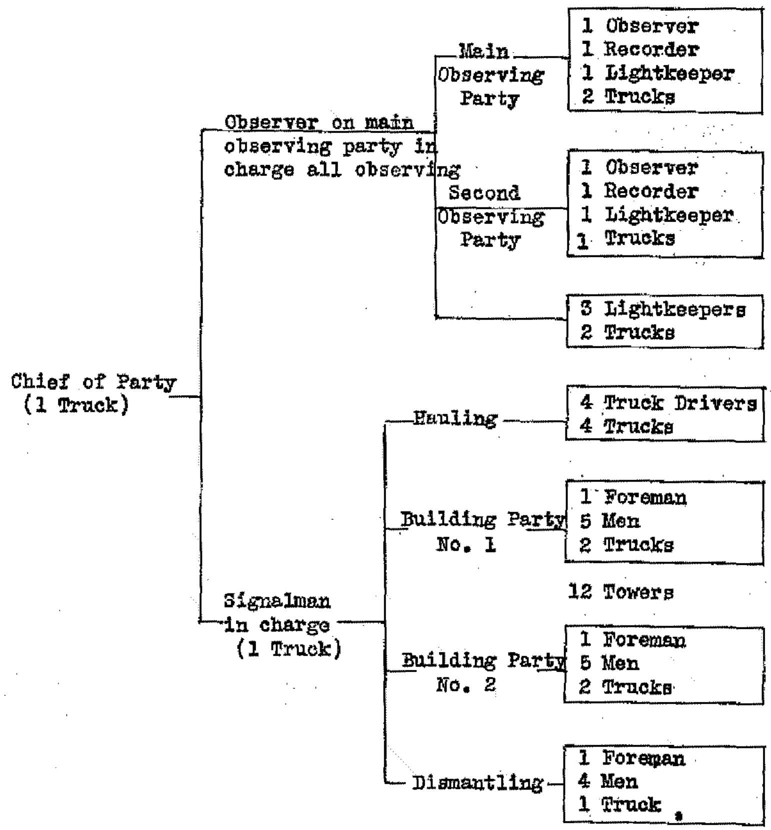
0 Party is the main observing party; 00 Party is second observing party; LK represents lightkeepers; PL indicates stations on which lights have been posted.

Stations in solid black are stations in actual use by the observing parties.

P A R T Y   O R G A N I Z A T I O N

Double Units

For 116 ft. towers and higher



Total Personnel including Chief of Party	32
Total Number of Trucks	16
Total Number of Towers	12

FROM SEASON'S REPORT OF PAUL A. SMITH 1930-31

C.&G.S.-419

PROGRESS ON THE GEORGES BANK PROJECT

Prepared in the Division of Hydrography and Topography.

Field work on the Georges Bank project, started in 1930 by the parties on the LYDONIA and OCEANOGRAPHER, was resumed the latter part of May, 1931, by the parties on the HYDROGRAPHER, OCEANOGRAPHER, LYDONIA and GILBERT and continued until the latter part of September.

Approximately one-third of the Bank proper was surveyed during the season. This included large areas having depths less than 20 fathoms. These were found to have extremely irregular bottom and required close development. It is estimated that one more season will be required to complete the project.

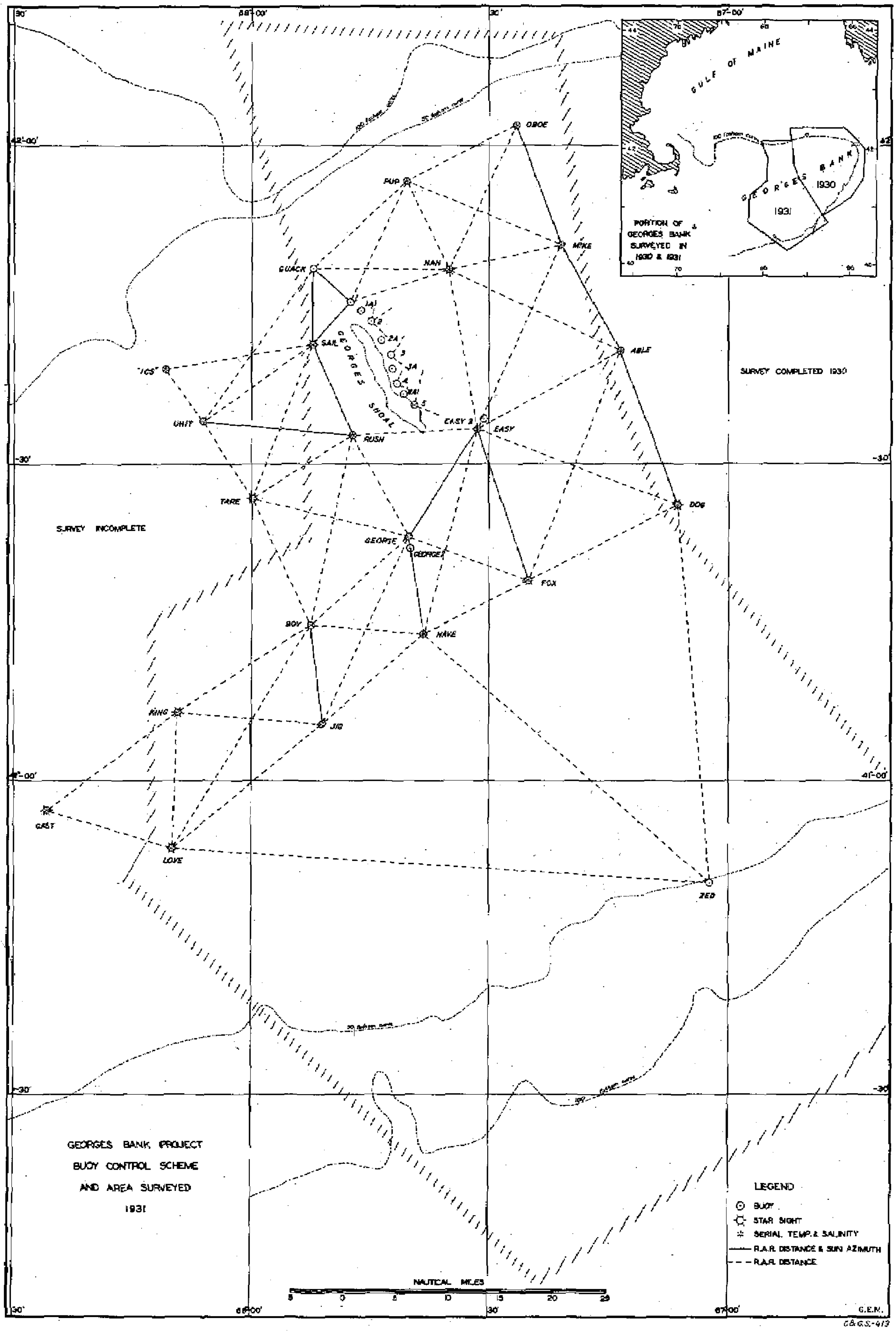
In general, the LYDONIA and GILBERT served as magnetophone station ships while the HYDROGRAPHER and OCEANOGRAPHER did the sounding. The one exception to this program was the survey, by the GILBERT, of Georges Shoal which was considered dangerous territory for the deeper draft ships.

While serving as magnetophone stations, the LYDONIA and GILBERT accumulated a large amount of current, astronomical, water temperature, salinity and weather data, which will prove useful in a study of this important region and will undoubtedly assist in the further development of offshore survey methods.

Several submarine valleys, lying in the track of trans-atlantic shipping, were found along the edge of the Continental Shelf. The outline of one of these, which is considerably larger than "Corsair Gorge", discovered during the 1930 season, is shown on an accompanying plate. Illustrating the report of Lieutenant-Commander Adams on the "Echometre", in this issue of the bulletin, is shown a copy of the actual record made on the French Line S.S. DeGRASSE when crossing westbound over this feature.

Urgent requests from fishing and shipping industries for early information concerning the results of the season's work prompted the making of a preliminary print which was compiled directly from the boat sheets of the field parties. This print, considered as a "Notice to Mariners", was available for distribution in about two months after the close of the field season. Copy of a section of the print is included in this bulletin.

With the exception of the survey of Georges Shoal by the GILBERT, where hand lead and three-point visual fixes on floating signals were used, practically all of the soundings were by fathometer and were controlled by R.A.R. distances from the two floating magnetophone stations. On one occasion more than 500 miles of fully controlled, fathometer sounding lines were run in 24 hours of continuous fog.



GEORGES BANK PROJECT
BUOY CONTROL SCHEME
AND AREA SURVEYED
1931
GULF OF MAINE
GEORGES BANK
1930
1931
PORTION OF GEORGES BANK SURVEYED IN 1930 & 1931
100 fathom curve
SURVEY COMPLETED 1930
SURVEY INCOMPLETE
GEORGES SHOAL
OBOE
PUP
MIKE
QUACK
NAN
ABLE
SAIL
"ICS"
UNIT
RUSH
EASY 2
EASY
TARE
DOG
GEORGE
GEORGE 2
FOX
BOY
NAVE
KING
JIG
CAST
LOVE
ZED
1A1
2
2A
3
3A
4
4A1
5
42°-00'
41°-00'
-30'
68°-00'
67°-00'
30'
LEGEND
BUOY
STAR SIGHT
SERIAL TEMP. & SALINITY
R.A.R. DISTANCE & SUN AZIMUTH
R.A.R. DISTANCE
NAUTICAL MILES
5 0 5 10 15 20 25
G.E.N.
C.&G.S.-413

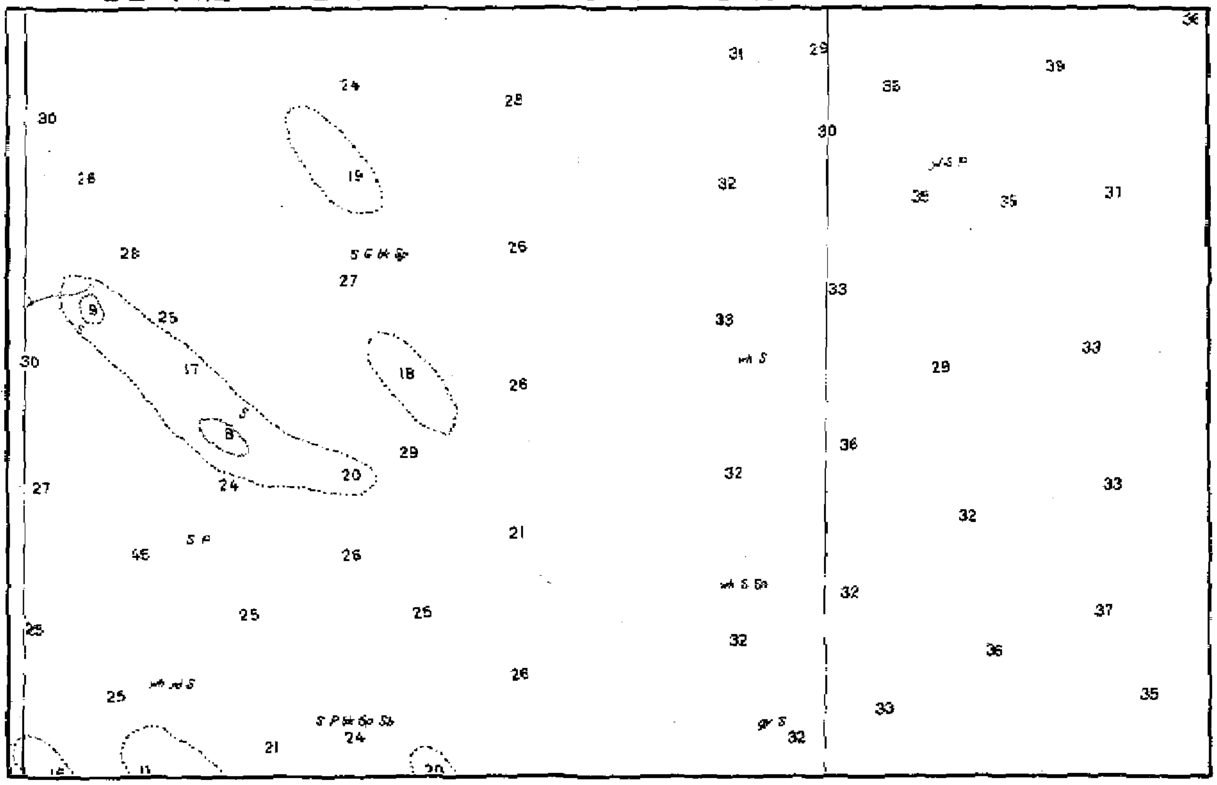
The R.A.R. triangulation scheme which fixed the positions of the magnetophone stations was carried westward from buoy ABLE, the position of which was carried over from the previous season, to buoy CAST - a distance of 70 miles. The latter buoy was planted by the U. S. Lighthouse Service and will serve to carry position to next year's work. Astronomical sights taken in the vicinity of CAST indicate that the true position is somewhat to the westward of the position computed through the scheme. The evidence is not sufficiently conclusive, however, to warrant stretching the scheme. Any adjustment in this respect, found necessary after next year's work, can readily be made by changing the scale of the sheets.

An accompanying plate shows the scheme of R.A.R. triangulation. The individual quadrilaterals were adjusted for closure under the supervision of Lieutenant-Commander G. D. Cowie by the equal area method developed by Dr. O. S. Adams. This method is described elsewhere in this bulletin and is accompanied by the complete adjustment of one of the figures in the 1931 scheme. The adjustment did not change any length of any side in any of the quadrilaterals by more than 35 meters, thus giving considerable weight to the accuracy of the bombed distances.

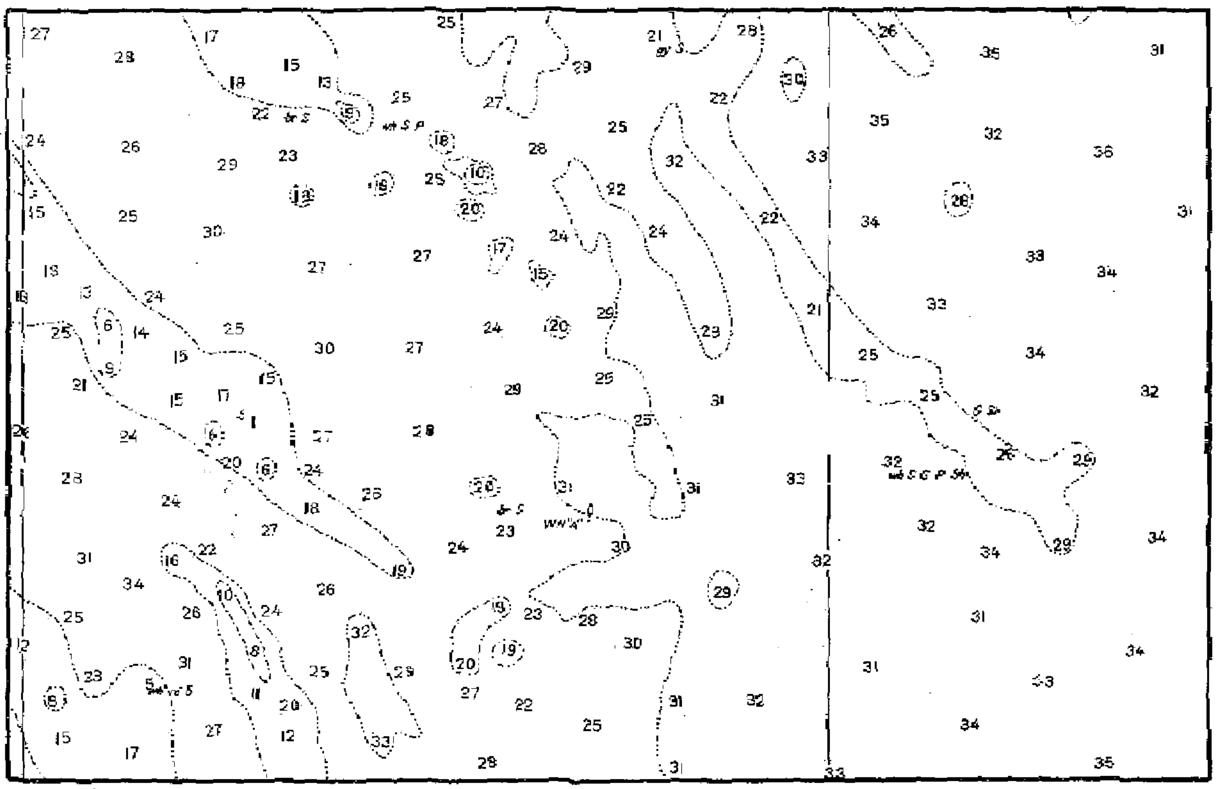
Frequent celestial azimuths were obtained through the scheme. To have attempted to hold each of these fixed would have necessitated changing the angles resulting from the length adjustment and would have required a very complicated and unwarranted adjustment. Consequently, the main scheme was first computed through as a traverse holding (1) the adjusted lengths, (2) the angles resulting from the adjusted quadrilaterals, and (3) the mean of three azimuths which happened to have been observed in one quadrilateral. All of the observed azimuths in the scheme were then compared with the corresponding computed azimuths and the entire scheme swung by the resulting algebraic mean of the differences. This amounted to about 7 minutes. The main scheme was then recomputed as a traverse by way of ABLE-EASY-GEORGE-BOY-KING and CAST, while stations DOG-FOX-JIG and LOVE on the south side of the scheme were computed as branches from this traverse using the mean of the two adjusted lengths obtained for each line common to two quadrilaterals.

Accompanying plates and tabulations show some of the results obtained on this interesting project, while other articles in this issue of the bulletin describe definite phases of the work. Additional information will be given in future bulletins as reports from the field parties become available.

SECTION OF GEORGES BANK
BEFORE AND AFTER MODERN HYDROGRAPHIC SURVEYS



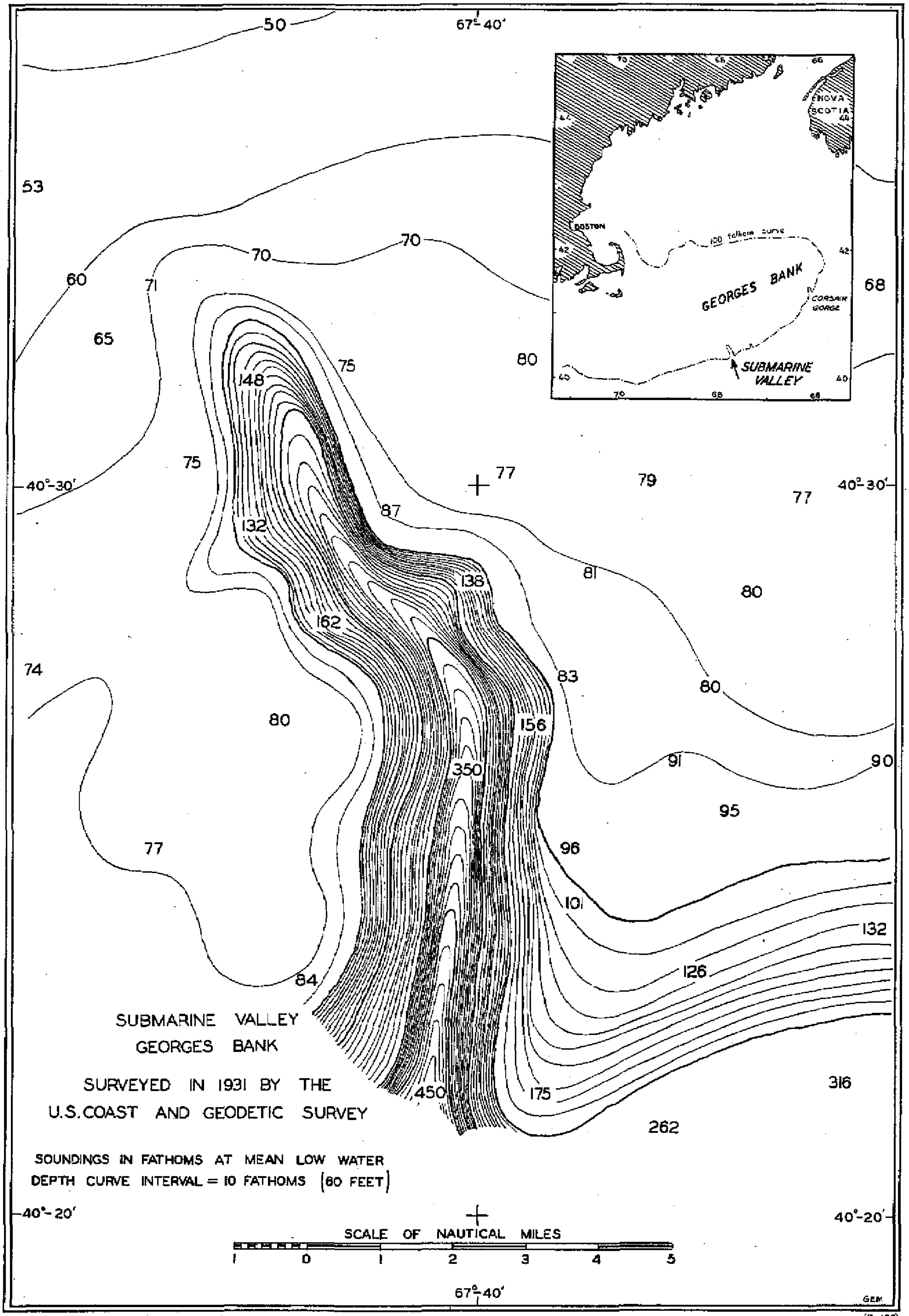
1913



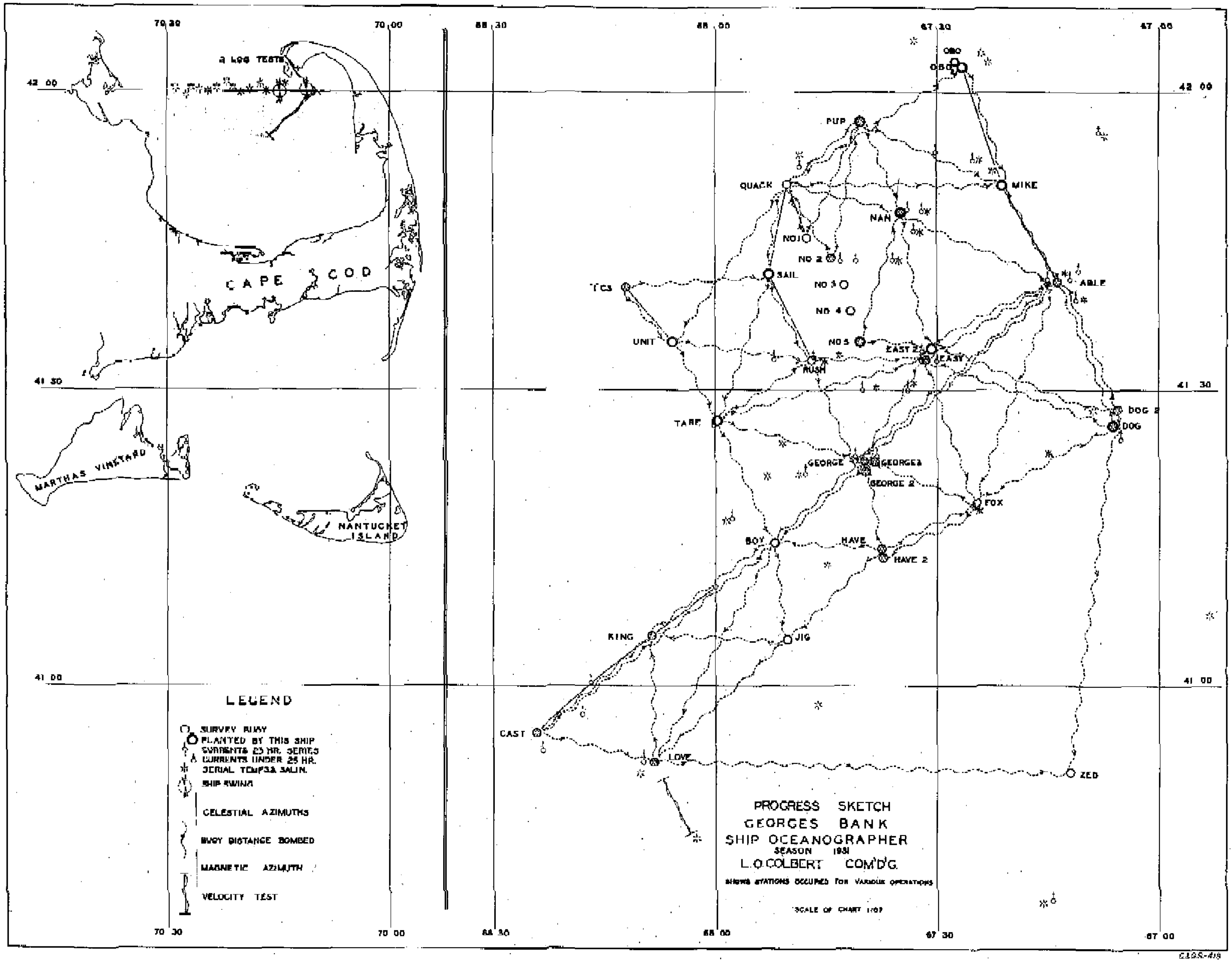
C.&G.S. 419

GEM

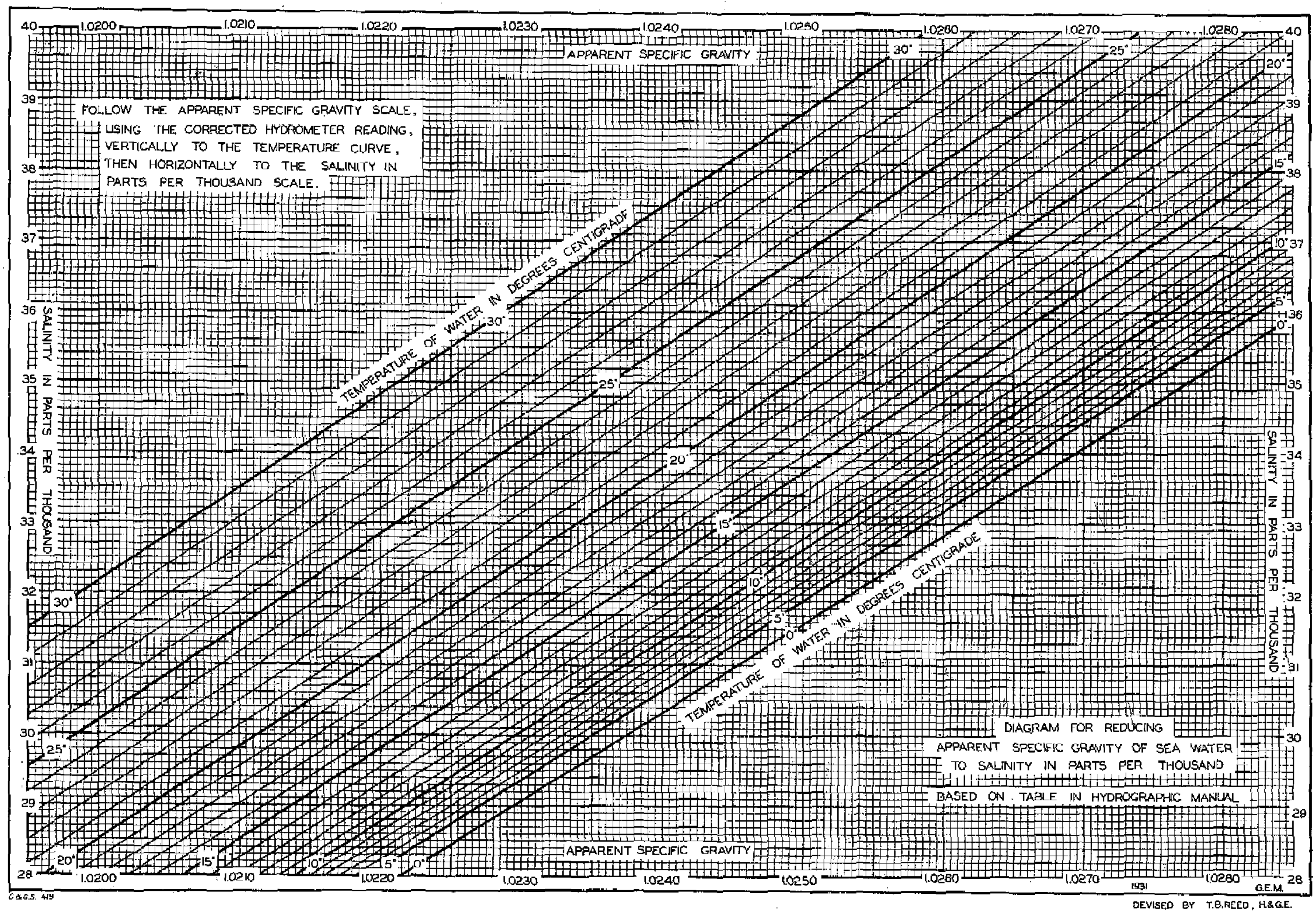
1931


SUBMARINE VALLEY
GEORGES BANK
SURVEYED IN 1931 BY THE
U.S. COAST AND GEODETIC SURVEY
SOUNDINGS IN FATHOMS AT MEAN LOW WATER
DEPTH CURVE INTERVAL = 10 FATHOMS (60 FEET)
SCALE OF NAUTICAL MILES
1 0 1 2 3 4 5
67°-40'
67°-40'
40°-30'
40°-30'
40°-20'
40°-20'
50
53
60
65
70
70
71
75
75
148
132
162
138
87
77
79
77
80
81
80
83
80
74
80
156
350
91
90
95
77
96
101
132
126
84
450
175
262
316
68
NOVA SCOTIA
BOSTON
100 fathom curve
GEORGES BANK
CORSAIR GORGE
SUBMARINE VALLEY
GEM

(R-138)



PROGRESS SKETCH
GEORGES BANK
SHIP OCEANOGRAPHER
SEASON 1931
L.O. COLBERT COM'D'G.
SHOWS STATIONS OCCUPIED FOR VARIOUS OPERATIONS
SCALE OF CHART 1107
LEGEND
SURVEY BUOY
PLANTED BY THIS SHIP
CURRENTS 25 HR. SERIES
CURRENTS UNDER 25 HR.
SERIAL TEMP'S & SALIN.
SHIP SWING
CELESTIAL AZIMUTHS
BUOY DISTANCE BOMBED
MAGNETIC AZIMUTH
VELOCITY TEST
CAPE COD
MARTHAS VINEYARD
NANTUCKET ISLAND
2 LOG TESTS
PUP
QUACK
MIKE
NAN
ABLE
SAIL
TC3
UNIT
RUSH
EAST 2
EASY
TARE
DOG 2
DOG
GEORGE
GEORGES
GEORGE 2
FOX
BOY
HAVE
HAVE 2
KING
JIG
CAST
LOVE
ZED
NO 1
NO 2
NO 3
NO 4
NO 5
70 30
70 00
68 30
68 00
67 30
67 00
42 00
41 30
41 00
C&GS-418


APPARENT SPECIFIC GRAVITY
FOLLOW THE APPARENT SPECIFIC GRAVITY SCALE, USING THE CORRECTED HYDROMETER READING, VERTICALLY TO THE TEMPERATURE CURVE, THEN HORIZONTALLY TO THE SALINITY IN PARTS PER THOUSAND SCALE.
TEMPERATURE OF WATER IN DEGREES CENTIGRADE
SALINITY IN PARTS PER THOUSAND
DIAGRAM FOR REDUCING
APPARENT SPECIFIC GRAVITY OF SEA WATER
TO SALINITY IN PARTS PER THOUSAND
BASED ON TABLE IN HYDROGRAPHIC MANUAL
1931
G.E.M.
C&G.S. 419
DEVISED BY T.B.REED, H&G.E.

CONVERSION TABLES

METERS	FATHOMS	FATHOMS	METERS
1	0.546806	1	1.828804
2	1.093611	2	3.657607
3	1.640417	3	5.486411
4	2.187222	4	7.315215
5	2.734028	5	9.144018
6	3.280833	6	10.972822
7	3.827639	7	12.801626
8	4.374444	8	14.630429
9	4.921250	9	16.459233

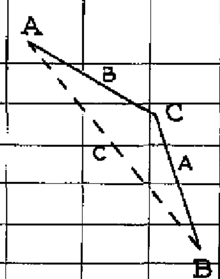
CONVERSION TABLES (ABOVE)
AND FORMS (BELOW FOUND USEFUL
IN COMPUTATION OF R.A.R. WORK ON GEORGES BANK

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES
GIVEN: TWO SIDES AND THE INCLUDED ANGLE

State: ....

11—9121



NO.	~~STATION~~	~~OBSERVED~~ ANGLE	~~CORR'N~~	~~SPHER'L ANGLE~~	~~SPHER'L EXCESS~~	~~PLANE ANGLE AND DISTANCE~~	LOGARITHM
	C	175-25-06				A	4.127 298
	C/2	87-42-33				B	3.851 826
	45°+Ø	62-03-45.52				TAN(45°+Ø)	0.275 472
	Ø	17-03-45.52				TAN Ø	9.487 035
	½(A+B)	2-17-27				COT ½C	8.602 102
	½(A−B)	0-42-12.45				TAN ½(A−B)	8.089 137
	A	2-59-39.45				B	1-35-14.55

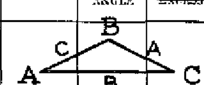
FORMULAE: $\tan \frac{1}{2}(A-B) = \tan Ø \cot \frac{1}{2}C$; $\frac{1}{2}(A+B) = 90° - \frac{1}{2}C$; $\frac{A}{B} = \tan(45°+Ø)$

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES
GIVEN: THREE SIDES

State: ....

11—9121



NO.	~~STATION~~	~~OBSERVED ANGLE~~	~~CORR'N~~	SPHER'L ANGLE	SPHER'L EXCESS	~~PLANE ANGLE AND DISTANCE~~	LOGARITHM
A	28 895					M	3.747 4484
B	46 985	S-A 4.321 1011				S-A	4.321 1011
C	23 802	S-B 3.455 7582	A/2	14-56-38		TAN A/2	9.426 3473
	2 99 682	S-C 4.415 6243	A	29-53-16		S-B	3.455 7582
S	49 841	12.192 4836	B/2	62-56-20		TAN B/2	0.291 6902
S-A	20 946	S 4.697 5867	B	125-52-40		S-C	4.415 6243
S-B	2 856	7.494 8969	C/2	12-07-02		TAN C/2	9.331 8241
S-C	26 039	M 3.747 4484	C	24-14-04			

FORMULAE: $S = \frac{A+B+C}{2}$; $M = \sqrt{\frac{(S-A)(S-B)(S-C)}{S}}$

$\tan A/2 = \frac{M}{S-A}$; $\tan B/2 = \frac{M}{S-B}$; $\tan C/2 = \frac{M}{S-C}$

GEN
C.&G.S.-419

RELATING MAGNETOPHONE TO BUOY ANCHOR On R.A.R. BUOY CONTROL HYDROGRAPHY
I. METHODS USED ON THE HYDROGRAPHER

R. A. Riddell, Jr.H.& G. Engineer, U.S.C. & G. Survey.

One of the largest sources of error on R.A.R. work when using floating magnetophone stations lies in relating the position of the magneto phone to the anchor of the buoy marking the station.

As the magnetophone must be maintained at some distance astern of the station ship in order to be free from ship noises, it is generally necessary for the vessel to anchor several hundred meters from the buoy to avoid fouling the magnetophone cable on the buoy, when the vessel swings with the current.

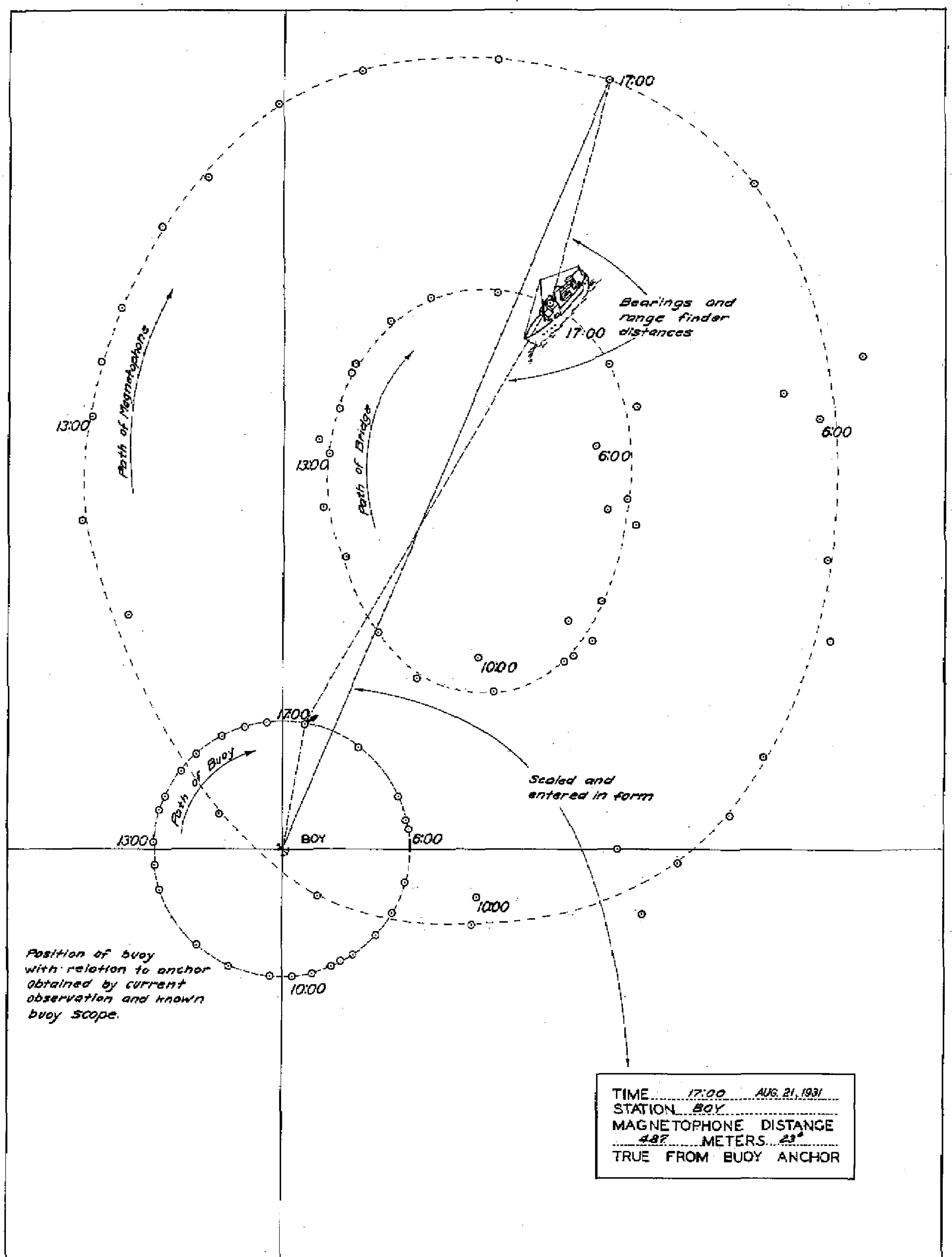
The accompanying plate, reduced considerably in scale, shows the actual plotting of the relationship between the magnetophone and buoy anchor on August 21, 1931, while the HYDROGRAPHER was serving as a station ship at Buoy "Boy", Georges Bank.

The necessary observations, ordinarily made at half hourly intervals, are (l) current observation, (2) bearing and range finder distance from bridge to buoy, and (3) bearing and range finder distance from bridge to magnetophone.

The plotting is done on as large a scale as convenient. From an assumed position of the buoy anchor, the circle representing the path of the buoy is swing, using the scope of the buoy as a radius. For a particular observation, the buoy is plotted on the circle from the data furnished by the current observation. The position of the bridge is then back plotted from the buoy and the position of the magnetophone plotted from the distance and bearing to it from the bridge. The true bearing and distance of the magnetophone from the buoy anchor is then scaled directly from the plot, entered in the records and radioed to the sounding vessels. The form used for entering the data in the records of the several units is shown on the plate,

It will be noted that the path of both the bridge and magnetophone, as determined by half hourly plottings, is definitely elliptical. The major axes of the ellipses undoubtedly result from the straightening out of the ship's anchor chain during the strength of the current. The question naturally arises as to what the actual path of the buoy is and how much it differs from a circle. Tests made to settle this point have not, thus far, been conclusive.

When using the method described above on R.A.R. triangulation to obtain the correction at the magnetophone end of a bombed line, the component of the eccentric distance measured along the azimuth of the line between the two buoys is obtained and applied as a plus or minus correction to the bombed distance. In much the same way, the correction at



RELATING POSITION OF MAGNETOPHONE
TO POSITION OF BUOY ANCHOR
GEORGES BANK

STATION: BUOY "BOY" DATE: AUGUST 21, 1931

GEM FAR

C.& G.S.-415

the other end, necessary to relate the bomb to the second buoy anchor, is obtained.

In case the combined eccentricity of bomb and magnetophone, normal to the line, is large enough to cause appreciable error, due to assuming that the actual distance is the same as its projection on the line between the buoys, a correction for the difference must he applied. With a line 18000 meters (approximately 10 miles) in length and a resultant magnetophone and bomb eccentricity, normal to the line of 600 meters, the correction amounts to 18000 - 18000 Cos 1° - 55 ′ = 10.1 meters.

II. METHODS USED ON THE LYDONIA.

G. D. Bowie, H. & G. Engineer, Commanding LYDONIA.

When the LYDONIA acted as a magnetophone station, and a range finder was available, she obtained the same data that the HYDROGRAPHER has mentioned. When none was available, she obtained distances by sextant angles. A base was measured from stem to stern on the LYDONIA, and two observers stood at the ends of the base. Each observer measured the angle between the other's sextant and the buoy. These angles plotted on the base gave the distance from the ship and the direction with reference to the ship's head. When the buoy was almost ahead or astern, this method could not be used, and so a depression angle and pelorus bearing was taken to the buoy.

The range finder was the most accurate method of finding distances. By hanging a lantern on the buoy, distances to the buoy could be measured at night by the range finder. Other methods would not work at night.

In plotting the data, instead of starting with the buoy anchor and working to the magnetophone, as done by the HYDROGRAPHER, the LYDONIA started with the ship's bridge or the base of the ship and worked to both the magnetophone and the buoy anchor. The base was laid off on coordinate paper and the angles plotted to the buoy positions. From the buoy positions a line was drawn in the direction opposite that of the current for a distance equal to the scope of the buoy. The distance and direction of the magnetophone float were plotted from the position of the ship's bridge. A line was drawn from the position of the magnetophone float to the anchor of the buoy. The length of the line gave the distance between the magnetophone and the buoy anchor. The angle between this line and the line of the ship's head, plus the true bearing of the ship, gave the direction between the magnetophone and the buoy anchor.

Examples of tabulation of data are shown on an accompanying plate.

FORM USED FOR DATA TO RELATE MAGNETOPHONE TO BUOY ANCHOR
(1) When Using Depression Angle or (2) When Using Base Line on Station Ship

May 25, 1931 - near Buoy KING - Scope of Buoy = 104 meters, Magnetophone 21.5 m. astern

Time 60th Mer.	Ship's Head P.S.C.	Dev. & Var.	Ship's Head True	Bridge to Buoy			Mag. to Buoy		Pelorus to Mag. Float		Bridge to Buoy		Remarks
				Pel-orus	① Dep. ② Angle A	Meters Angle B	True Brg.	Meters	Bridge	Stern	True	M	
7:25	317	-15.2	301.8		② 17-37	153-10	244.7	56		180			Buoy to Stbd.
8:45	351	-14.8	336.2	173	① 3-43	113	353.6	51		"			" " "
10:13	35	-16.2	18.8	168	① 3-26	122	51.5	50		"			" " "
13:05	160	-19.3	140.7		② 145-44	17-22	148.9	246		"			" " "
13:25	160	-19.3	140.7	15	① 6-08	82	145.9	220		"			" " "
14:00	174	-19.2	154.8	358	① 5-12	81	154.0	241		"			Buoy to Port

Note: No range finder available on this date.
① Distance to buoy measured by depression angle.
② Distance to buoy measured by angles A and B from ends of base line.

CONVERTING BOMBED DISTANCE TO DISTANCE BETWEEN BUOY ANCHORS
(Computation Method)

CASE 1

Distance between anchor of Buoy A and anchor of Buoy B =

$$D = \sqrt{R^2 - (X_A - X_B)^2} - Y_A + Y_B$$

R = distance from position of bomb explosion to hydrophone

= Bomb time (corrected) x velocity of sound.

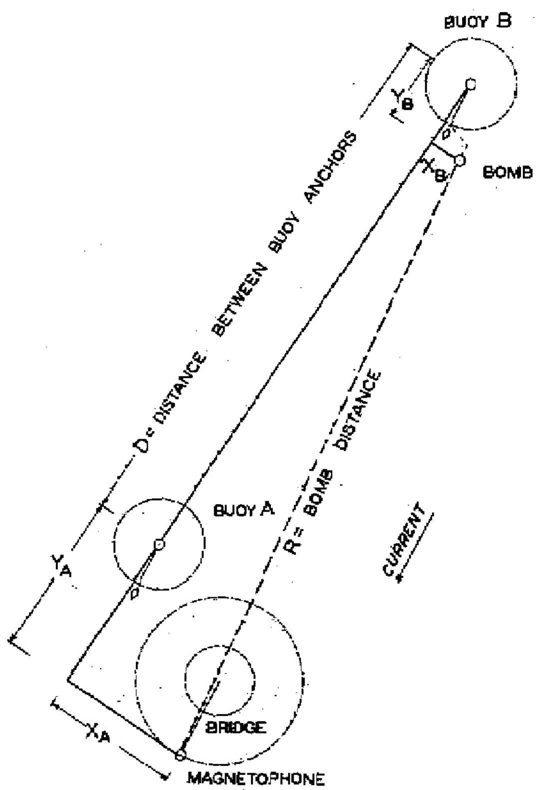
CASE 2

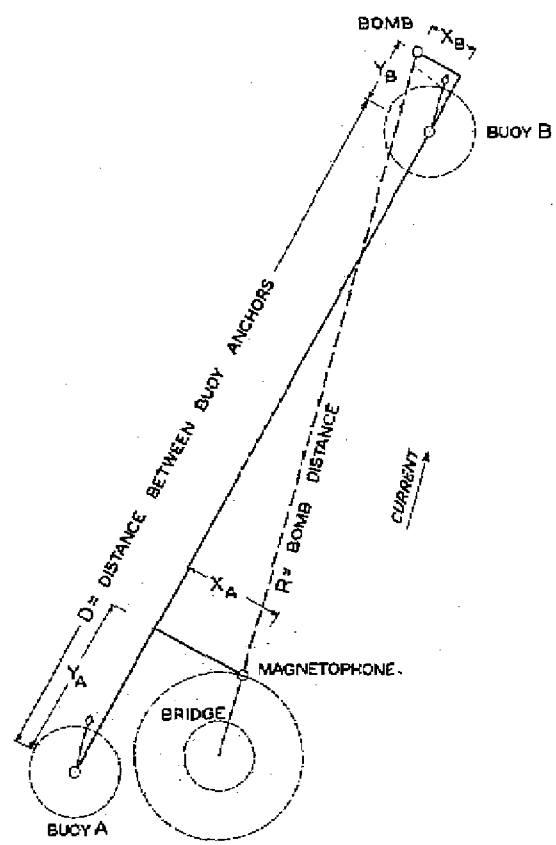
Distance between anchor of Buoy A and anchor of Buoy B =

$$D = \sqrt{R^2 - (X_A - X_B)^2} - Y_A - Y_B$$

R = distance from position of bomb at the time of explosion to hydrophone.

= Bomb time (corrected) x velocity of sound.





GEM

ADJUSTMENT OF A COMPLETE QUADRILATERAL WHEN ALL LENGTHS ARE MEASURED

Dr. O. S. Adams, Senior Mathematician,
U.S.C. & G. Survey.

(This method was used for the adjustment of all the quadrilaterals in the R.A.R. buoy control scheme of triangulation on Georges Bank, 1931. The work was accomplished under the supervision of G. D. Cowie. Complete adjustment of one of the actual figures in the scheme is given in this article.)

In Δ with sides a, b, and c, we have

$$4\text{ Area} = \sqrt{(a+b+c)(-a+b+c)(a-b+c)(a+b-c)}$$

With measured lengths L_1 L_2, and L_3, we must add a "v" to each length if any conditions enter into the computation.

Now

$$(L_1 + L_2 + L_3 + v_1 + v_2 + v_3)^{\frac{1}{2}} = \sqrt{L_1 + L_2 + L_3} + \frac{v_1 + v_2 + v_3}{2\sqrt{L_1 + L_2 + L_3}}$$

in which we use only the first powers of the v's. In the same way

$$(-L_1 + L_2 + L_3 - v_1 + v_2 + v_3)^{\frac{1}{2}} = \sqrt{-L_1 + L_2 + L_3} + \frac{-v_1 + v_2 + v_3}{2\sqrt{-L_1 + L_2 + L_3}}$$

So also for the other two parts of the formula. Then multiplying these four factors retaining only the first powers of the v's, we have

$$4\text{ Area} = \sqrt{(L_1+L_2+L_3)(-L_1+L_2+L_3)(L_1-L_2+L_3)(L_1+L_2-L_3)}$$

$$+ \frac{\sqrt{(-L_1+L_2+L_3)(L_1-L_2+L_3)(L_1+L_2-L_3)}}{2\sqrt{L_1+L_2+L_3}}\,(v_1+v_2+v_3)$$

$$+ \frac{\sqrt{(L_1+L_2+L_3)(L_1-L_2+L_3)(L_1+L_2-L_3)}}{2\sqrt{-L_1+L_2+L_3}}\,(-v_1+v_2+v_3)$$

$$+ \frac{\sqrt{(L_1+L_2+L_3)(-L_1+L_2+L_3)(L_1+L_2-L_3)}}{2\sqrt{L_1-L_2+L_3}}\,(v_1-v_2+v_3)$$

$$+ \frac{\sqrt{(L_1+L_2+L_3)(-L_1+L_2+L_3)(L_1-L_2+L_3)}}{2\sqrt{L_1+L_2-L_3}}\,(v_1+v_2-v_3)$$

There will be a similar expression for the area of each of the other three triangles. The condition is obtained by setting the sum of the areas of two of the Δ equal to the sum of the other two. We multiply each expression by 2 to remove the factors in the denominator. We will then have

$$
\begin{aligned}
&\frac{\sqrt{(-L_1+L_2+L_3)(L_1-L_2+L_3)(L_1+L_2-L_3)}}{\sqrt{L_1+L_2+L_3}}(v_1+v_2+v_3) \\
&+\frac{\sqrt{(L_1+L_2+L_3)(L_1-L_2+L_3)(L_1+L_2-L_3)}}{\sqrt{-L_1+L_2+L_3}}(-v_1+v_2+v_3) \\
&+\frac{\sqrt{(L_1+L_2+L_3)(-L_1+L_2+L_3)(L_1+L_2-L_3)}}{\sqrt{L_1-L_2+L_3}}(v_1-v_2+v_3) \\
&+\frac{\sqrt{(L_1+L_2+L_3)(-L_1+L_2+L_3)(L_1-L_2+L_3)}}{\sqrt{L_1+L_2-L_3}}(v_1+v_2-v_3) \\
&+\frac{\sqrt{(-L_3+L_4+L_5)(L_3-L_4+L_5)(L_3+L_4-L_5)}}{\sqrt{L_3+L_4+L_5}}(v_3+v_4+v_5) \\
&+\frac{\sqrt{(L_3+L_4+L_5)(L_3-L_4+L_5)(L_3+L_4-L_5)}}{\sqrt{-L_3+L_4+L_5}}(-v_3+v_4+v_5) \\
&+\frac{\sqrt{(L_3+L_4+L_5)(-L_3+L_4+L_5)(L_3+L_4-L_5)}}{\sqrt{L_3-L_4+L_5}}(v_3-v_4+v_5) \\
&+\frac{\sqrt{(L_3+L_4+L_5)(-L_3+L_4+L_5)(L_3-L_4+L_5)}}{\sqrt{L_3+L_4-L_5}}(v_3+v_4-v_5) \\
&-\frac{\sqrt{(-L_1+L_4+L_6)(L_1-L_4+L_6)(L_1+L_4-L_6)}}{\sqrt{L_1+L_4+L_6}}(v_1+v_4+v_6) \\
&-\frac{\sqrt{(L_1+L_4+L_6)(L_1-L_4+L_6)(L_1+L_4-L_6)}}{\sqrt{-L_1+L_4+L_6}}(-v_1+v_4+v_6) \\
&-\frac{\sqrt{(L_1+L_4+L_6)(-L_1+L_4+L_6)(L_1+L_4-L_6)}}{\sqrt{L_1-L_4+L_6}}(v_1-v_4+v_6) \\
&-\frac{\sqrt{(L_1+L_4+L_6)(-L_1+L_4+L_6)(L_1-L_4+L_6)}}{\sqrt{L_1+L_4-L_6}}(v_1+v_4-v_6) \\
&-\frac{\sqrt{(-L_2+L_5+L_6)(L_2-L_5+L_6)(L_2+L_5-L_6)}}{\sqrt{L_2+L_5+L_6}}(v_2+v_5+v_6) \\
&-\frac{\sqrt{(L_2+L_5+L_6)(L_2-L_5+L_6)(L_2+L_5-L_6)}}{\sqrt{-L_2+L_5+L_6}}(-v_2+v_5+v_6) \\
&-\frac{\sqrt{(L_2+L_5+L_6)(-L_2+L_5+L_6)(L_2+L_5-L_6)}}{\sqrt{L_2-L_5+L_6}}(v_2-v_5+v_6) \\
&-\frac{\sqrt{(L_2+L_5+L_6)(-L_2+L_5+L_6)(L_2-L_5+L_6)}}{\sqrt{L_2+L_5-L_6}}(v_2+v_5-v_6) =
\end{aligned}
$$

$$-2\sqrt{(L_1+L_2+L_3)\ (-L_1+L_2+L_3)\ (L_1-L_2+L_3)\ (L_1+L_2-L_3)}$$

$$-2\sqrt{(L_3+L_4+L_5)\ (-L_3+L_4+L_5)\ (L_3-L_4+L_5)\ (L_3+L_4-L_5)}$$

$$+2\sqrt{(L_1+L_4+L_6)\ (-L_1+L_4+L_6)\ (L_1-L_4+L_6)\ (L_1+L_4-L_6)}$$

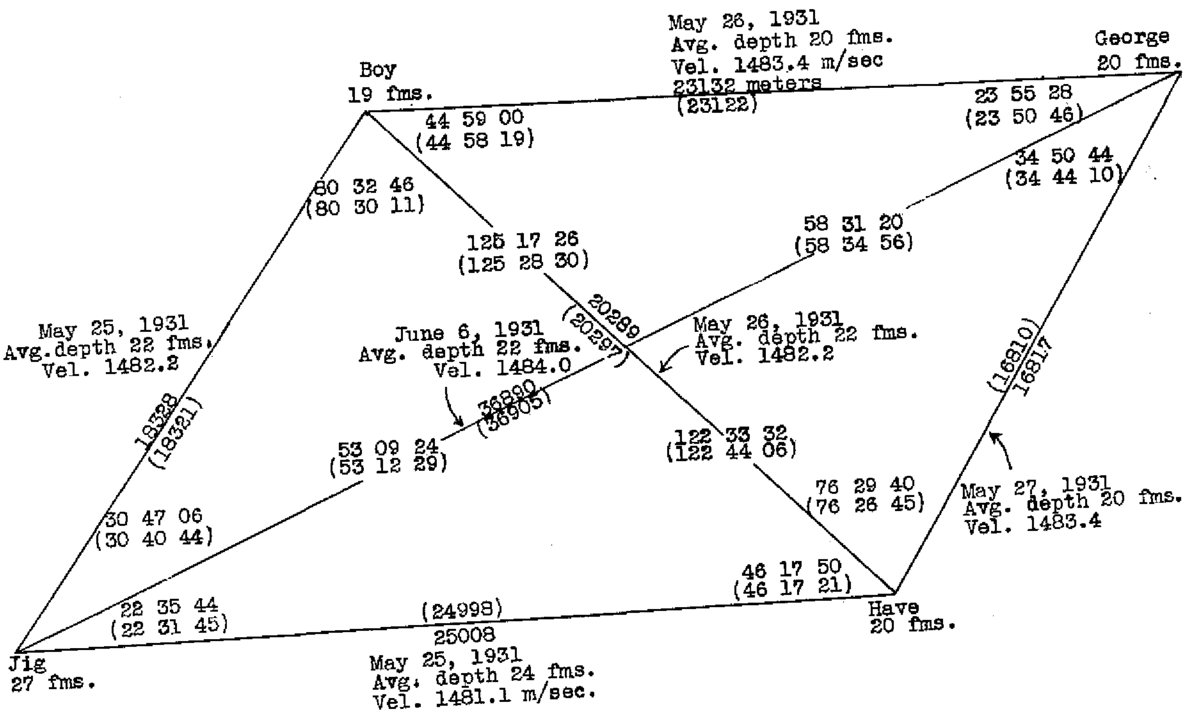
$$+2\sqrt{(L_2+L_5+L_6)\ (-L_2+L_5+L_6)\ (L_2-L_5+L_6)\ (L_2+L_5-L_6)}$$

Complete adjustment of one of the quadrilaterals in the 1931 R.A.R. scheme of triangulation follows: The adjusted figure, Boy-George-Have-Jig, is shown below. The distances not shown in parenthesis are actual bomb distances corrected for eccentricity of magnetophone and bomb. They are in reality the observed distances between buoy anchors. (See article by F. A. Riddell in this issue of the bulletin). The angles not shown in parenthesis are those resulting from the computation of triangles using observed distances. The discrepancies in the figure using these angles are shown in the table.

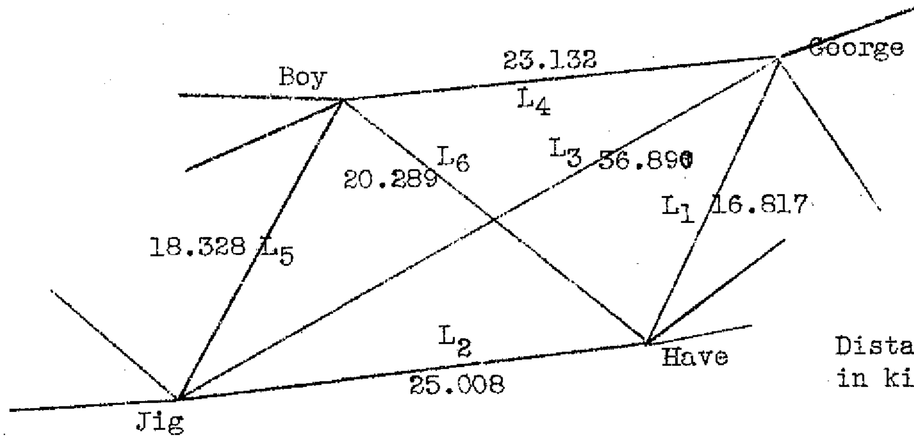
The distances given in parenthesis are those obtained from adjustment by the Adams' method, while the angles given in the parentheses are those corresponding to the adjusted distances.

Angular values before adjustment.

	o	'	"		o	'	"		o	'	"		o	'	"
BGJ	23	55	28	GHB	76	29	40	HJG	22	35	44	JBH	80	32	46
JGH	34	50	44	BHJ	46	17	50	GJB	30	47	06	HBG	44	59	00
BGH	58	46	12	GHJ	122	47	30	HJB	53	22	50	JBG	125	31	46
BGH	58	31	20	GHJ	122	33	32	HJB	53	09	24	JBG	125	17	26
Diff.		14	52	Diff.		13	58	Diff.		13	26	Diff.		14	20



C.& G.S.-419



Distances given in kilometers.

Computation of Areas and Coefficients.

$\triangle_1$

$L_1+L_2+L_3$	$-L_1+L_2+L_3$	$L_1-L_2+L_3$	$L_1+L_2-L_3$
16.817	25.008	16.817	16.817
25.008	36.890	36.890	25.008
36.890	61.898	53.707	41.825
78.715	-16.817	-25.008	-36.890
	45.081	28.699	4.935

1.8960575	5.7012050	5.7012050	5.7012050	5.7012050
1.6539935	3.7921150	3.3079870	2.9157336	1.3865744
1.4578668	2)1.9090900	2)2.3932180	2)2.7854714	2)4.3146306
0.6932872	0.9545450	1.1966090	1.3927357	2.1573153
2)5.7012050				
2.8506025				
708.9287	9.0063	15.7257	24.7022	143.6532

Note: The above derives the values corresponding to the first 4 lines of the equation given on page 18 as well as the first line of the right side of the equation (except the coefficient 2) given at the top of page 19.

Δ_2

$L_3+L_4+L_5$	$-L_3+L_4+L_5$	$L_3-L_4+L_5$	$L_3+L_4-L_5$
36.890	23.132	36.890	36.890
23.132	18.328	18.328	23.132
18.328	41.460	55.218	60.022
78.350	-36.890	-23.132	-18.328
	4.570	32.086	41.694

1.8940390	5.6803444	5.6803444	5.6803444	5.6803444
0.6599162	3.7880780	1.3198324	3.0126312	3.2401472
1.5063156	2)1.8922664	2)4.3605120	2)2.6677132	2)2.4401972
1.6200736	0.9461332	2.1802560	1.3338566	1.2200986
2)5.6803444				
2.8401722				
692.1054	8.8335	151.4453	21.5703	16.5996

Δ_3

$L_1+L_4+L_6$	$-L_1+L_4+L_6$	$L_1-L_4+L_6$	$L_1+L_4-L_6$
16.817	23.132	16.817	16.817
23.132	20.289	20.289	23.132
20.289	43.421	37.106	39.949
60.238	-16.817	-23.132	-20.289
	26.604	13.974	19.660

1.7798705	5.6437216	5.6437216	5.6437216	5.6437216
1.4249469	3.5597410	2.8498938	2.2906414	2.5871670
1.1453207	2)2.0839806	2)2.7938278	2)3.3530802	2)3.0565546
1.2935835	1.0419903	1.3969139	1.6765401	1.5282773
2)5.6437216				
2.8218608				
663.5303	11.0152	24.9410	47.4832	33.7503

Δ_4

$L_2+L_5+L_6$	$-L_2+L_5+L_6$	$L_2-L_5+L_6$	$L_2+L_5-L_6$
25.008 -	18.328	25.008	25.008
18.328	20.289	20.289	18.328
20.289	38.617	45.297	43.336
63.625	-25.008	-18.328	-20.289
	13.609	26.969	23.047

1.8036278	5.7309332	5.7309332	5.7309332	5.7309332
1.1338262	3.6072556	2.2676524	2.8617296	2.7252288
1.4308648	2)2.1236776	2)3.4632808	2)2.8692036	2)3.0057044
1.3626144	1.0618388	1.7316404	1.4346018	1.5028522
2)5.7309332				
2.8654666				
733.6124	11.5302	53.9054	27.2021	31.8311

$\Delta_1 + \Delta_2$

− 708.9287
− 692.1054
−1401.0341

$\Delta_3 + \Delta_4$

663.5303
733.6124
−1397.1427
−1401.0341
−3.8914
× 2
−7.7828

Substituting values:

+9.0063 $(V_1+V_2+V_3)$ + 15.7257 $(-V_1+V_2+V_3)$ + 24.7022 $(V_1+V_2+V_3)$ + 143.6522 $(V_1-V_2-V_3)$ + 8.8335 $(V_3+V_4+V_5)$ + 151.4453 $(-V_3+V_4+V_5)$ + 21.5703 $(V_3-V_4+V_5)$ + 16.5996 $(V_3+V_4-V_5)$ − 11.0152 $(V_1+V_4+V_6)$ − 24.9410 $(-V_1+V_4+V_6)$ − 47.4832 $(V_1-V_4+V_6)$ − 33.7503 $(V_1+V_4-V_6)$ − 11.5302 $(V_2+V_5+V_6)$ − 53.9064 $(-V_2+V_5+V_6)$ − 27.2021 $(V_2-V_5+V_6)$ − 31.8311 $(V_2+V_5-V_6)$ = −7.7828

Summing values of V_1, V_2, V_3 etc.

+ 9.0063	− 15.7257	+ 9.0063	− 24.7022	+ 9.0063	− 143.6522
24.7022	11.0152	15.7257	11.5302	15.7257	151.4453
143.6522	47.4832	143.6522	27.2021	24.7022	− 295.0975
24.9410	33.7503	53.9064	31.8311	8.8335	+ 96.4376
+202.3017	−107.9744	+222.2906	−95.2656	21.5703	−198.6599
−107.9744		− 95.2656		16.5996	V_3
+ 94.3273		+127.0250		+96.4376	
V_1		V_2			

+ 8.8335	− 21.5703	+ 8.8335	− 16.5996	+33.7503	− 11.0152
151.4453	11.0152	151.4453	11.5302	31.8311	24.9410
16.5996	24.9410	21.5703	53.9064	+65.5814	47.4832
47.4832	33.7503	27.2021	31.8311		11.5302
+224.3616	− 91.2768	+209.0512	−113.8673		53.9064
−91.2768		−113.8673			27.2021
+133.0848		+ 95.1839			−176.0781
V_4		V_5			+ 65.5814
					−110.4967
					V_6

$+94.3273V_1 + 127.0250V_2 - 198.6599V_3 + 133.0848V_4 + 95.1839V_5 - 110.4967V_6 = -7.7828$

v^2
8897.64
16135.35
39465.75
17711.56
9059.98
12208.23
103478.51

$$\frac{-7.7828}{103478.51} = -0.0000752118 = C$$

	Observed	adjusted
V_1 = −.0071	16.8170	16.8099
V_2 = −.0096	25.0080	24.9984
V_3 = +.0149	36.8900	36.9049
V_4 = −.0100	23.1320	23.1220
V_5 = −.0072	18.3280	18.3208
V_6 = +.0083	20.2890	20.2973

For final corrected adjustment see next page.

Check Computation

$\triangle_1$

16.8099	78.7132	78.7132	78.7132	1.8960476	
24.9984	33.6198	49.9968	73.8098	1.6541130	
36.9049	45.0934	28.7164	4.9034	1.4581299	
78.7132				0.6904973	
				2)5.6987878	
				2.8493939	= 706.9584

$\triangle_2$

36.9049	78.3477	78.3477	78.3477	1.8940262	
23.1220	73.8098	46.2440	36.6416	0.6568549	
18.3208	4.5379	32.1037	41.7061	1.5065550	
78.3477				1.6201995	
				2)5.6776356	
				2.8388178	= 689.9503
				=	1396.9087

$\triangle_3$

16.8099	60.2292	60.2292	60.2292	1.7798072	
23.1220	33.6198	46.2440	40.5946	1.4250352	
20.2973	26.6094	13.9852	19.6346	1.1456687	
60.2292				1.2930221	
				2)5.6435332	
				2.8217666	= 663.3865

$\triangle_4$

24.9984	63.6165	63.6165	63.6165	1.8035698	
18.3208	49.9968	36.6416	40.5946	1.1341675	
20.2973	13.6197	26.9749	23.0219	1.4309599	
63.6165				1.3621411	
				2)5.7308383	
				2.8654192	= 733.5322
				=	1396.9187

+ 1396.9187
− 1396.9087
+ .0100
2
+ .0200 amount of failure due to approximation introduced. Correct constant term by this amount and correct v's to take care of it.

Second Adjustment:

− 7.7828
+ .0200
− 7.7628

$$\frac{-7.7628}{103478.51} = -0.000750185 = C$$

	Observed	Adjusted	discrepancy
V_1 = −.0071	16.8170	L_1 = 16.8099	1 part in 2400
V_2 = −.0095	25.0080	L_2 = 24.9985	" 2600
V_3 = +.0149	36.8900	L_3 = 36.9049	" 2500
V_4 = −.0100	23.1320	L_4 = 23.1220	" 2300
V_5 = −.0071	18.3280	L_5 = 18.3209	" 2600
V_6 = + .0083	20.2890	L_6 = 20.2973	" 2400

Second or Final Check Computation

Δ_1	16.8099	78.7133	78.7133	78.7133	1.9960482
	24.9985	33.6198	49.9970	73.8098	1.6541139
	36.9049	45.0935	28.7163	4.9035	1.4581284
	78.7133				0.6905062
					2)5.6987967
					2.8493984 - 706.9658

Δ_2	36.9049	78.3478	78.3478	78.5478	1.8940268
	23.1220	73.8098	46.2440	36.6418	0.6568645
	18.3209	4.5380	32.1038	41.7060	1.5065564
	78.3478				1.6201985
					2)5.6776462
					2.8388231 = 689.9589
					- 1396,9247

Δ_3	16.8099	60.2292	60.2292	60.2292	1.7798072
	23.1220	33.6198	46.2440	40.5946	1.4250352
	20.2973	26.6094	13.9852	19.6346	1.1456687
	60.2292				1.2930221
					2)5.6435332
					2.8217666 = 663.3865

Δ_4	24.9985	65.6167	63.6167	63.6167	1.8035712
	18.3209	49.9970	36.6418	40.5946	1.1341675
	20.2973	13.6197	26.9749	23.0221	1.4309599
	63.6167				1.3621449
					2)5.7308435
					2.8654218 = 773.5366
					+ 1396.9231

-1396.9247
+1396.9231
- .0016
2
- .0032 or failure equals 3.2 square meters

Computation of △S of two best △S

		:		
S = 30.1146	1.4787771	:	S = 31.8084	1.5025418
S - a = 13.3047	1.1240051	:	S - a = 6.8099	0.8331407
S - b = 6.9926	0.8446387	:	S - b = 13.4875	1.1299315
S - c = 9.8173	0.9919921	:	S - c = 11.5110	1.0611131
	2.9606359	:		3.0241853
	1.4787771	:		1.5025418
	2)1.4818588	:		2)1.5216435
	0.7409294	:		0.7608218

° ' "			:	° ' "		
22 29 09.6	tan ½A	9.9169243	:	40 15 05.2	tan ½A	9.9276811
44 58 19.2 (19.2)	A		:	80 30 10.4	A	
38 13 22.8	tan ½B	9.8962907	:	23 08 40.3	tan ½B	9.6308903
76 26 45.4 (45.7)	B		:	46 17 30.6	B	
29 17 27.5	tan ½C	9.7489373	:	26 36 14.6	tan ½C	9.6997087
58 34 55.0 (55.1)	C		:	53 12 29.0	C	

COMPUTATION OF TRIANGLES

R.A.R. triangulation

State: Mass. (Georges Bank)

11—9121
U. S. GOVERNMENT PRINTING OFFICE: 1930

NO		STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
Plane angles from computation on previous page (3 sides known)								
	2-3						16809.9	4.3255651
	1	Boy	44 58		19.4	0.2	19.2	0.1507274
Δ3	2	George	58 34		55.4	0.3	55.1	9.9311459
	3	Have	76 26		46.0	0.3	45.7	9.9377330
	1-3		Boy-Have			.84	20297.3	4.3074384
	1-2		Boy-George				23132.0	4.3640255
	2-3						20297.3	4.3074383
	1	Jig	53 12		29.3	0.3	29.0	0.0964675
Δ4	2	Boy	80 30		10.7	0.3	10.4	9.9940064
	3	Have	46 17		20.9	0.3	20.6	9.8590393
	1-3		Jig-Have			.93	24998.4	4.3979122
	1-2		Jig-Boy				18320.8	4.2629451
Plane angles from computation similar to above (3 sides known) but not shown.								
	2-3						16809.9	4.2255651
	1	Jig	22 31		44.7	0.3	44.4	0.4166300
Δ1	2	George	34 44		09.9	0.3	09.6	9.7557193
	3	Have	122 44		06.3	0.3	06.0	9.9248892
	1-3		Jig-Have			.90	24998.5	4.3979144
	1-2		Jig-George				36904.9	4.5670843
	2-3						36904.9	4.5670840
	1	Boy	125 28		30.4	0.3	30.1	0.0891790
Δ2	2	George	23 50		46.4	0.3	46.0	9.6066839
	3	Jig	30 40		44.2	0.3	43.9	9.7077622
	1-3		Boy-Jig			.87	18320.9	4.2629469
	1-2		Boy-George				23122.0	4.3640252

Do not write in this margin

SUMMARY OF DATA USED IN COMPUTING BUOY CONTROL SCHEME

SHIPS

HYDROGRAPHER, OCEANOGRAPHER, LYDONIA and GILBERT.

GEORGES BANK, 1931.

Compiled by, T.B.R. & L.S.H.

Quad or Δ	Line	Date	Average Depth Fms.	Vel. of Sound M/Sec	Bomb Distance Meters	No. of Obs.	Prob. Error Meters	C/n to close Quad	Adjusted Length Meters	Observed Azimuth	Computed Azimuth	O-C	Angle discrepancy before adjustment	Ship Bombing.
Able	A-D	May 23	27	1479.4	28767	4	3	-10.8	28756.2	338-42.2	339-01-59	-19.9	A 10-39"	Ocec.
Dog	D-F	"	26	1480.0	29898	3	4	-10.9	29887.1				D 10-15	"
Fox	F-E	"	22	1482.2	28802	3	13	-10.9	28791.1	161-15.3	161-06-36	+8.7	F 10-18	"
Easy	E-A	"	24	1481.1	28800	3	18	-11.4	28788.6				E 10-42	"
	F-A	"	22	1482.2	44131	3	9	+16.4	44147.4					"
	E-D	"	25	1480.6	37770	3	6	+14.4	37784.4				Mn 10-28	"
Easy	E-F	May 28	22	1482.2	28802	3	13	-12.5	28789.5	341-10.9	341-02-10	+ 8.7	E. 22-52	Oceo.
Fox	F-H	" 27	22	1482.2	19902	3	12	-13.5	19888.5				F 18-44	"
Have	H-G	" "	20	1483.4	16817	4	4	-24.1	16792.9	168-13.5	168-05-36	+ 7.9	H 35-52	"
George	G-E	" 26	20	1483.4	22735	3	4	-20.7	22714.3	212-21.1	212-06-05	+14.9	G 40-00	"
	H-E	Jun 6	21	1485.9	36663	4	7	+30.0	36693.0					Hydro.
	G-F	May 27	22	1482.2	22886	3	4	+17.4	22903.4				Mn 29-22	Oceo.
George	G-H	May 37	20	1483.4	16817	4	4	-07.1	16809.9				G 14-52	Oceo,
Have	H-J	" 25	24	1481.1	25008	3	8	-09.6	24998.4				K 13-58	"
Jig	J-B	" 25	22	1482.2	18328	3	26	-07.2	16320.8	171-51.0	172-00-38	- 8.6	J 13-26	"
Boy	E-G	" 26	20	1483.4	23132	3	10	-10.0	23122.0				B 14-20	"
	J-G	Jun 6	22	1484.0	36890	4	9	+14.9	36904.9					Hydro.
	B-H	May 26	22	1482.2	20289	3	10	+08.8	20297.3				Mn 14-09	Oceo.
Boy	B-J	May 25	22	1482.2	18328	3	26	+18.0	18346.0				B 34-18	Oceo.
Jig	J-L	" 24	27	1479.4	34289	3	2	+25.4	34314.4				J 31-20	"
Love	L-K	" 25	26	1480.0	23877	3	20	+16.4	23893.4				L 25-58	"
King	K-B	" 25	22	1482.2	29007	3	19	+26.2	29033.2	232-46.6	233-28-14	-41.6	K 28-56	"
	L-B	" 24	25	1480.6	47120	3	19	-38.4	47081.6					"
	K-J	" 25	24	1481.1	25980	3	3	-21.2	25958.8				Mn 30-08	"
King	K-L	May 25	26	1480.0	23877	3	20	+16.4	23893.4					Oceo.
Love	L-C	" 24	28	1478.8	23287	3	20							"
Cast	C-K	" 25	24	1481.1	28801	3	20			229-41.7	230-05-42	-24.0		"

G.&G.S. 419

Quad Or Δ	Line	Date	Average Depth Fms.	Vel. of Sound M/sec	Bomb Distance Meters	No. of Obs.	Prob. Error Meters	C/n to close Quad	Adjusted Length Meters	Observed Azimuth	Computed Azimuth	O-C	Angle discrepancy before adjustment	Ship Bombing.
Additional Lines.	G-A	Jun 5	21	1484.8	49575	2	20							Oceo.
	B-A	Sep 18	21	1507.0	72923	3	4							"
	B-C	" 16	23	1506.7	57983	2	2							"
	B-C	" 16	23	1508.1	57899	6	9							Hydro.
	B-C$_2$	" 18	23	1506.7	57895	4	4							"
	H$_2$-F	Jun 8	22	1485.0	20005	3	17							Oceo.
	L-2	Jul 8	41	1481.5	80852	3	37							"
	H$_2$-Z	Jul 8	35	1485.0	57330	3	10							Hydro.
	D$_2$-Z	" 10	38	1487.0	70280	3	11							Oceo.
	H$_2$-D$_2$	Jun 18	25	1486.0	51377	3	10							Hydro.
	G-D$_2$	" 18	24	1487.0	48441	3	3							"
	E$_2$-B$_2$	Jul 12	25	1492.0	36162	2	2							Oceo.
	A-D$_2$	Jun 18	27	1484.9	25111	3	39							"
Able Easy 2 Nan Mike	A-E$_2$	Jul 12	24	1493.0	28749	2	6	-12.9	28736.1				A 19-42	Oceo.
	E$_2$-N	" 12	24	1493.0	28450	2	9	-13.1	28436.9				E$_2$ 13-39	"
	N-M	" 13	23	1493.7	20468	5	3	-18.2	20449.8				N 19-44	Hydro.
	M-A	" 13	25	1491.6	20740								M 25-47	Oceo.
	E$_2$-M	" 12	25	1492.0	35980	5	7	+20.5	36000.5					Hydro.
	N-A	" 13	23	1494.0	32608	3	7	+23.2	32631.2				Mn 19-43	Oceo
	M-A	" 12	26	1489.0	20637					333-10.0	332-55-08	+14.9		Hydro.
	A-M	Sep 19	26	1502.5	20708									"
	A-M		26		20710	6	7	-18.0	20692.0	153-14.5	152-59-40	+14.8		H & O.
Mike Nan Pup Oboe	M-N	Jul 13	23	1493.7	20468	5	8	+08.3	20476.3				M 9-40	Hydro.
	N-P	" 13	26	1491.6	18905	3	2	+08.7	18913.7				N 11-55	Oceo.
	P-O	" 16	26	1493.2	21727	4	7	+07.2	21734.2				P 11-17	Hydro.
	O-M	" 13	23	1494.0	23443	7	17	+06.9	23449.9				O 9-02	"
	P-M	" 13	24	1493.3	29851	3	14	-13.7	29837.3					Oceo.
	N-O	" 13	22	1495.0	29788	8	5	-08.9	29779.1				Mn 10-28	Hydro.
Pup Nan Two Quack	P-N	Jul 13	26	1491.6	18905	3	2	+06.8	18911.8				P 9-34	Oceo.
	N-2	" 30	20	1501.0	15500	4	24	+07.0	15507.0				N 11-16	Hydro.
	2-Q	Aug 12	20	1505.0	17238	3	11	+07.0	17245.0				2 11-58	Oceo.
	Q-P	" 6	22	1504.4	18739	3	15	+06.1	18745.1				Q 10-15	"
	2-P	" 12	20	1505.0	27307	3	4	-10.4	27296.6					"
	Q-N	" 6	23	1504.4	22398	4	14	-08.5	22389.5				Mn 10-46	"
Pup Nan One Quack	P-N	Jul 13	26	1491.6	18905	3	2	+02.9	18907.9				P 5-47	Oceo.
	N-1	" 30	18	1501.0	18528	3	15	+04.3	18532.3				N 5-32	Hydro.
	1-Q	Aug 12	18	1505.0	12061	5	15	+04.6	12065.6				1 3-47	Oceo.
	Q-P	" 6	22	1504.4	18739	3	15	+04.7	18743.7				Q 9-02	"
	Q-N	" 6	23	1504.4	22398	4	14	-05.3	22392.7					"
	1-P	" 12	18	1505.0	25590								Mn 7-17	"
	1-P	" 6	18	1503.9	25377	2	0							Hydro.
	1-P				25484	5	13	-06.1	25477.9					H & O.

Quad or	Line	Date	Average Depth Fms.	Vel. of Sound M/sec	Bomb Distance Meters	No. of Obs.	Prob. Error Meters	C/n to close Quad	Adjusted Length Meters	Observed Azimuth	Computed Azimuth	O-C	Angle dis-crepancy before adjustment	Ship Bombing.
Mike	Q-M	Sep 19	21	1506.4	41757	3	9							Oceo.
Quack	Q-O_2	" 19	22	1506.0	43204	3	27							Oceo.
Oboe 2	M-O_2	" 19	25	1504.0	22859	3	1			170-09.0	*170-09-00	0		"
	M-O_2	" 19	25	1496.6	22948						*Identical		Obs.Az. held fixed.	Hydro.
Additional Lines	1-E_2	Jul 30	20	1501.0	32118	2	23							Hydro.
	2-E_2	" 30	22	1500.5	26273	4	9							"
	5-E_2	" 29	15	1502.0	13157	5	6							Oceo.
	5-N	" 29	20	1502.1	25594	3	12							"
	3-E_2	" 30	23	1500.1	20880	3	11							Hydro.
	3-N	" 30	22	1500.5	17461	3	4							"
	4-N	" 30	22	1500.2	21011	3	32							"
	4-E_2	" 30	21	1501.0	16954	5	5							"
Quack	Q-1	Aug 12	18	1505.0	12061	5	16	+04.6	12065.6	341-44.2	341-47-15	- 3.0		Oceo.
One	1-S	Sep 20	15	1505.0	10137	3	7			41-18.0	*41-41-58	-23.9		Hydro.
Sail	S-Q	" 5	19	1509.0	19300	3	3			188-58.2	188-37-57	+20.0		Oceo.
Cul-Sh.	C-S	Sep 20	15	1507.0	27541	3	4							Oceo.
Sail	S-U	" 5	18	1508.8	23465	3	4	-16.5	23448.5					Hydro.
Unit	U-Cul	" 20	14	1507.0	14045	3	7							Oceo.
	U-Q	" 5	17	1509.0	39430	4	3							"
Sail	S-R	Sep 5	14	1509.0	18107	3	16	-12.7	18094.3	335-50.7	335-51-54	- 1.2	S 20-08	Oceo.
Rush	R-T	" 5	18	1508.4	21095	3	7	-18.1	21076.9				R 22-20	"
Tare	T-U	" 5	16	1509.0	16255	3	8	-13.9	16241.1				T 24-26	"
Unit	U-S	" 5	18	1508.8	23465	3	4	-16.5	23448.5				U 22-14	Hydro.
	T-S	" 5	18	1509.0	29443	3	11	+22.0	29465.0					Oceo.
	U-R	" 5	14	1509.0	26602	3	11	+21.5	26623.5	275-51.8	276-01-58	-10.2	Mn 22-17	"
Rush	R-G_2	Sep 4	16	1508.4	21075	3	12	-23.3	21051.7				R 28-37	Oceo.
George 2	G_2-B	" 17	20	1508.5	21862	4	11	-20.1	21841.9				G 28-47	Hydro.
Boy	B-T	" 4	20	1508.4	25378	3	5	-19.4	25358.6				B 23-53	Oceo.
Tare	T-R	" 5	18	1508.4	21095	3	7	-19.3	21075.7				T 23-43	"
	B-R	" 5	20	1508.8	34673	4	1	+31.4	34704.4					Hydro.
	T-G_2	" 4	20	1508.4	27983	4	14	+26.3	28009.3				Mn 26-15	Oceo.
Rush	R-E_2	Sep 4	17	1508.4	21709	3	9	-03.4	21705.6				R 7-00	Oceo.
Easy 2	E_2-G_2	" 4	20	1508.4	23882	3	3	-01.3	23880.7				E_2 4-49	Hydro.
George 2	G_2-T	" 4	20	1508.4	27983	4	14	-01.5	27981.5				G_2 2-26	Oceo.
Tare	T-R	" 5	18	1508.4	21095	3	7	-03.2	21091.8				T 4-37	"
	G_2-R	" 4	16	1508.4	21075	3	12	+01.7	21076.7					"
	T-E_2	" 4	17	1508.4	41429	3	3	+04.3	41433.3				Mn 4-43	"

* Inverse computation between adjusted positions of "1" & "S".

Note: The adjusted lengths and azimuths tabulated are the results after least square adjustments of the quads, and rotation of the scheme so that clockwise and anti-clockwise discrepancies in observed azimuths balance. The distribution of the closing error at "Quack" between the left hand and right hand system of triangulation, and its effect on adjusted lengths and azimuths, is not considered in this table.

RECORDING OF STRONG EARTHQUAKE MOTIONS

N. H. Heck, H. & G. Engineer, U.S.C. & G. Survey

For several years engineers have complained, though they are not entirely free from negligence in the matter, that the seismologist has failed to give them information that is needed for the design of buildings to resist earthquakes. The situation is as follows:

As time goes on regions which have suffered severe earthquakes in the past and which may expect them in the future are becoming more and more centers of population. This means that not only are there more buildings and congestion of people and valuable accumulations of property to consider, but that there will necessarily be large structures such as office buildings (skyscrapers), factories, auditoriums, and other buildings which continuously from time to time contain great numbers of people and large amounts of valuable property and records. There are also other structures to be considered such as great bridges, high dams, tall chimneys, water supply systems and miscellaneous structures.

In such regions the various types of structures have been erected and are being erected at the present time. In many cases, though not all, an effort is made to design them to resist earthquake damage. To accomplish this studies are made of buildings that have resisted damage or have been partly damaged in strong earthquakes, working models of buildings are tested on shaking platforms, as at Stanford University, and arbitrary assumptions of maximum acceleration are made, the latter with some success provided a proper factor of safety is allowed. There is one important additional need in the case of the United States - there have been no satisfactory measurements of earthquake motions in the central region of a strong earthquake.

The visit of Mr. John E. Freeman and other engineers to the World Engineering Congress in Tokyo impressed on them the importance of the work of the Earthquake Research Institute of the Tokyo Imperial University, which included among other things investigations of strong earthquake motions. The general interest aroused in this subject on their return had the eventual result of an increased appropriation by the last Congress for the work in terrestrial magnetism and seismology of the bureau which has made the development of the instruments and the start of the work possible. The same interest resulted in the entry into this field of the Massachusetts Institute of Technology, the work being sponsored by the late Dr. Stratton, placed under the general charge of Professor George L. Hosmer, well-known to all members of the Coast and Geodetic Survey for his textbooks in higher surveying and geodesy, and under the immediate direction of Mr. M. W. Braunlich.

The various instruments needed have been developed by the Coast and Geodetic Survey, the Bureau of Standards, and the Massachusetts Institute of Technology. Earthquake waves are in three dimensions and it is, therefore, necessary to measure three components - with two instruments recording horizontal motions set at right angles to each other and a third recording vertical motions. The Bureau of Standards, through Dr. Frank Wenner, who had previously developed the type of teleseismic instrument installed at our Porto Rico and Sitka observatories, has, with the aid of a transfer of funds from this bureau, developed a three-component accelerometer which is able to survive and record strong earthquake motions. The recording is photographic. These components are always ready to record, but can do so only when the recording light is on.

Photographic recording if continuous requires a great deal of expensive paper and, except in times of strong earthquakes, nothing would appear on the record except a series of straight lines. Accordingly, it is necessary to have the record started by the earthquake. The automatic recorders which will be described are so arranged that when the earthquake comes the light goes on, the time marking device starts, and a warning signal is given that an earthquake has occurred. The turning of the drum may or may not be started by the earthquake.

A device known as a starting accelerometer is due to Mr. Braunlich. It is so arranged that it does not respond to an earthquake until a definite acceleration is reached when an electric circuit is broken which results in starting the various operations. The instrument can be set for any desired acceleration. The interval between the operation of the starting device and the full speed of the drum is about 0.2 second so that little record is lost even if the drum starts from rest.

In some of the proposed sites electric current will be available and also competent operators. In these a recorder designed by Mr. D. L. Parkhurst, Chief of the Instrument Division, will be used. This is intended for continuous operation of the drum though the earthquake may be made to start it if preferred. The drum is electrically driven ordinarily from the alternating current line, but direct current motors driven from a storage battery are on the same shaft so that in a case of failure of power on account of the earthquake the record goes on. No change in speed accompanies the shift from one motor to the other. Special features of this drum include a simple method of obtaining the necessary gear reduction, the stopping of the records after a full revolution in case the earthquake does not continue, and the stopping after half an hour in any case. When the drum stops the light goes off and the photographic record stops.

For stations where no facilities are available a recorder designed by Mr. H. E. McComb, Chief of the Section of Observatories and Equipment, is used. This is clock driven and is started by the earthquake. An instrument of this type has been successfully used in all the preliminary tests of the accelerometers. This recorder has all the features that have been previously described except an electric drive.

It is planned to start installation of these instruments in the near future, the first to be placed in California.

A recent visitor to Washington was Professor K. Suyehiro, Director of the Earthquake Research Institute of Japan, who came to this country under the auspices of the American Society of Civil Engineers. In addition to giving a general lecture he attended conferences at the Coast and Geodetic Survey and the Bureau of Standards. His advice in regard to the present program of measurement of strong earthquake motions, also in regard to the future development of these instruments and to the extension of the investigation in other directions, has proved invaluable.

# #

WAR DEPARTMENT
Office of the Chief of Engineers
Washington

October 1, 1931.

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

Dear Sir:

1. This office is in receipt of a letter from the District Engineer, Savannah, Ga. , dated September 22, 1931, commending lieutenant C. A. Egner and his party on the survey ship NATOMA for their cooperation in connection with making a survey of Port Royal Harbor, S. C, luring the spring and early summer of 1931.

2. It gives me great pleasure to express my appreciation of the efficient manner in which the work was carried Out by Lieutenant Egner and his party.

Very truly yours,

(Signed) Lytle Brown
Major General,
Chief of Engineers.

# #

"An engineer's experience has led him to realize that nothing ever is as <u>good</u> as it appears on first blush, and that nothing ever is quite as <u>bad</u> as it first looks. It is the engineer's lot to study a problem with an unbiased mind; to analyze thoroughly and honestly each particular phase of every situation in order to give his client the proper advice. The present national situation is a challenge to the best ability and professional ethics of the engineer - each engineer." William S. Lee, President, A.I.E.E.

SIDE EQUATION TEST USED IN THE FIELD

Paul A. Smith, Jr. H. and G. E., U. S. C. & G. S.

The side equation test was used on several occasions to locate errors in observing. If used properly it will ordinarily indicate the point or points where the largest errors exist. This test is more definite when the errors occur in small angles, But is, of course, not completely dependent on this consideration. From the adjustments of many first order triangulation nets, it is known that the probable error of an observed direction is about 0".4 The probable error of an observed angle - the difference of two directions - is then $0''.4 \sqrt{2}$ or 0".56. The average error of an angle without regard to sign will be about 1.2 x 0".56 or 0".67, roughly 0".7. (See Leland "Practical Least Squares", first edition, page 158). It is somewhat shorter and more convenient to make this test by forming the side equation by the angle method than by the direction method as it eliminates the summing of the products of the correction to each direction and the differences of the logarithms of the sines for 1" of the corresponding angles. The test is only approximate, so the shorter the method the better.

The test is made in the following manner:

Divide the constant term of the side equation by the sum of the differences of the logarithms of the sines for 1" of each of the observed-angle. (The sum of the differences is taken without regard to sign). The quotient will be the average correction to an angle irrespective of sign to close the side equation in particular. It should be less than 0".7 for satisfactory first-order triangulation. It is well to take the pole at each of the vertices of the quadrilateral, writing four side equations, then analyze the results with reference to the triangle closures. At first glance this may appear to be rather laborious, but in fact, it is a fairly short process and is undoubtedly the most certain method available for finding an error if one exists. For references see U. S. Coast and Geodetic Survey Special Publication No. 138, page 208, and Instructions to Engineers, Geodetic Survey of Canada, page 54.

An example of the use of this test in discovering the existence of errors at two stations is given below.

In the quadrilateral Pace-Ford-Hunter-Doggett, all the angles were observed and from the first occupation the closures of the four triangles were -1".87, +3".11, -3".03 and +4".27. On account of the large closures, it was evident that some angles were in error.

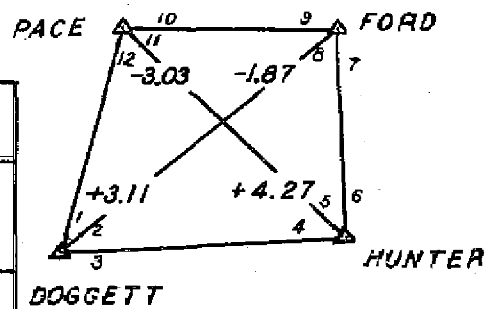
Four side equations were written, taking the pole at each of the four vertices of the figure. These equations gave average angle errors of 1".24 for the pole at Doggett, 0".41 for the pole at Hunter, 0".76 for the pole at Pace, and 0".65 for the pole at Ford. The large closing errors of opposite sign of triangles on both sides of the line Ford-

Doggett suggested at once that there was an error at one or both ends of this line. The side equation with pole at Doggett, however, gave the largest average angle error, and as none of the angles at Doggett enter into this equation, it was safe to assume that the error affecting this diagonal was at Ford. This direction (8) was assumed to be increased by 3".00 and the effect on each of the equations noted. This was an easy process for the differences of the logarithms of the sines for 1 second of each of the angles were already listed. An increase of 3".00 indirection 8 helped the triangle closures and in the side equations changed the average corrections to angles to about 0".29 with the pole at Doggett, to 1".10 with the pole at Hunter, to 0".07 with the pole at Pace, and, of course, caused no change with pole at Ford. There was still the error of -3".11 in the triangle Pace-Hunter-Doggett. It should also be noted that the side equations with poles at Hunter and Ford now gave the largest average angle corrections, so that if there were any remaining error in the angles it must be either at Doggett or Pace. A further substitution of values and a study of the effects of the substitution showed that if direction 11 at station Pace were decreased the side equations would have better closures and the closing errors of the triangles would also be smaller. So in the above case, it was decided to first reoccupy Ford, then Pace. The results obtained after reobserving showed that this reasoning was correct.

A study of the abstracts of directions together with an analysis similar to the preceding one will often help in doubtful cases in deciding where the error lies, as sometimes the abstracts give indications of a change in value of the directions in question. In the case given above only a single observing party was operating, and it was decidedly economical to determine, if possible, where the errors might be found.

Occasionally all the triangles in a quadrilateral will close well, or at least within the limit of error permissible, but the lengths of the sides as computed from different triangles will not check. In such cases the above test is very valuable, and, as far as possible, the triangles should be computed up to date in order to guard against such errors occurring. Several instances of poor side checks were found when the triangles closed well within the allowable limit of 3".00, and the error was found and corrected before the towers were released by use of the side equation test and reobservations.

This method of testing for errors requires practice to obtain the best results, as well as judgment in its use. It should not be regarded as the final decision and should not be used alone. The consideration of all indications of error in the abstract of directions, comments in the records on observing conditions, and, in general, all factors affecting observations will usually enable one to decide upon the most likely station to reobserve.



Pole at Doggett			
-8 +9	34°18'59".07	9.751 0962	+3.09
-4 +6	85 57 20.34	9.998 9172	+0.15
-11+12	58 40 53.68	9.931 6062	+1.28
		9.681 6196	
-10+12	109 38 11.03	9.973 9791	-0.75
-7 +8	50 17 57.16	9.886 1470	+1.75
-4 +5	41 31 31.35	9.821 4818	+2.38
		9.681 6079	
		+ 117	9.40

Assuming +3".00 on direction (8)

$\frac{11.7}{9.40} = 1.24$ $\frac{2.7}{9.40} = 0.29$

Pole at Hunter			
-11+12	58 40 53.68	9.931 6062	+1.28
- 7 +9	84 36 56.23	9.998 0794	+0.20
-2+3	43 44 39.09	9.839 7544	+2.20
		9.769 4400	
-1 +3	79 47 32.60	9.993 0710	+0.38
-10+11	50 57 17.35	9.890 2251	+1.71
-7 +8	50 17 57.16	9.886 1470	+1.75
		9.769 4431	
		31	7.52

$\frac{3.1}{7.52} = 0.41$ $\frac{8.3}{7.52} = 1.10$

Pole at Pace			
-5 +6	44 25 48.99	9.845 1234	+2.15
-1 +3	79 47 32.60	9.993 0710	+0.38
-8 +9	34 18 59.07	9.751 0962	+3.09
		9.589 2906	
-7 +9	84 36 56.23	9.998 0794	+0.20
-4 +5	41 31 31.35	9.821 4818	+2.38
-1 +2	36 02 53.51	9.769 7210	+2.89
		9.589 2822	
		- 84	11.09

$\frac{8.4}{11.09} = 0.76$ $\frac{0.8}{11.09} = 0.07$

Pole at Ford			
-2 +3	43 44 39.09	9.839 7544	+2.20
-10+12	109 38 11.03	9.973 9791	-0.75
-5 +6	44 25 48.99	9.845 1234	+2.15
		9.653 8569	
-4 +6	85 57 20.34	9.998 9172	+0.15
-1 +2	36 02 53.51	9.769 7210	+2.89
-10+11	50 57 17.35	9.890 2251	+1.71
		9.658 8633	
		64	9.85

$\frac{6.4}{9.85} = 0.65$

SIDE EQUATION TEST FIRST OCCUPATION

PAS

C&GS-4.9

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

COMPUTATION OF TRIANGLES

State: Texas and Louisiana.

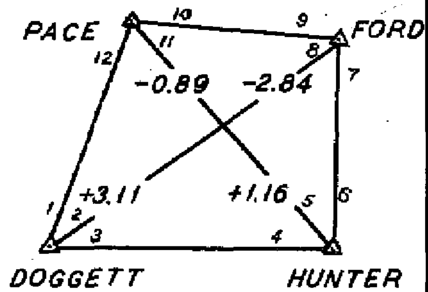
11—6121

NO.	STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
	(FIRST OCCUPATION)						
	2-3						
-5+6	1 Hunter	44 25 48.99					
-10+11	2 Pace	50 57 17.35					
-7+9	3 Ford	84 36 56.23					
	1-3						
	1-2						
		180 00 02.57	-1.87		0.70		
	2-3						
-1+3	1 Doggett	79 47 32.60					
-11+12	2 Pace	58 40 53.68					
-4+5	3 Hunter	41 31 31.35					
	1-3						
	1-2						
		179 59 57.63	-3.11		0.74		
	2-3						
-1+2	1 Doggett	36 02 53.51					
-10+12	2 Pace	109 38 11.03					
-8+9	3 Ford	34 18 59.07					
	1-3						
	1-2						
		180 00 03.61	-3.03		0.58		
	2-3						
-4+6	1 Hunter	85 57 20.34					
-2+3	2 Doggett	43 44 39.09					
-7+8	3 Ford	50 17 57.16					
	1-3						
	1-2						
		179 59 56.59	-4.27		0.86		

Do not write in this margin

C&G.S. 419

(After re-observing Ford)



After Re-obsering at Pace

Pole at Doggett

-8 +9	34 18 56.93	9.751 0897	+3.09
-4 +6	85 57 20.34	9.998 9172	+0.15
-11+12	58 40 53.68	9.931 6062	+1.28
		9.681 6131	
-10+12	109 38 11.03	9.973 9791	-0.75
-7 +8	50 18 00.27	9.886 1524	+1.75
-4 +5	41 31 31.35	9.821 4818	+2.38
		9.681 6133	
		2	9.40

0.2 / 9.40 0.02 — 1.6 / 9.40 0.2

Pole at Hunter

-11+12	58 40 53.68	9.931 6062	+1.28
-7 +9	84 36 57.20	9.998 0796	+0.20
-2 +3	43 44 39.09	9.839 7544	+2.20
		9.769 4402	
-1 +3	79 47 32.60	9.993 0710	+0.38
-10+11	50 57 17.35	9.890 3251	+1.71
-7 +8	50 18 00.27	9.886 1524	+1.75
		9.769 4485	
		83	7.52

8.3 / 7.52 1.10 — 3.6 / 7.52 0.5

Pole at Pace

-5 +6	44 25 48.99	9.845 1234	+2.15
-1 +3	79 47 32.60	9.993 0710	+0.38
-8 +9	34 18 56.93	9.751 0897	+3.09
		9.589 2841	
-7 +9	84 36 57.20	9.998 0796	+0.20
-4 +5	41 31 31.35	9.821 4818	+2.38
-1 +2	36 02 53.51	9.769 7210	+2.89
		9.589 2824	11.09
		17	

1.7 / 11.09 0.15

Pole at Ford

-2 +3	43 44.39.09	9.839 7644	+2.20
-10+12	109 38 11.03	9.973 9791	-0.75
-5 +6	44 25 48.99	9.845 1234	+2.15
		9.658 8569	
-4 +6	85 57 20.34	9.998 9172	+0.15
-1 +2	36 02 53.51	9.769 7210	+2.89
-10+11	50 57 17.35	9.890 2251	+1.71
		9.658 8633	
		64	9.85

6.4 / 9.85 0.65 — 3.3 / 9.85 0.3

SIDE EQUATION TEST

AFTER RE-OBSERVING AT FORD AND PACE

FAS

C&G.S.-419

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form 25
Ed. Jan., 1929

11—6121

FIELD COMPUTATION

COMPUTATION OF TRIANGLES

After occupying Ford and Pace the second time.

State: Louisiana and Texas

NO.		STATION	OBSERVED ANGLE	CORR'N	SPHER'L ANGLE	SPHER'L EXCESS	PLANE ANGLE AND DISTANCE	LOGARITHM
	2-3							4.202 7467
-5+6	1	Hunter	44 25 48.99	-0.42	48.57	0.24	48.53	0.154 8778
-10+12	2	Pace	50 57 15.79	-0.42	15.37	0.24	14.93	9.890 2209
-7+9	3	Ford	84 36 57.20	-0.43	56.77	0.23	56.64	9.998 0795
	1-3							4.247 8455
	1-2							4.355 7040
			180 00 01.98	-1.27		0.71		
	2-3							4.355 7040
-1+3	1	Doggett	79 47 32.78	+0.60	33.38	0.25	33.13	0.006 9288
-11+12	2	Pace	58 40 55.13	+0.59	55.72	0.25	55.47	9.931 6085
-4+5	3	Hunter	41 31 31.06	+0.59	31.65	0.25	31.40	9.821 4820
	1-3							4.294 2413
	1-2							4.184 1148
			179 59 58.97	+1.78		0.75		
	2-3							4.202 7467
-1+2	1	Doggett	36 02 53.51	-0.16	53.35	0.20	53.15	0.230 2800
-10+12	2	Pace	109 38 10.62	-0.16	10.46	0.19	10.27	9.973 9796
-8+9	3	Ford	34 18 56.93	-0.16	56.77	0.19	56.58	9.751 0886
	1-3							4.407 0063
	1-2							4.184 1153
			180 00 01.06	-0.48		0.58		
	2-3							4.407 0063
-4+6	1	Hunter	85 57 20.05	+0.43	20.48	0.29	20.19	0.001 0829
-2+3	2	Doggett	43 44 39.27	+0.43	39.70	0.30	39.40	9.839 7551
-7+8	3	Ford	50 18 00.27	+0.43	00.70	0.29	60.41	9.886 1526
	1-3							4.247 8443
	1-2							4.294 2418
			179 59 59.59	+1.29		0.88		

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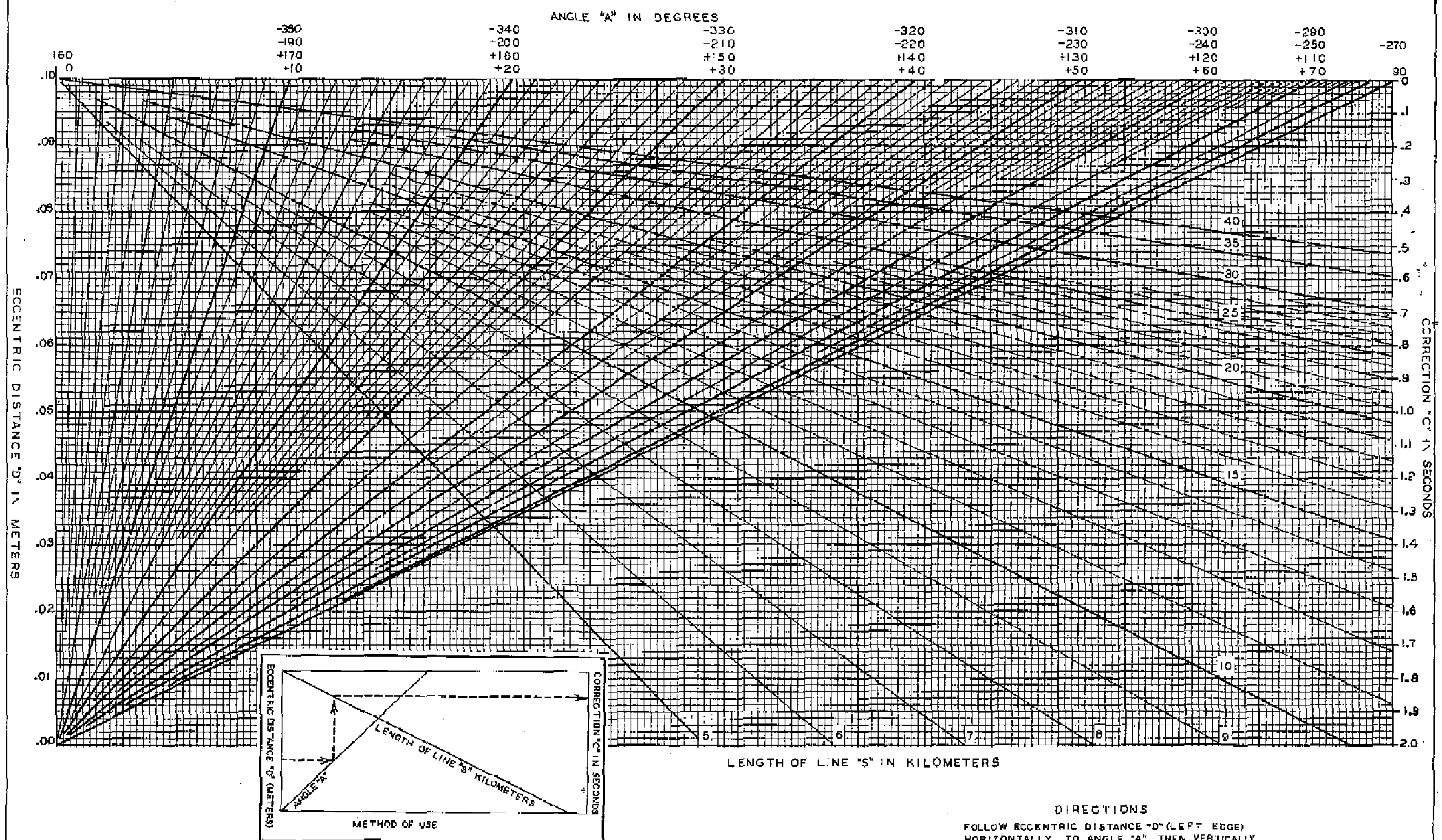


DIRECTIONS

FOLLOW ECCENTRIC DISTANCE "D" (LEFT EDGE) HORIZONTALLY TO ANGLE "A" THEN VERTICALLY TO DISTANCE "S" THEN HORIZONTALLY TO "C" RIGHT EDGE. SIGN OF "C" IS SAME AS ANGLE "A."

REDUCTION TO CENTER

DEVISED BY PAUL A. SMITH JR. H.&G.E. U.S.C.&G.S.

(R-179)

THE DETERMINATION OF THE COMPASS ERROR

A Simple Method of Obtaining Compass Deviations When the Ordinary Means are not Available.

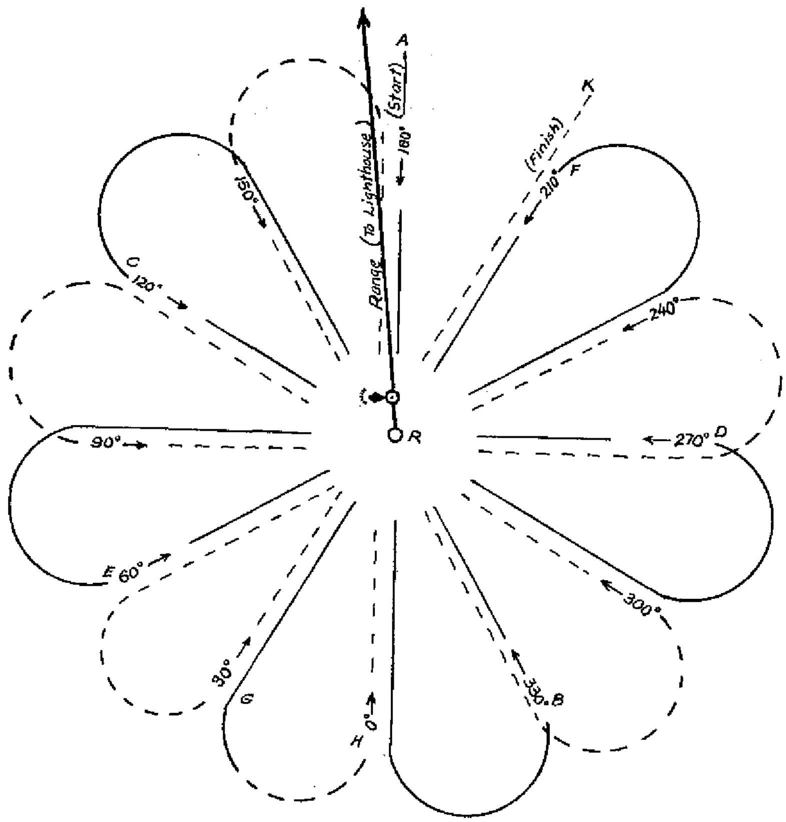
G. T. Rude, H. & G. Engineer, U.S.C. & G. Survey

Standard books on navigation describe several methods for determining the compass error - by reciprocal bearings, requiring a station on shore; by bearings of the sun, requiring a clear day; by ranges, requiring that the magnetic bearing of the range be known; and by a distant object, requiring the object to be at a considerable distance from the ship. The following "gadget", not described in books on navigation, so far as is known, proved of value to the writer. In a sense it combines two methods, the bearing of a distant object and a range; except in the way employed, the "distant object" need be only a few miles away and the bearing of the range need not be known; in fact, the two objects comprising the range need not even be charted.

This method is confined to the determination of deviations of compasses in the fore-and-aft amidship line, when the distribution of magnetic metal to starboard and port is fairly symmetrical. Since practically all compasses are so placed, the method may be regarded as universal. It is not confined to any size vessel except that it may prove time-consuming on a slow-turning vessel of long turning radius. The writer employed the method with very satisfactory results on a vessel 250 feet in length, but it can be used on larger vessels.

The vessel steamed successively on twelve headings (on every alternate 15° rhumb) across the range of Smith Point Lighthouse, Chesapeake Bay, and the lighted buoy six and one-half miles to the southward. The bearing of this range, a few hundred yards to the southward of the buoy, was obtained on each heading by pelorus compared with the standard compass. For the accepted correct magnetic bearing of the range the average of all the compass bearings was used. The deviation on each heading was then obtained by a comparison of the compass bearing of the range on that heading with the mean magnetic bearing of the range obtained by averaging all the compass bearings.

The method was conceived rather from necessity than choice. It has the advantages, however, that it can be used at any time when terrestrial objects are visible - in clear or cloudy weather, during the day or night. It can also be varied according to circumstances. During the day a flag buoy may be anchored and the vessel "swung" with that in range with a lighthouse or headland, or another vessel at anchor in range with a lighthouse or with any natural object; at night a lantern on a small boat at anchor may be used in range with a light, none of which need be charted objects.



The "swing" can be made without maneuvering the vessel with the engines (see figure). The vessel can begin at A, with the lighted buoy a few degrees off the bow, and head 180° (south) by compass. As she passes the range at position R the bearing of the range is observed by compass or by pelorus, compared with compass. After continuing past the range about the same distance as from position A to position R, with a starboard helm, she turns to position B and on to a course 330° (by compass), again observing the compass bearing of the range at position R as she crosses it. This procedure is continued with a starboard helm in each case as indicated by solid lines on the diagram (see figure), on to a course 120° at position C; then to 270° at position D; to 60° at position E; to 210° at position F. Having completed the 210° course at position G, still with a starboard helm, she swings to 0° (north) (by compass) at position H, and now following the broken lines of the diagram steers successively on the following headings (by compass); 150°, 300°, 90°, 240°, and 30°, completing the "swing" at position K. (In order to obviate any confusion the dashed lines and solid lines have been widely separated in preparing the diagram. In actual practice, of course, the two systems of courses on opposite headings represented by these lines may cover practically the same ground). The vessel has now headed successively on the following compass courses in the order named: 180°, 330°, 120°, 270°, 60°, 210°, 0°, 150°, 300°, 90°, 240°, and 30°, with the following compass bearings of the range on the different headings.

Ship's head by compass	Bearings of range by compass	Average bearing of range by compass	Difference of columns B & C or deviation
(A)	(B)	(C)	(D)
Degrees	Degrees	Degrees	Degrees
0	351 or 351	359.7	+ 8.7 or 9 E
50	353 or 353	359.7	+ 6.7 or 7 E
60	358 or 358	359.7	+ 1.7 or 2 E
90	4 or 364	359.7	- 4.3 or 4 W
120	7 or 367	359.7	- 7.3 or 7 W
150	8 or 368	359.7	- 8.3 or 8 W
180	8 or 368	359.7	- 8.3 or 8 W
210	7 or 367	359.7	- 7.3 or 7 W
240	3 or 363	559.7	- 3.3 or 3 W
270	356 or 356	359.7	+ 3.7 or 4 E
300	352 or 352	359.7	+ 7.7 or 8 E
350	349 or 349	359.7	+ 10.7 or 11 E
Average of bearings by compass	359.7		

The average is taken of all the bearings of the range by compass on all headings, in this case 359°.7. For purposes of illustration it may be unfortunate that Smith Point lighthouse actually happens to bear 359°½ from the lighted buoy; that is, so nearly 360° or the whole of a circle; while, of course, this average bearing might be any degree of the compass, depending upon the actual geographic positions of the objects comprising the range and their actual bearings from each other.

The deviation on each heading is then obtained by comparing the bearing on that heading with this average magnetic bearing. These deviations are plotted, as usually done, on the Napier diagram, from which the deviations may be taken by inspection for any other headings. In this case the deviations were obtained with the ship's head on given compass courses. The deviation on each heading is therefore laid down on the dotted lines passing through that graduation of the vertical scale of the Napier diagram representing that heading.

As under other methods, a single swing with one helm will furnish determinations of deviations with a precision sufficient for practical purposes. For the greatest accuracy, of course, two swings should be made with different helms, and for the final Napier curve the mean of the two deviations on each course taken, as is usually done.

It is realised that coefficient A cannot be determined from the swing illustrated. Since A becomes, however, of appreciable amount only when the compass is located off the amidship line, or for some like cause, its value is usually so small that it may be neglected for all practical purposes, or its value from a previous swing may be used.

NEW CONNECTION OF THE GEODETIC TRIANGULATIONS OF MEXICO AND THE UNITED STATES OF AMERICA, ACROSS THE FRONTIER OF BOTH COUNTRIES

*Manuel Medina
(Translation by Earl S. Belote)

In February of the current year, the Department of Geographical and Climatological Research of Mexico and the Coast and Geodetic Survey of the United States made a new connection of their triangulation systems across the Rio Bravo del Norte. This connection was made between the triangulation work that Mexico has planned in the State of Chihuahua and the Texas-California arc of the U. S. Coast and Geodetic Survey.

This international connection is the third of its kind that has been made between Mexico and the United States, the two other connections being that of the arc along the meridian 98 degrees west of Greenwich with the corresponding arc in the United States, and that between the triangulation in Upper and Lower California.

The preliminary reconnaissance of the connecting figure was made in January of this year by the technical representatives of both countries. They agreed upon a quadrilateral with diagonals, two vertices of which are located in Mexican territory and the other two in the United States. The former are located on San Ignacio Hill and on La Sierra del Puerto del Presidio, in the State of Chihuahua (see adjoining figure} and the latter coincide with the points Franklin and Cerro Alto of the Texas-California arc of triangulation of the Coast and Geodetic Survey.

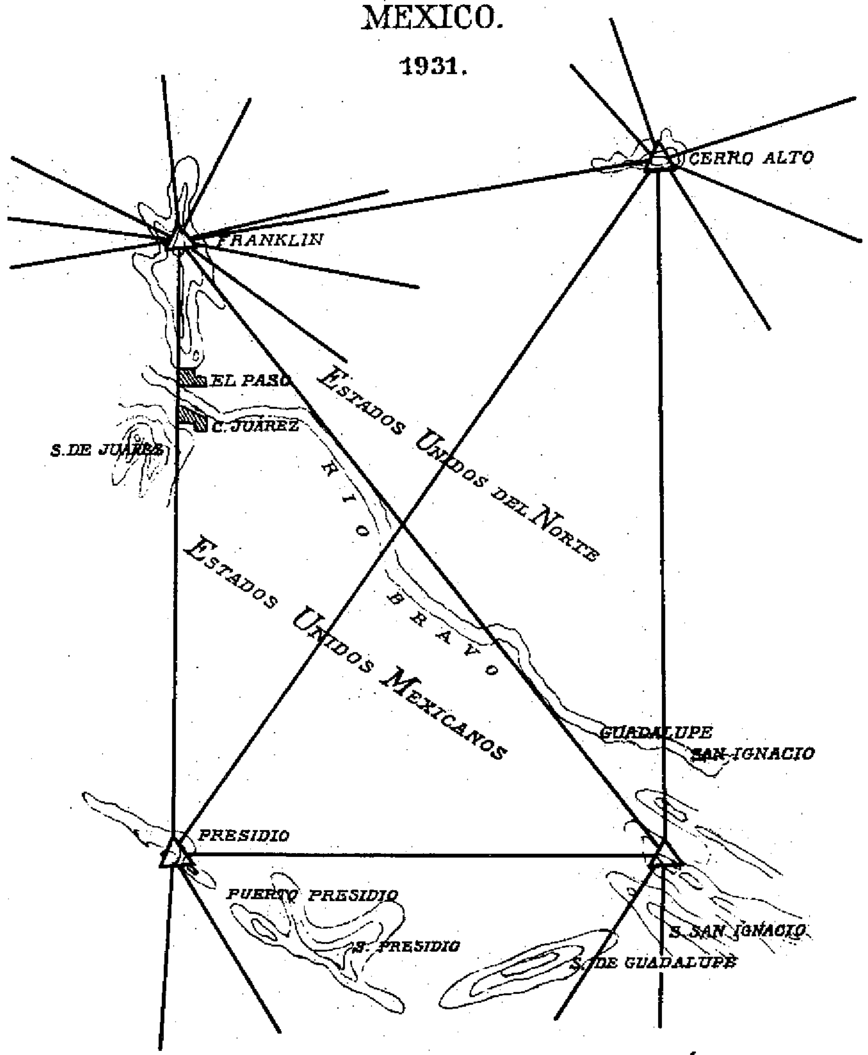
The Mexican vertices were established in such a manner that they can easily be tied in with the extreme north of the geodetic chain that is planned in the State of Chihuahua, a work that will be begun in a very short time.

The measurement of the angles was made simultaneously by the appointed United States and Mexican observers, stationed at the ends of the lines Cerro Alto, San Ignacio and Franklin, Puerto del Presidio, respectively. This measurement was made at night, using electric lights on towers of identical construction for the signals at the vertices. The United States observer, Lieut. Ralph L. Pfau, used a special type of altazimuth of the U. S. Coast and Geodetic Survey, provided with micrometers, by use of which the reading may be made correct to one sexagesimal second. The Mexican delegate, Ing. Horacio Herrera, used a "Wild" precision theodolite, in which the direct reading is made with 0".2 approximation. Both observers repeated the measurement of the directions eighteen times, the initial setting of the instrument being changed for each set of observations.

DIRECCION DE ESTUDIOS GEOGRAFICOS Y CLIMATOLOGICOS.

MEXICO.

1931.



LIGA ENTRE LAS TRIANGULACIONES GEODÉSICAS DE MEXICO Y ESTADOS UNIDOS DEL NORTE.

Esc. 1: 700,000.

The observations in the four vertices of the connecting figure were taken from the 18th of February until the 1st of March, at which time they were completed. The observers had to contend generally with bad atmospheric conditions, which on various nights made it impossible to take observations.

The mean length of this international figure is 60 kilometers and the mean angular closure of the triangles, 1.5 sexagesimal seconds.

This connection of the triangulation of Chihuahua with that of the Texas-California arc has been very important for Mexico, for we may refer directly to the North American datum the arcs that are developed in the west and north of this country, thus giving a greater rigidity to the general geodetic system of the Republic.

THE LOSS OF THE JEFFERSON

E. H. Lukens, H. & G. Engineer, U.S.C, & G. Survey.

Of the many trials faced by Superintendent Bache in his efforts to get the much needed coast survey of the Pacific Coast started, perhaps the most disheartening was the loss of the steamship Jefferson on the coast of Patagonia while en route from Philadelphia to San Francisco in the summer of 1851.

The Jefferson was an iron paddle wheel steamer with a draft of about 11 feet. New boilers were installed and other repairs were made to put her in condition for the long voyage through the Straits of Magellan to California. At her trials on the Pelaware River, she made a speed of 10 miles against the current and wind with a steam pressure of 35 pounds. Her paddle wheel was 20 feet, 8 inches in diameter, and at easy steaming, she made 13 R.P.M. while with forced fires she was able to turn up 20 R.P.M. From the trials the engineers estimated that she would burn 5 tons of coal per day.

The Jefferson left the Delaware Capes on March 10, 1851, and struck head winds for the first part of the voyage. They soon found out that the coal consumption was 8 tons instead of 5 and that she made very poor speed in head winds and seas. By the time they reached the northeast trades, there were but 18 tons of coal left, so they shut down the plant and used sail. She had three masts and was probably barkentine rigged. While sailing, the buckets were removed from the paddle wheels to avoid their dragging and steam was raised only when in a calm. She arrived at Rio de Janeiro on April 24, 1851,

In a letter written from this port, Lieutenant Commanding F. K. Murray, the commanding officer, writes: "I find yellow fever raging here particularly among the shipping and am using every exertion to avoid risk to the crew - - - - Many vessels in port have lost their entire crews."

He thought that the voyage to California would be a long one due to the slow speed of the Jefferson, but added that she was a good sea boat and would no doubt perform the voyage in safety.

The Jefferson arrived at her next port, Montevideo, on May 4th. Although no one on board had contracted yellow fever, "they were subjected to a 6-day quarantine at this port. As they were now entering the season of winter gales," they experienced a series of storms while trying to coal from lighters, and it was not until May 19th that they sailed from this port.

On May 24th, during a very low barometer, a northerly gale overtook them and the Jefferson scudded before it with full steam and all seal that could be safely carried. On the afternoon of the 25th, a heavy cross sea boarded her and threw the vessel on her beam ends when she immediately broached to and lay exposed to the terrific seas following her.

Orders were given to let fly all sheets (except the staysail), but finding that she did not recover, the order was given to cut away the masts. The crew jumped to this dangerous work with a will and succeeded in getting the fore and main over the side. Relieved of two of her three masts, she righted and fell off before the wind much to the delight of all hands, for while the masts were being cut away it seemed that she could never remain afloat. They were now able to heave to under steam and a reefed spanker, the only sail left.

About 6:00 P.M., another heavy sea broke onboard and swept her fore and aft, staving in the bulkheads of the engine room, wheelhouse, etc., and carrying the steering wheel overboard. This shock strained the hull terribly, and Murray was afraid that she would break in two. As soon as the hatches could be opened, provisions, stores and everything that could be spared were jettisoned and some improvement was noted.

To add to the seriousness, the hull began to leak badly and the bilge pumps promptly choked up with coal and would not work. The frames of the engines had started from the hull and were momentarily expected to break. Under full steam they could make but 6 R.P.M. At this point, Murray states; "It appeared that nothing but a miraculous interposition of Providence could save us, and we have great cause for gratitude that this was accorded us; for in a few minutes after the shock which disabled the vessel, the wind hauled to southward and began to die away, and the sea to subside."

They laid to until noon of the next day, when they found by observation that they were 110 miles NE. by N. from Sea Bear Bay on the east coast of Patagonia. The sea having gone down, a jury mainmast was rigged and they painfully made their way to Sea Bear Bay, where they arrived on the afternoon of May 28, having taken over two days to make 110 miles. On June 2, Murray moved the vessel to Port Desire (within sight of Sea Boar Bay), finding it better protected from the gales which prevail at this season.

Murray sadly realised that the Jefferson was a hopeless wreck. She leaked badly, two of her masts were gone and her hull was badly hogged. He appointed a board of officers to survey the vessel and make recommendations. The board found her entirely unseaworthy and beyond repair except in a dry dock. As there were no such docks available, they recommended that, after ramoving all valuable property, the Jefferson be abandoned. This recommendation was approved by the commanding officer and the work of salvage was started at once.

As ships were scarce, Murray chartered the first available vessel, a French barque, the "Austide", of 160 tons, to carry his crew and the lighter machinery back to the United States. The "Austide" put into Montevideo for supplies, and there Murray and his crew transferred to the Naval supply ship "Relief", which vessel arrived in New York November 2, 1851, The boilers, which were too heavy for the "Austide", were shipped by a later vessel.

In his report to Superintendent Bache, Lieutenant Commanding Murray commanded very highly the actions of his officers and crew during the gale, and refers to the "noble conduct" of Mr. Henry Powell, the proprietor of the guano settlement near Port Dosire where the Jefferson was abandoned. Mr. Powell put himself and his men on a short allowance of food in order to supply the crew of the Jefferson and rendered them many kindnesses in other ways.

# #

THE PERSONAL EQUATION AT SEA
(From Pacific Marina Review, July, 1931)

The natural foundation for a ship is sea water. Any well found, shipshape, modern, seagoing steamer or motorship is safe so long as she has plenty of water under her keel, plenty of fuel in her "bunkers, a competent navigator on her bridge, and a well trained and disciplined crew at their various stations. Naval architects have provided a safe, commercial, seagoing hull. Marine engineers have provided dependable and economical steam generators and auxiliary machinery. Metalurgists have provided strong, corrosion-resisting materials for every necessary purpose. Chemists have provided protective coatings. Every branch of engineering and science has contributed to that composite marvel - the modern passengger and cargo vessel - with the net result that to-day sea transport of passengers and cargo is the safest and most economical method known to man. In fact, the only real danger to a modern vessel at sea is that uncertain quantity, the "Personal Element".

Let a vessel be supplied with every effective equipment for safeguarding the navigation of her hull or for maintaining the economy of her propulsion plant, or for aiding the comfort and peace of mind of her passengers - and yet she will surely go ashore or be a hog for fuel, or achieve a bad reputation among the traveling public - unless her navigating officers, her engineers, and her stewards are constantly on the alert to intelligently use the equipment with which she is provided.

One of the worst phases of the personal element factor is the almost universal tendency in the human mind to get careless in the matter of simple routine. This is particularly evident in comparatively short coastwise runs where its results are most dangerous. The crews of coastwise passenger vessels on fast schedules, running up a record of one thousand - two thousand round trips without incident, should be watched very carefully to see that they are alert and are constantly using and gaining confidence in the equipment that at any moment in an emergency may be the means of saving not only the ship but all her passengers.

This is particularly true of navigation equipment. It seems to us that operating management having provided safe navigation devices should formulate some plan for their constant use and devise adequate checking systems to insure the application of that plan. At sea, as everywhere else, we are being continually reminded of the truth of the old adage, "Eternal vigilance is the price of success - and of safety".

THE NEW SECOND ORDER THEODOLITE AND COASTAL TRIANGULATION

R. W. Woodworth, H. & G. Engineer, U.S.C. & G. Survey

FIELD TEST OF NEW SECOND ORDER THEODOLITE

It was the good fortune of the party on the New York Harbor and vicinity control project to be assigned the new Parkhurst 6½-inch Direction Instrument (H-313) with a practical field test in view. Structurally this 2-micrometer, 2-second theodolite is a sturdy, compact, and altogether excellent instrument; the micrometers and circle are quickly and easily read; the tangent-screw assembly is the smoothest the writer has ever used; the telescope definition is superior to any yet encountered, due apparently to an exceptionally high light-gathering power. The ease of adjustment, simplicity and smoothness of operation, and the uniformly good results obtained renders H-313 a pleasure to handle.

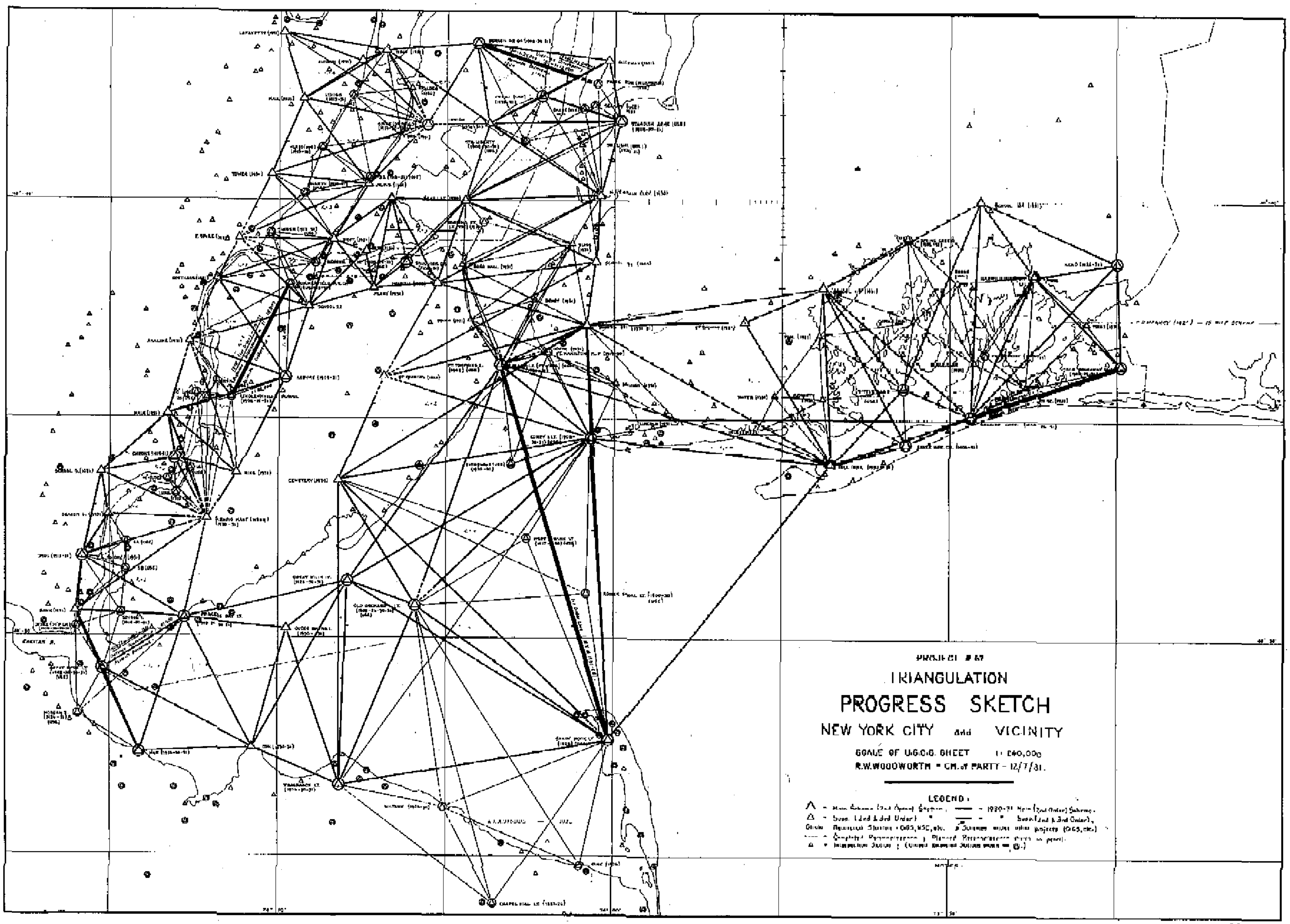
Field use of this instrument has not been as extensive as might be desired for a thorough trial, since the observations now available for statistical purposes cover only the short period from August 21 to October 15, 1931. During this time one observer occupied 34 second-order stations for main and supplemental scheme observations. These stations involved the many types of set-up common to city triangulation; all of which were suitable for third-order occupancy, but including a number only made sufficiently stable for satisfactory second-order observing through special equipment and precautions. Visibility conditions were far from ideal or desirable on the majority of days - the haze, smoke, and heat waves so common to the New York City area supplying additional observing difficulties. The short-line schemes, with their variety of signals, provided still further possibilities for inaccuracy. Despite these handicaps a complete sense of reliability in the accuracy of second-order theodolite H-313 has been imparted by results obtained.

Results Obtained:

1. Low Initial Closures - For the 344 positions taken the average closure of 1.8 seconds indicates an entire lack of drag.

Although the signal chosen for the initial from each station is invariably the one affording the best available pointing, even it may not furnish the clear-cut signal necessary to yield successive directions of small variance. Hence, given a reasonable expectancy as regards visibility conditions, it is felt that this instrument would yield an average initial closure much less than the satisfactory closure already quoted.

2. Few Rejections - For the 1188 directions taken only 57, or 5%, were rejected as exceeding five seconds from the mean. Of these rejected directions 35 were found to have been noted in the horizontal-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NEW YORK CITY and VICINITY
SCALE OF U.S.C.&.G.S. SHEET 1:240,000
R.W.WOODWORTH - CH. of PARTY - 12/7/31.
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direction records as obtained on signals of poor visibility. The 22 remaining rejections include 16 secured from set-ups at 11 stations liable to instability, namely, 4 marsh stations requiring tripod and observer stands plus complete lack of movement within 20-30 feet of the set-up, 2 stations atop old and extremely shaky wooden buildings, 2 atop concrete grain elevators vibrating from elevator machinery within, 2 on slippery tar roofs, 1 on a railroad fill disturbed by passing trains. Eliminating those rejected directions caused by faulty visibility, there remains but a 2% rejection for all directions secured. Carrying this elimination process still further and discarding those rejected directions quite possibly caused by set-ups of doubtful stability there then remains but 6 rejections of directions that should, apparently, have been good. Hence, for the purposes of the field test, it may reasonably be claimed that of all directions obtained only 6, or one-half of 1%, were rejected for causes unknown. This percentage is so extremely small as hardly to be ascribed to instrumental deficiencies, but rather to observational or recording errors.

It is felt that theodolite H-313, functioning under normal conditions of set-up and seeing, would yield abstracts of directions entirely free of any rejections. This opinion is supported by the fact that of these 34 stations under discussion, 9 show abstracts free of rejections, while, of the 25 remaining stations, 4 alone are responsible for 50% of the rejected directions.

3. Good Triangle Closures - Of the many triangles observed with this instrument only those involving non-eccentric stations have been computed to date. These - 10 in number - show an average triangle closure of -1.5 seconds (with a maximum of 2.6 seconds).

As the other station abstracts show equally good results, there would seem little reason for not expecting similar closures for the remaining triangles.

Recommendations:

Several improvements of a minor nature, suggested with a view towards convenience of operation, were approved for incorporation in the three additional second-order theodolites to be constructed shortly. These included:

1. Finely-drawn vertical hairs, spaced for day-observing on various types of intersection signals. These hairs are to be of the finely-drawn glass type recently perfected in the Instrument Division.

2. An astronomical eyepiece - The same was a necessary accessory at four 1931 stations where eccentric distances to the apex of tall beacons could only be obtained through angular measurement from close-up bases. Such an eyepiece is to be supplied with one of the new theodolites for projects similar to the New York City control survey.

3. Marking the magnification power on each telescope eyepiece for the observer's convenience.

4. Open sights on two sides of the telescope - The single pair on H-313 is an excellent device for obtaining eccentric directions over distances short of the telescope focus.

5. A chain-drop and plumb-line hook to reach through the tripod center-serew.

6. Cup-shaped eyepieces on the micrometer tubes to facilitate centering the observer's eye and to aid in eliminating side-light.

7. A uniform dark dull finish on all metal parts of the micrometer box and drum - Bright brass fittings are distracting to the observer's eye when reading the graduated drum.

8. Longer and knurled-end covers for the micrometer tube lamps to facilitate their removal.

9. A medium weight, cross-braced tripod to insure proper stability for second-order work - This type offers several advantages over the lighter, unbraced type; cutting down vibration set up by wind or heavy machinery; lessening the amount of leg slip invariably encountered on tarred roof and other slippery set-ups; obviating possibility of damage to instrument through a tripod leg being kicked out by a careless foot.

10. More tolerance in the tripod head for centering - At least 1½ inches.

11. Increasing the plumb-line fairlead through the tripod center-screw - There are occasional set-ups where the tripod head can not be made level. With the improved method of securing tripod to instrument (by clamping the tripod to a bearing plate resting on the shoulders of the three tribrach footscrews) the tripod center-screw is always normal to the tripod head-plate, which, however, need not be at right angles to the theodolite's vertical axis. A slight deviation from a level set-up cuases the plamb-line to bear against the lower rim of the present small fairlead opening - a contingency the observer must guard against if true centering is to be expected. A 1-inch fairlead diameter and center-screw made as short as possible should prove satisfactory for normal set-ups.

12. Decreasing friction between flexible binding-plate and foot-screws - With the present highly polished tripod plates, to insure the maintenance of the instrument centering, it is necessary to clamp the instrument so tightly to the tripod head that the tribrach footscrews turn rather stiffly. Altered plate surfaces or materials will permit lessened compression.

13. Improved theodolite-box construction - to prohibit any chance of contact between box and standards - micrometer drums - or telescope eyepiece. Heavy leather pack-straps and positive type door catches are to be standard equipment with future boxes.

COASTAL TRIANGULATION

Advantages of this newly developed light-weight 6-½-inch direction instrument over the 7-inch repeating theodolites customarily used for coastal triangulation are manifold, with but few minor points in favor of the latter type instrument. The new direction instrument grants materially increased accuracy, with marked reduction of the observing time, in a sturdy theodolite weighing but slightly more than the 7-inch repeating type. Comparative weights are as follows:

6½" Direction theodolite & box	= 44#	7" Repeating theod, & box	= 32#
Braced tripod for same	= 21#	Unbraced tripod for same	= 13#
Total weight	= 65#	Total weight	= 45#

Should the increased weight not appeal for back-packing up Alaska coast peaks, the braced tripod may always be abandoned in favor of the lesser and compacted weight of observing-stand material. If risk or particularly difficult climbing does not merit transport of the more expensive direction instrument, the 7-inch repeater may be substituted. Since the rugged construction of this new direction instrument is fully equal, or superior, to the long-used 7-inch repeating theodolites, there would seem no reason why it should not effectively supplement the latter for ship-board use with its consequential rough handlings necessitated by surf landings, etc. As for actual field usage, the more precise direction instrument may be used to accomplish the main scheme coastal control in the minimum time - while the 7-inch repeating theodolite is used, as formerly, for the third order fill-in control.

Quoting from Special Publication 145 - "In the matter of speed the direction instrument with micrometer microscopes is superior, as a given accuracy in the angle measurements can be attained more quickly with it than with the repeating type of instrument." This may be illustrated with comparative statistics from the New York City control survey, where, to attain the desired accuracy under poor observing conditions, it has been found necessary to adhere to the following observing program:

2nd order main-scheme observing	Normal obs. time (6 stations)
Using 6½" Direction Theod. - 10 positions -	3 hours, 20 min.
Using 7" Repeating Theod. - 3 sets	5 hours, 20 min.

The one hour difference in observing time very often means a two-station occupancy instead of one as a normal day's work. The time statistics already listed are for occupancies unhindered by the temporary obscuring of signals which is of frequent occurrence in city triangulation - heat waves and smoke shifted by vagrant winds, moving ships and dock cranes being main causes of lost time. It is in the combating of these observing nuisances that the direction type instrument is far superior to the repeating theodolite. The former more readily permits the skipping of a temporarily obscured signal without delay or hindrance in the closing of the set. This one advantage alone renders the direction instrument almost essential for the efficient prosecution of city triangulation.

"The fact that with the usual type direction theodolite the observer must constantly move about the instrument while observing makes the direction theodolite unsuitable for work in cramped quarters". For set-ups, so cramped or unstable as to require a minimum of movement, the repeating theodolite is unquestionably superior. However, such set-ups are infrequently encountered even on city triangulation - the New York City control survey listing but 5% of all set-ups as being within this category. On ordinary coastal triangulation there should be an even smaller percentage of set-ups definitely requiring a repeating theodolite.

To more efficiently extend comprehensive second-order coastal control and accomplish city triangulation over the waterfront areas, the new second-order theodolites should prove admirable instrumental aids. For the supplemental triangulation requiring lower accuracy, and for mountain work where weight is the controlling factor, the 7-inch repeating theodolite will undoubtedly serve as heretofore. In so far as accuracy is concerned, any Parkhurst 6½-inch second-order direction theodolite (provided with a circle equal to the one installed on H-313) should give first-order accuracy, under normal observing conditions, with but a minimum of positions.

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From Season's Report of P. A. Smith on First Order Triangulation

Several engineers in the larger towns through which the party was operating requested that we establish two or more points which might be used to extend future first order work within the city. The ordinary intersection points, such as water tanks, spires and stacks, are not adequate for this purpose. Observations are usually made on such objects during the day and large errors caused by phase, atmospherics and poor objects for signals are likely to result. I believe that we should make it a rule to establish in each city which lies within an arc of our first order triangulation at least two occupied stations, the positions of which have been determined with first order accuracy. At present, most engineers consider the intersection stations which we publish in our lists of geographic positions as strictly first order positions. While the number of engineers at present who thoroughly appreciate first order accuracy are few, there are nevertheless enough of them who really need a control base, and who would use such a line if given to them, to warrant the slight additional cost necessary for such work. Even the short lines used at present on first order work are too long for the local engineer. None of these engineers can afford the cost of building such high signals as are usually required. It is therefore recommended that each town of importance be given a suitable line which is intervisible from each end if possible, at least one end of which has been occupied. In larger cities these points should preferably be on high and permanent buildings.

COST OF HYDROGRAPHY

F. S. Borden, H. & G. Engineer, U. S. C. & G. Survey

The following statistics are based on a study of the cost of hydrographic work accomplished since 1920. They are given for the larger survey units only. Lack of cost data prevents the inclusion of a considerable number of projects.

In determining the unit cost of hydrographic work involving a wide range in the spacing of sounding lines, it is apparent that the unit "cost per square mile" can not be used. The unit should be based on the intensity of the work, that is, either "soundings per square mile" or "miles per square mile". The former could possibly have been used before the advent of echo sounding, but with that method available, the cost of "soundings per square mile" will depend largely on how many soundings one cares to record. Consequently, the unit "cost of miles per square mile", or what amounts to the same thing "cost per mile", has been used.

Intensity of sounding (I) = miles per square mile = average spacing of sounding lines in "lines to the mile"

$$\text{Unit cost} = \frac{C}{I} = \frac{\text{cost per square mile}}{\text{miles per square mile}} = \text{cost per mile.}$$

I. PROJECTS PRIOR TO "USE OF R.A.R. AND ECHO SOUNDING (includes all other methods)

Vessel	Localities	Miles based on	Unit cost
SURVEYOR	S.E. & S.W. Alaska	20736	$11.74
GUIDE	U.S. (Pacific)	16662	11.90
HYDROGRAPHER (I)	U.S. (Gulf of Mexico)	16816	12.02
NATOMA	U.S. (Pacific)	4250	12.28
EXPLORER	S.E. Alaska	3050	13.74
PIONEER	U.S. (Pacific) & Alaska	17379	14.27
DISCOVERER	U.S. (Pacific), Alaska & T.H.	9336	17.63
BACHE	U.S. (Atlantic and Gulf)	16506	18.53
RANGER	U.S. (Gulf) and Virgin Islands	6882	20.22
LYDONIA	U.S. (Atlantic, Pacific) and Alaska	23875	24.11

Mean (weighted) of entire fleet = $16.02

II. PROJECTS SINCE USE OF R.A.R. AND ECHO SOUNDING (includes all methods)

Vessel	Localities	Miles based on	Unit cost
PIONEER	U.S. (Pacific) & T.H.	30905	$ 5.96
DISCOVERER	U.S. (Pacific)	7814	6.65
SURVEYOR	S.W. Alaska	3142	7.43
GUIDE	U.S. (Pacific) and T.H.	8603	8.22
NATOMA	U.S. (Atlantic)	4671	8.91
LYDONIA	U.S. (Atlantic)	3988	13.72
RANGER	U.S. (Atlantic)	2309	13.73
OCEANOGRAPHER	U.S. (Atlantic and Gulf)	6543	17.82

Mean (weighted) of entire fleet = 38.45

Reduction in cost since development of echo sounding and R.A.R.

$$\frac{16.02 - 8.45}{16.02} = 47\%$$

III. LOCALITIES

	Unit Cost	
	Before echo sounding	Since echo sounding
S.W. Alaska	$19.24	$ 7.43
S.E. Alaska	12.99	---
U.S. (Pacific)	14.81	7.77
U.S. (Atlantic)	19.03	13.25
U.S. (Gulf)	16.53	---
Hawaiian Islands	16.48	5.19
West Indies	12.43	---
Mean (weighted)	16.02	8.45

Notes and Explanations:

1. The unit cost given under the OCEANOGRAPHER includes the LYDONIA on their combined project on Georges Bank, 1930.

2. The relatively high cost of hydrography on the Atlantic Coast is due partially to the more expensive control required but largely to the fact that a greater percentage of the areas must be sounded at reduced speeds than is necessary on the other coasts.

3. The comparatively low cost of hydrography in the Hawaiian Islands since the advent of echo sounding is partially due to the fact that the projects on which it is based include sounding lines to and from the working ground which have averaged several hundred miles from the base of operations.

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The percentage of the total annual budget of the United States appropriated to the Coast and Geodetic Survey is less than three-quarters of one-tenth of one per cent.

The per capita cost per year to citizens of the United States for maintaining the Bureau is less than two cents.

The reduction in production of the Bureau resulting from the 1933 economy budget is 5 per cent; the corresponding reduction in per capita cost is one-tenth of a cent.

THE SACRAMENTO-SAN JOAQUIN DELTA PROJECT

O. S. Reading, H. & G. Engineer, U.S.C. & G. Survey

Some ideas and Ideals which have had much discussion around the office are going to be tried out in California shortly. Two new 1:40,000 charts of the delta and lower reaches of the Sacramento and San Joaquin Rivers have been authorized and fortunately, it has bean possible to arrange for the employment of the latest developments in both control and aerial photographic surveys on the project. In addition, the problems to be met are very similar to those along almost the whole of the Atlantic and Gulf coasts where the development of intercoastal waterways demands new charts.

Dredging is in progress under a Federal appropriation which will establish a 35-foot channel up the San Joaquin River some 45 miles to Stockton and 10 feet will be maintained some 59 miles up the Sacramento River to Sacramento. An area of about 850 square miles around and above the junction of these rivers is interlaced with navigable streams and sloughs used to transport agricultural products from the diked farms of the delta and by various small pleasure craft. The area is flat with enough trees to necessitate high signals for many of the triangulation stations.

The dredging and improvements are under the supervision of the U. S. Engineer Corps which has made surveys along the principal channels for use in its work. The area was also surveyed on a scale of 1:31,680 by the Geological Survey around 1908.

The main problems are the coordination and revision of existing surveys, and especially provision for the accurate application of future surveys and developments by the Engineer Corps to the charts.

For some time there has been a growing appreciation of the desirability of breaking down the long lines of the first order control and establishing two or more stations readily intervisible without expensive high towers near each locality where sizable engineering works are likely. A first order double observer triangulation party under Lieutenant John Bowie recently completed an arc down the San Joaquin valley and then took up work on title control for this project. This party will run an arc of first order triangulation with stations five to ten miles apart along both rivers to connections with the main first order arc which spans the valley with considerably longer lines in this vicinity. The party is equipped with ten 90-foot Bilby portable steel towers and first order theodolites. The main scheme stations will be of first order rather than second became with such modern equipment and trained observers there is little difference in cost between first order and second order work, night observations on lights being most economical over the marsh for either class. In addition to the main scheme stations, there will be occupied supplemental stations at intervals of about two miles, the majority of which will be intervisible without tall signals and which will also be stations of the Engineer Corps triangulation and traverse wherever practicable. Lieutenant Bowie reports that the Engineer Corps has offered the meet cordial cooperation and that he expects to tie-in practically all of their stations. As the Engineers' stations along the San Joaquin are each narked with about 5 tons of concrete, there is no doubt that future surveys will he thoroughly coordinated with the present project.

The short and frequently intervisible lines will make it simple to recover the fundamental control for such revisions as may become necessary from time, to time without going a long distance or building tall towers for the purpose. A report discussing the results and costs of this control survey, especially the practicability and desirability of continuing such work in similar areas will doubtless appear in future numbers of the bulletin.

The control will be followed by an air photo topographic survey "which it is hoped will be more accurate as well as more economical than any as yet accomplished on the 1:10,000 scale to be used. The Army Air Corps is cooperating most cordially on the project by photographing the area with the new five lens camera. In addition, it is expected that the most distinguished aerial photographer in the country, Captain Albert W. Stevens, will operate the camera and Lieutenant J. F. Phillips, a photographic pilot of rare skill, will fly the job. The five lens camera with its extraordinary field of 135 degrees and its six-inch focal length will photograph a strip five miles wide on the 1:10,000 scale from an altitude of 5,000 feet. The photographs will be overlapped sixty per cent, both along the strip and laterally and successive strips will be crabbed fifteen degrees in opposite directions. As the centers of some eleven successive photographs will appear on each picture, there will be such an interlocking of the photographs as to give a most rigid radial line plot throughout the area as well as along the closely controlled river banks.

The detail will be carefully traced from the photographs and then reproduced on the 1:10,000 scale by photo-lithographic methods. Blue line prints on aluminum mount ad paper to exact scale and without appreciable distortion will be sent to the field for use as planetable sheets on which the temporary hydrographic signals can be located directly. Other distortion free prints will be supplied for boat sheets and smooth sheets. B1ack and white prints of the sheets on chart paper will also be issued to the general public at fifty cents per copy. Some forty sheets £5 x 30 inches in size will be required to cover the area. In addition to supplying information for the charts, it is hoped that the sheets will be of considerable use for salt water barrier, flood control, and other engineering studies as wall as for the general future development of the area.

The hydrographic surveys of the Engineer Corps will be reduced to the 1:10,000 scale and. applied to the sheets. This hydrography will be supplemented by soundings in the sloughs and channels not regularly surveyed by the Engineer Corps. It is expected that the sheets will be accurate enough to stand enlarging to 1:5,000 where this seals is necessary to show the depths of narrow channels. A special camera which can do this enlarging without appreciable, distortion is to be built.

It is expected that the resulting surveys will be truly basic in both accuracy and quantity of information, that all types of maps may be revised or compiled from them and that revision surveys of the future may be plotted without discrepancies for an indefinitely long period.

Articles describing the outcome of all these expectations will doubtless appear in future numbers of the bulletin on account of the importance of the results for planning surveys of similar areas along the East Coast.

An especially noteworthy feature of the work thus far is the cordial and effective cooperation existing between the various governmental organizations concerned. The photographic survey with the five lens camera could not have been accomplished without the assistance of the Air Corps. The free interchange of information between the Engineer Corps and the Coast and Geodetic Survey will result in more up-to-date charts on the one hand and accurate coordination of surveys on the other; a gain in total efficiency on account of division of work which will not be lost through lack of cooperation between separate organizations.

Noteworthy also has been the activity of the Inspector of the San Francisco Field Station in promoting the project and assisting in this cooperation as well as in arrangements for placing photographic targets on control stations where necessary and otherwise assisting the field operations.

OLD SURVEYS AND NEW

Hugh C. Mitchell
Senior Mathematician, Division of Geodesy.

A major function of a scheme of first-order triangulation across any region is the full coordination and correlation of all detail surveys of that region. This does not mean only those surveys which are contemporary with or which may come after the first-order scheme, but there are good reasons why earlier surveys - even back to the earliest ones - should, through a principal control survey, find full reference, each with all the others.

While a full coordination and correlation of hydrographic charts are of fundamental importance to all who use them, the actual comparison of the old surveys of an area with the new is of no concern to the mariner. He is concerned only with the present. He desires the best obtainable charts showing present conditions. As soon as a new edition of a hydrographic chart is issued, the edition which it replaces is marked "Obsolete". But such a chart is obsolete only so far as the navigator conning his vessel through its waters is concerned. Apart from their value as an historical record of certain conditions at a certain epoch, such charts have large value for engineers. The student of physical hydrography engaged in tracing shoreline changes - the scouring of new chan-nels, the filling-in of old - will require a number of such "obsolete" charts, each for a different epoch, and the value of his studies will depend not only on an orderly sequence of the epochs of the charts used, but in a large degree on the coordination and correlation of the records on which they are based. In tracing the building up or wearing away of a shoreline, the sequence of the charts may often have great cadastral value and acquire strong legal quality. Likewise in the planning of shore structures, whether they be constructive, as wharves and docks, or remedial, as retaining walls and dykes, a knowledge of what has occurred in the past is essential to good planning for the future.

The various functions and values of a first-order control are well exemplified in the proposed triangulation over Long Island Sound and across Long Island itself, for which the reconnaissance is now being made. These shores have been covered a number of times by surveys of this Bureau, the first surveys in this region going back close to a hundred years. The successive surveys in each region have followed the ordinary procedure of having each survey obtain length and position and orientation from some preceding one, and being thereby subject not only to any inaccuracies in the marking of the older stations, as well as to errors of recovery, but also to an accumulation of errors - not blunders, but errors - legitimate errors, but errors none the less, which will accumulate as the detail survey becomes more and more remote, in time as well as place, from basic control.

Fortunately for the surveys along the shores of the Sound, there are in that region a number of stations which have been recovered and used a number of times, and connecting these stations to the first-order triangulation will satisfy all requirements. Some of these stations are lighthouses which have been used repeatedly as hydrographic signals. Others are points marked on the ground, which, because of natural conditions, have been sheltered from the decay and erosion that ordinarily come with the passing of time, and through fortunate location have escaped destruction by man - either in legitimate building operations, through, ignorance of their nature and value, or because of vandalism.

A strong contrast to conditions in the Sound with its rock-ribbed shores is furnished by the southern shores of Long Island, with its marshy margins, its shoal bays, and its ever shifting sands. Here, in places, even the best of survey monuments must yield before nature's onslaughts, and it is the irony of survey conditions that in those regions where property values are high and old survey stations most valuable changes have been greatest and the recovery of old stations most difficult.

The survey sheets of the Coast and Geodetic Survey are steadily becoming more and more valuable as records showing shoreline changes, and are proving of great assistance in settling certain types of property disputes. Whenever it is possible to obtain a modern determination of geographic positions of objects on an old survey sheet, indisputable evidence is secured relating the old surveys to the new, showing for a certainty the sum of the changes which have occurred between the two dates. While in some cases, as has just been instanced for the shores of Long Island Sound, it seems reasonably certain that a sufficient number of old stations, points marked on the ground and such structures as lighthouses, will be recovered to give an accurate answer to the question of relating the old and new surveys, in other regions it may be that not a single marked station will be recovered and dependence must be placed wholly on other objects which were determined as supplementary stations. It is in the recovery and use of these supplementary stations of the early surveys that experience and good judgment are most essential, for here what may seem a normal, logical conclusion may sometimes prove erroneous and load the engineer astray. Instance the report made on a triangulation station called "Norwalk north spire", determined in 1834, and reported as lost by an officer of the Survey in 1909, who, by investigation, found that the edifice having become too small to accommodate the congregation was taken down and rebuilt on the same site in 1840; that some of the old timbers were used in the tower for the new spire, and that the weather vane on the new spire was the same that surmounted the old. He reported that the old spire was on the eastern end of the church, the new one on its southern end. How easy it would have been to assume a recovery of the old station - until observations proved something wrong. Another instance where things were not just what they seemed was the case of a life saving station tower on the south coast of Long Island which was visited by an officer of the Survey after he had secured several cuts on it; he found it was being moved to a new site on the beach. Years later another report on this object stated briefly:

"The .... described building evidently had not reached its destination in 875".

In spite of such instances as the above, buildings, or rather definite points thereon, stake good stations for the control of detail surveys and maps. The danger in their subsequent use lies in the possibility of a remodeling which will cause a shifting of the point observed on. Church spires especially make splendid objects on which to observe, but they must be used with extreme caution. It not infrequently happens that a church is enlarged several times to meet the needs of a growing congregation; sometimes it is entirely rebuilt on the original site. With alterations or rebuilding, a spire is apt to undergo a change of position, sometimes so slight as to make one suspicious of the observations rather than of an actual change of position. An historical inquiry will usually prove most profitable and discover any changes that may have occurred in a building since it was first determined.

An inquiry into the history of a building, such as a church, is usually not a difficult matter. The church's own records and the data usually carried on the cornerstone or on a memorial tablet may furnish all the evidence required in tracing its history in relation to alterations and a possible rebuilding of the structure. With other buildings one may have to depend upon a personal inquiry among the residents of the neighborhood and in rare cases there is always the final resort of a redetermination by triangulation of the point in question.

That time and trouble may sometimes be saved by a preliminary inquiry into possible changes in a neighborhood even before a search is made for a marked and described point is shown by the following report on a station established in 1875 on the ocean side of long Island:

> "The above described station undoubtedly is no longer in existence. Although the present shore (ocean side) of the beach is 250 meters south of where the station stood in 1875, the C. and G. Topo. Survey of 1879 shows that between 1875 1879 the shore had receded 150 meters to the northward, showing that the beach was washed away subsequent to 1875 and remade at some time since 1879."

In the face of this study a field search for the station would be a waste of time, though without the study many fruitless hours might have been spent digging and probing in the ground around the spot where the station had stood.

Flagpoles are unsatisfactory objects for perpetuating a control; they are sometimes blown down or struck by lightning or otherwise destroyed and are not always (perhaps "not usually" is a more accurate term) renewed in the same position. Furthermore, the history of a flagpole is not easily traced. Chimneys are more satisfactory objects than flagpoles in holding detail control, especially where symmetry of form compensates for bulkiness. Even where a chimney is torn down its foundation often remains, and where a house is permitted to fall into ruins the chimney may remain (at least in part) even after the house has suffered the fate of so many abandoned houses - gone up in flames.

There are many objects with well defined points on them which make admirable targets on which to observe and which, because of location and apparent permanency, might have wide use in future surveys. To select only a few of these objects for determination is unwise, since no one can say which ones will be destroyed in the future and which will remain - and we know that the mortality among such objects selected for survey purposes may be quite high.

If an object is carefully described when first determined - describing not only the particular part pointed on in the observations, but any other characteristics of the structure which will help identify it - subsequent visits to the stations are aided and future recoveries of the station or proof of its loss are made easier. Even where the object is known to be a temporary character, a statement to that effect is desirable. It may be taken as an axiom that ANY OBJECT WORTH DETERMINING IS WORTH DESCRIBED.

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NATOMA HAS CLOSE CALL

While at anchor in Pollock Rip Channel observing currents on the night of September 9, 1931, the NATOMA narrowly escaped destruction by being run down by the Hamburg-American liner Cleveland. Although the night was clear and the NATOMA had the regulation lights, the German liner apparently did not recognize her as a vessel at anchor until very close and then, with a blast of her whistle, she made a quick turn to starboard and flashed by, side-swiping the NATOMA and leaving a streak of black paint on the NATOMA'S bulwarks. No material damage was done.

(Circular letter No, 22, 1951, amends paragraph 516 of the Regulations which prescribes the signal lights to be shown when engaged upon survey work).

HEADQUARTERS

TREASURY DEPARTMENT
UNITED STATES COAST GUARD
WASHINGTON

15 July, 1931.
JUL 17 9 35 AM

Captain R. S. Patton,
Director, Coast and Geodetic Survey,
Washington, D. C.

Dear Captain Patten:

There has just come to my desk the June Bulletin of the Association of Field Engineers, U.S.Coast and Geodetic Survey, I have looked through its pages with interest, and wish to compliment your organisation upon publishing such an instructive and creditable Service bulletin. I am confident it is proving very helpful to the personnel of the Coast and Geodetic Survey as well as to those interested in the operations of your Service,

Very sincerely yours,

F. C. BILLARD,
Rear Admiral, U.S. Coast Guard,
Commandant.

Brigadier H. St. J. L. Winterbotham,
Director, Ordnance Survey Office,
Southampton, England.

Ordnance Survey Office,
Southampton, 4th August, 1931

My dear Bowie:

This morning I found on my table an envelope which contained a copy of the June 1931 Bulletin of the Association of Field Engineers of the United States Coast and Geodetic Survey. The briefest glance at its scope shows that it is not only valuable but, one might say, indispensable to us in the Ordnance Survey.

First of all, then, I want to thank you for your personal intervention which, I take it, resulted in my having this copy, and, secondly, I would like to know through what channels I can acquire the first two Bulletins, for I see this is marked No. 3.

Yours sincerely,

(Signed) Winterbotham

W. Bowie, Esqre.

DEPARTMENT OF COMMERCE
BUREAU OF LIGHTHOUSES
WASHINGTON

July 28, 1931.
JUL 30 9 54 AM 31

Captain R. S. Patton, Director,
U. S. Coast and Geodetic Survey,
Washington, D. C.

My dear Captain Patton:

I have just spent a delightful hour or two with the June Bulletin of the Association of Field Engineers. Perhaps this was helped by an unusually reminiscent mood from having spent last Sunday evening with Major and Mrs. Julian DeCourt. I do not know whether you will personally recall the then Captain DeCourt, but there must be a number of officers of the Survey who will recall his cooperation in combating the pulajanes and the baguios on the east coast of Samar during the seasons of 1905 and 1906 or thereabouts, when the PATHFINDER was working in that section, and later on when Captain DeCourt was stationed at Boac on Marinduque. At Boac Captain DeCourt and his bride of a month were guests on board the FATHOMER at a dinner welcoming the writer and his bride of two weeks.

Passing abruptly from reminiscence to the very practical present, I have been especially interested in the articles in the Bulletin pertaining to some of the strictly modern phases of the Survey's work, particularly the RAR, and the use of aerial photography in the revision of topographic surveys. As suggested in the article on some supplemental use of air photo topographic sheets, it appears to me that the Lighthouse Service might find these sheets very useful in various ways. I do not know whether it would be practicable for your field parties to collect data by this means of other than incidental value to the Lighthouse Service, but If so, I venture to suggest that aerial photographs of lighthouse reservations on a fairly large scale would be of immense value to this Bureau.

I have personally found this copy of the Bulletin of such interest that were it a strictly official publication, and not limited as I realize it must be in the number of copies available, I would be disposed to request that copies be furnished to each one of our district superintendents.

Very sincerely yours,

Deputy Commissioner of Lighthouses

KDK:EBF

Translation - A.Ervin

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852
THIRTY-THREE WEST THIRTY-NINTH STREET
NEW YORK

July 16, 1931

MR. RAYMOND S. PATTON
M. Am. Soc, C.E.
U.S. Coast and Geodetic Survey
Washington, D.C.

Dear Mr. Patton:

We are just in receipt of the June Bulletin No. 3 of the Association of Field Engineers of the U.S. Coast and Geodetic Survey. This is a very excellent piece of work and I find many items that are interesting and instructive. Please extend our congratulations on the result they have accomplished to those who are responsible for gathering together those interesting articles and putting them together in this attractive form. The makeup of mimeographed sheets with full page illustrative sheets is unusual but the result is both pleasing and effective.

Very sincerely yours

SYDNEY WILMOT
Manager of Publications

Office of Secretary,
International Association of Geodesy,
of the
International Geodetic and Geophysical Union.

78 rue d'Anjou, Paris (8).
FRANCE.

PARIS, August 9, 1931.

My dear President;

I have to-day received Bulletin No. 3 of the Association of Field Engineers of the U.S, Coast and Geodetic Survey (June, 1931.)

I suppose that it is you who sent me this volume, unless it might be one of the authors of the articles on photogrammetry which are inserted in it: Messrs. O.S. Reading, W.J. Chovan, etc. for those-articles are marked with a red crayon in the Table of Contents. In any case, I find this issue very interesting by the number and variety of the articles which it contains, and I wish to ask you if it is possible for you to have the Association of Field Engineers make regular service to the Library of our Association, that is to say, to send previous Numbers 1 and 2, and to forward numbers in the future.

In exchange, if that Association so desires, I shall send directly to it the publications of the Association of Geodesy.

Accept, I beg, my dear President, my best wishes,

(Signed) G. Perrier,
Secretary.

Mr. W. Bowie.

C.&G.S.419

OFFICE OF THE SUPERINTENDENT COAST GUARD ACADEMY

TREASURY DEPARTMENT

UNITED STATES COAST GUARD

NEW LONDON, CONN.

28 August, 1931.

Association of Field Engineers,
U. S. Coast & Geodetic Survey,
Washington, D. C.

Gentlemen:

On returning from the Cadet Summer Practice Cruise is found a copy of your Bulletin No. 3 for June. Its contents are of such absorbing interest to and value for cadets, and for officers as well, in the course of instruction here that I have to request that the two previous numbers be sent to us to be placed in our library.

Please advise if there is any charge for these bulletins, which we will be glad to defray

Respectfully,

H. G. HAMLET,
Captain, U. S. Coast Guard,
Superintendent.

Potsdam, den 27. August 1931

Dear Dr. Bowie: :

Several days ago, I received the Bulletin of the Field Engineers of the U. S. Coast and Geodetic Survey, No. 3, June, 1931. I assume that it was sent to me through your kindness. I wish to express my sincere thanks to you for doing it and I wish to tell you that this publication has interested me very much. I would feel very much obliged to you if you could let me have also the two preceding copies and to send me every subsequent publication. If this remittance has not been occasioned by you, then I wish that you would direct my thanks to the publisher or to the one who sent me this copy.

I was especially interested in your letter to Commander Borden, concerning the aim and purpose of the Bulletin, and also your report concerning the progress of the control surveys which you are executing at the present time. I congratulate you sincerely that you have succeeded in receiving a fourfold increase in the appropriation for your institution and in addition an increase in your personnel.

Thanking you again and with sincere greetings, I remain

Your Devoted

Prof. Dr. E. Kohlschütter,
Director, Geodetic Institute,
Potsdam, Germany.

ADDRESS ALL COMMUNICATIONS TO SUPERINTENDENT OF LIGHTHOUSES CHARLESTON, S. C.

DEPARTMENT OF COMMERCE

LIGHTHOUSE SERVICE

HLB:SO'B

OFFICE OF SUPERINTENDENT, 6TH DISTRICT
CHARLESTON, S. C.

August 6, 1931

The Chairman,
Executive Committee,
Association of Field Engineers,
U. S. Coast and Geodetic Survey,
Washington, D. C.

Dear Sir:-

Some good friend of mine and associate of the old days when I was a member of the field organization of the Coast and Geodetic Survey is probably responsible for my having received a copy of the June, 1931, number of the Bulletin of the Association of Field Engineers. I wish to express my sincere thanks for his action.

The Bulletin is an exceedingly interesting publication, particularly to an old Coast Survey officer whose recollections of his work and associates in that Service will always be fresh in his mind as well as most pleasant and agreeable.

The almost flawless perfection of its typographical make up is worthy of special mention. All of the articles are most interesting and informative. The comments and informal expressions of the individual views of the various authors, a good many of whom are well known to me, make it a fascinating publication.

Again I thank my friend whose identity is not known to me.

Sincerely and cordially,

H. L. BECK,
Superintendent of Lighthouses.

MEMBER ORGANIZATIONS

CORPS OF ENGINEERS, WAR DEPARTMENT
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INTERIOR DEPARTMENT BUILDING
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July 17, 1931.

Mr. O. S. Reading,
Coast and Geodetic Survey,
Washington, D. C.

My dear Mr. Reading:

I have pleasure in acknowledging, with thanks, a copy of the bulletin of your Association of Field Engineers, June, 1931, edition.

The bulletin is extremely interesting, particularly the articles it contains on the subject of photo-mapping. Do you think permission could be obtained to publish in the Board of Surveys and Maps section of The Military Engineer portions of the papers that might be of interest to readers of the magazine? Credit would, of course, be given in any case.

Very truly yours.

J. H. Wheat,
Secretary.

BUREAU HYDROGRAPHIQUE INTERNATIONAL
Monaco.

INTERNATIONAL HYDROGRAPHIC BUREAU
Monaco.
25th August 1931

My dear Captain Patton,

I wish to thank you for the June Bulletin, 1931, of the Association of Field Engineers, U.S.C. & G. Survey, which I appreciate very much.

I am asked to communicate to you the following: "Admiral Tonta appreciates very highly the gracious kindness of the Association of Field Engineers, U.S.C. & G. Survey, in sending to him Bulletin No. 3, June 1931, of that Association. He is convinced that this publication, the first example of a free hydrographic tribune, will contribute much to the progress of hydrography and navigation.

In the November number, 1931, of the Hydrographic Review, Admiral Tonta will publish a note on the "Exact Determination of Points at Sea", which was inspired by the interesting articles of Messrs. G. D. Cowie and K. T. Adams, published in the December, 1930, Bulletin of the Association of Field Engineers, U.S.C. & G. Survey."

Sincerely,

(Signed) Andrew T. Long

Captain R. S. Patton,
Director, U.S.C. & G. Survey,
Washington, D. C.

PACIFIC POWER & LIGHT COMPANY

PUBLIC SERVICE BUILDING

PORTLAND, OREGON

July 17 1931

JUL 22 12 08 PM '31

Commander F S Borden
Sec. Assn of Field Engineers
U S Coast and Geodetic Survey
Washington D C

My dear Commander Borden

To say that I am pleased with the Bulletin of the Association of Field Engineers is putting it mildly. This is certainly an enticing publication. When I opened it, through some freak of fate, I found myself looking at page 83, which is the beginning of the article about my grandfather McArthur's experience with the mutiny in San Francisco Bay.

This sort of publication it seems to me ought to be exceedingly valuable to the men in the field as it gives them a chance to exchange ideas and experiences.

Your courtesy and that of Captain Patton in keeping me in mind is greatly appreciated. I hope this is not the only copy of the Bulletin I will receive.

Yours faithfully,

LAMcA-GH

University of Minnesota
College of Engineering and Architecture
Minneapolis July 20, 1931.

Captain R. S. Patton,
Director, U. S. Coast and Geodetic Survey,
Washington, D.C.

My dear Captain Patton:

I have received a copy of Bulletin No. 3, June, 1931, of the Association of Field Engineers of the U.S. Coast and Geodetic Survey. The material in the volume made up of contributions from various officers of the Survey, is exceedingly interesting to me in view of my former service and long relations with the Survey. I wish to express my appreciation of the courtesy of the one to whom I am indebted for the volume and my congratulations to you as Director of the Survey for this evidence of a loyal and informal activity among your staff. I should be glad to know who the officers of this association are and especially who constitute the editorial staff of this publication. Please convey to them my appreciation and congratulations also.

The interest which has been aroused by this bulletin prompts me to ask if I may be supplied with the two preceding bulletins, since this one is number 3. Also, I hope my name may be continued on the mailing list.

On page 111, there is a note entitled, "Stories Needed". This publication would seem to be an appropriate place to compile and preserve many of the stories connected with the old days of the Coast Survey. Perhaps, it may not be amiss for me to contribute the following from my reminiscences of thirty years ago:

The old time devotion of field officers of the old school may be exemplified by a statement made in all seriousness by one of the older men in my presence that "If there is no Coast Survey in heaven, I don't want to go there".

About thirty years ago, there remained in the Computing Division several men of very long and distinguished service, including Mr. Schott, Mr. Doolittle, Mr. Courtney and Mr. Dennis. The active charge of the Division had been placed in the hands of Mr. Hayford. Mr. Schott, who for many years had been the Chief of the Division and the leading geodesist in the country, was then devoting his attention principally to the adjustment and determination of the transcontinental arc of triangulation and the eastern oblique arc of the United States. It was considered quite a joke among the younger men when someone referred to that activity as being carried on by the "Division of Archeology".

With kind regards, I remain

Very sincerely yours,
(Signed) O. M. Leland, Dean

The Metropolitan Water District
of Southern California
Los Angeles, California

Beaumont, California,
August 14, 1931.

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

My "dear Sir:

It was indeed a pleasure for me to read the splendid June, 1931, Bulletin of the Association of Field Engineers of the U. S. Coast and Geodetic Survey.

I believe this bulletin furnishes a much needed medium for expression of various ideas developed intentionally or accidentally by officers of the Bureau. It is a deplorable fact that there is a considerable economic waste of time and effort simply because we do not pass on to our successors many of the smaller hints and helpful methods which often do not seem important enough to become the subject of a special engineering article. In other words, we do not sufficiently profit by the experience of others, at least not in the smaller things.

May I suggest that the section entitled "Suggestions" be enlarged in the next issue and that each officer be requested to send in one or more short contributions developed from his experience or associations.

I shall appreciate receiving future copies of this splendid and useful publication. It has particular interest for me due to my former connection with the Service and with the Field Association, the memory of both of which I prize most highly.

Very sincerely yours,
(Signed) Floyd W. Hough
Geodetic Engineer.

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To Commander Frank S. Borden:

The next time you prepare a bulletin, would it not be well to include a note to the effect that if any of the engineers who have finished with their bulletins and can not keep them in their files, they should send them to you? I am sure there will be a call for those bulletins for months, or years, after they have appeared. It would be too bad if some of our engineers had to throw their copies away feeling they could not carry them around.

(Signed) W. Bowie
Chief, Division of Geodesy
Coast and Geodetic Survey.

Aerotopograph Corporation of America
1800 E Street, Northwest
Washington, D. C.

July 22, 1931.

Mr. O. S. Reading,
U. S. Coast and Geodetic Survey,
Washington, D. C.

Dear Mr. Reading:

I want to thank you for sending me a copy of the June, 1931, Bulletin, and hope that you will remember me for future copies if they are all as interesting and instructive as the present number, as I am sure they •ill be.

The information contained in the four articles bearing on the construction of maps from aerial photographs and on the practical use of such maps should prove of considerable interest to those readers who have not had an opportunity as yet to familiarise themselves with the possibilities inherent in the use of photographs for map construction.

I hope that some of your future articles will bear on the field of aerial photographs as a record of ground conditions and stress particularly the accuracy of such a record from the mathematical point of view. We all realise the very great importance placed on photography by the astronomers of the present day, and if they have found photography so valuable in a science requiring extreme precision of measurement, I think that the engineer and map constructor need have no hesitation in accepting the accuracy of measurement made on the proper type of aerial photograph.

With kindest regards, I am

Very truly yours,

(Signed) T. P. Pendleton
Chief Engineer

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COST OF BULLETINS

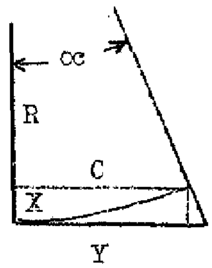
	#2-Dec., 1930 (300 copies)	#3-June, 1931 (518 copies)
Stencils and paper	$28.24	$56.25
Cutting stencils	35.00	35.00
Cover paper	15,00	16.97
Cuts for photographs	28.72	58.42
Printing photographs	10.00	23.00
Designs & drawings	20.00	25.00
Rotaprints	44.38	45.80
Binding & trimming	23.68	51.20
	300)205.02	512)312.64
	$0.68 each	$0.61 ea.

There will be 500 copies of this edition of the bulletin. It has been necessary to reduce the cost in order to balance the Association's budget. This has been done by omitting all photographs. The total cost of this issue will be approximately $250 or 50 cents apiece.

PLOTTING ARC OF CIRCLE WITH LARGE RADIUS AND COMPARATIVELY SMALL ANGLE AT THE CENTER

W. H. Burger
Professor of Civil Engineering, Northwestern University

(In commenting on the methods employed by Commander F. B. T. Siems of drawing R.A.R. distance circles of long radii, as described in the June, 1931, Bulletin, Professor Burger has submitted the following on that subject:)



By considering the curve parabolic, an approximation is arrived at which is accurate enough for all drafting purposes unless the angle cc is too large. Therefore the problem becomes one of laying off a parabola by offsets from the tangent "Y" or the chord "C". Burger's method is rather a quick method of using the chord "C".

Given the radius "R" and the angle α, compute "X" and "Y" by the ordinary methods of trigonometry. Decide on number of equidistant ordinates, and number as in the figure (seven in the illustration). The remainder of the work is rather mechanical and needs only a slide rule for rapid solution.

Formula:
Let N = the number of ordinates selected. Then:

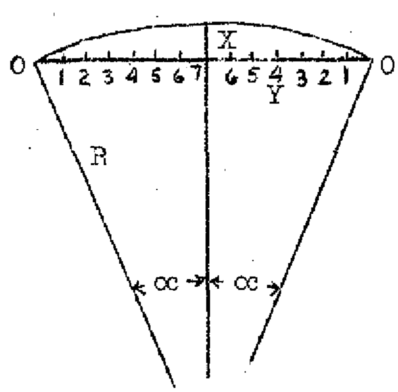
$(1) = \frac{X}{N} \cdot \frac{2N-1}{N}$

$(2) = \frac{2X}{N} \cdot \frac{2N-2}{N}$

$(3) = \frac{3X}{N} \cdot \frac{2N-3}{N}$

.. ..
.. ..

$(N) = \frac{NX}{N} \cdot \frac{2N-N}{N}$



Ordinate number

$(1) = \frac{X}{7} \cdot \frac{13}{7} = \frac{13}{49}X$

$(2) = \frac{2X}{7} \cdot \frac{12}{7} = \frac{24}{49}X$

$(3) = \frac{3X}{7} \cdot \frac{11}{7} = \frac{33}{49}X$

$(4) = \frac{4X}{7} \cdot \frac{10}{7} = \frac{40}{49}X$

$(5) = \frac{5X}{7} \cdot \frac{9}{7} = \frac{45}{49}X$

$(6) = \frac{6X}{7} \cdot \frac{8}{7} = \frac{48}{49}X$

$(7) = \frac{7X}{7} \cdot \frac{7}{7} = \frac{49}{49}X$

In case offsets are wanted from the tangent, the successive values obtained above should be subtracted from "X"

$(1)\ \frac{49}{49} - \frac{13}{49} = \frac{36}{49}X$ $(3)\ \frac{49}{49} - \frac{33}{49} = \frac{16}{49}X$

$(2)\ \frac{49}{49} - \frac{24}{49} = \frac{25}{49}X$ $(4)\ \frac{49}{49} - \frac{40}{49} = \frac{9}{49}X$

etc.

An examination of the numerators and denominators will at once suggest a short cut. Numerators (upward) 1^2, 2^2, 3^2, 4^2, . . . $(N-1)^2$, which is of course in accordance with the fundamental law of offsets from the tangent to the parabola, i.e., that they vary as the squares of the distances from point of tangency.

The above suggests a formula for offsets from the tangent:

$$(1) = \frac{(N-1)^2}{N^2} X$$

$$(2) = \frac{(N-2)^2}{N^2} X$$

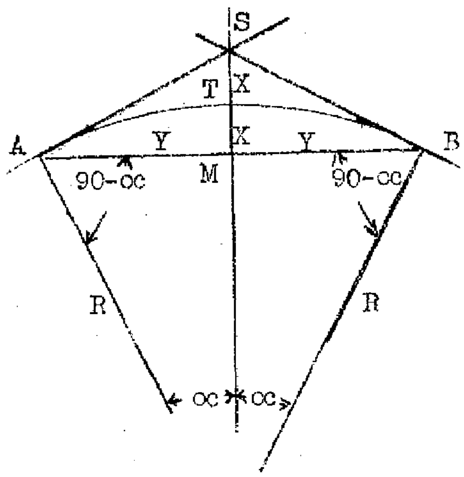
$$(3) = \frac{(N-3)^2}{N^2} X$$

$$(N-2) = \frac{2^2}{N^2} X$$

$$(N-1) = \frac{1^2}{N^2} X$$

$$(N) = \frac{0}{N^2} X$$

If Inconvenient to compute "X" and "Y" by trigonometry, the following method will provide a graphical solution of them:



Join A and B and at mid-point M erect a perpendicular. At A and B construct angles equal to 90°-∝. This will give direction of radius. SA constructed perpendicular to E will give tangent at A. SB constructed perpendicular to R will give other tangent at B. These two tangents will intersect on the perpendicular SM at S. Find point T midway between S and M, then T will be a point on the parabola and TM = X = ST; and MB = Y = AM. These values of X and Y may be scaled from the drawing.

CITY TRIANGULATION GADGETS

R. W. Woodworth, H. & G. Engineer, U.S.C. & G. Survey

MONUMENTS

The 1930-31 triangulation revision in the New York City vicinity has indicated two principal faults in previous station establishment; namely, non-permanent type markers and insufficient referencing.

Roof Monuments - Many previously established roof-stations were rendered difficult or impossible of recovery through removal of copper station-nails, rusting away of iron station-nails, or obliteration of the same through re-roofing operations. As the roof-stations searched for were all established prior to 1915, and the large majority during the period of 1903-08, most buildings in question have since been re-roofed. To obtain permission to cut through guaranteed 20-year roofing requires a bit of persuading - to cut through the same, unless the definite point is spotted from good reference tie-ins, is futile. To obviate these difficulties especial care was taken with the 1930-51 roof-station establishments to render the marks as permanent and as prominent as possible. Only buildings, the construction, age, and usage of which would indicate reasonable longevity, were utilized - providing, of course, conditions of present and future control were satisfied from these vantage points. As the majority of the buildings so used furnish very stable flat concrete roofs, the monuments are installed as follows:

Two slanting 3/4-inch holes, approximately 6 inches apart, are drilled in the roof to a depth as great as roof thickness permits. The holes are then filled with a fairly stiff mix of neat cement (or molten lead) into which 6-inch lag-screws are securely turned, the holes having been so drilled that the protruding lag-screws form an inverted "V". Over these tie-rods is set the dome-shaped metal form (ll" diam. x 6½" high) weighted down with a heavy iron ring. The interior and rim of this form are first heavily coated with heavy gear oil. Care is always taken to secure a not too liquid 2-to-l mix of fine sand and cement that may be firmly tamped to completely fill the form, which is readily removed with the concrete either partially or completely set by a slight leverage under the form rim. In fact, if proper care has been observed with the greasing, the mix, and clearing away of any outflow under the form rim, the form is often found completely loosened from the concrete of the monument. The juncture of monument-edge and roof is heavily flashed with plastic roofing cement to insure a water-tight installation. The resulting monuments, which have been uniformly excellent in shape and set, are: Permanent (re-roofing will not cover, can not be removed without considerable sledge-work, and then only with the chance of damage to the roof itself); readily recoverable (even with a minimum of reference tie-ins); one standard type (a neat monument, uniform, for all roof-stations).

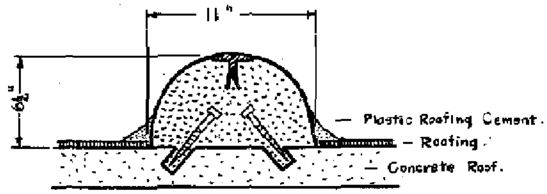
The same installation has also been utilized on several heavily-beamed wooden roofs. On other buildings, where unstable wooden roofs or other structural reasons prevented the use of this monument, the standard triangulation marker discs were set in drill-holes atop stone, brick, or terra-cotta wall parapets, and so placed that a theodolite or transit can readily be set up, without tripod support, over the center or reference discs.

The question will undoubtedly arise concerning difficulties encountered in gaining permission to cut through guaranteed roofing and to drill building roofs. Few concerns, plant engineers, or building super intendents are overjoyed at the request - in fact, the initial petition often elicits an uncompromising refusal. For this party, however, a persuasive pleader (backed by considerable law training and Irish ancestry) has gained the establishment of 31 such roof stations during 1931, with no refusal to data.

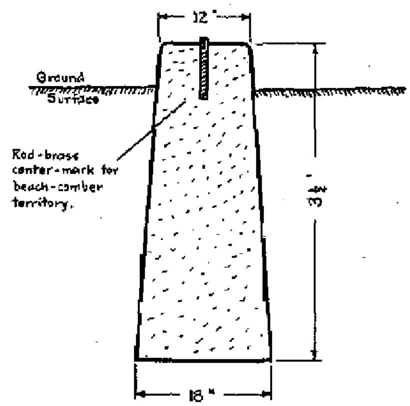
It would seem worthwhile to adopt standard forms for triangulation station establishment - to do away with the heterogeneous assortment of monuments which have resulted from the fact that heretofore any type station mark has been used which time, equipment, or personnel apparently dictated. Uniform and standard triangulation station monuments of good construction would go far towards giving a good impression (and a greater sense of reliability in the class of the triangulation itself) to other agencies using C. &. G.S. datum. With this in view, and although it adds one more non-essential item to an already large equipment list, it is thought desirable that a form, such as has been described, but constructed of heavy, highly compressed fiber board, be adopted for use on coastal triangulation. Such forms (the initial cost of which has prevented their use by this party) would cost but little in bulk lots, would nest - hence take up a small amount of stowage space, would be proof against moisture absorption if heavily shellaced. In addition to the usage already described, this form could be used to cap rough masses of concrete (all 1931 center-mark 12-inch tiles were so domed for additional height and identification), or could be lagged to bed-rock where a large expanse of unvarying surface Material renders a flush-set station disc inconspicuous and hard to recover. The inexpensive fiber form need not be removed, unless convenient for salvage after the monument has set, but could remain to gradually weather off the concrete.

Reference Measures - Another type roof-station, extensively used in the 1903-08 triangulation survey of Greater New York, namely, the flagpole, has been rendered doubtful of recovery through an almost total lack of reference tie-ins (to building walls, ventilators, chimneys, etc.). Of 43 flagpole stations (main and supplemental) located by this survey, 38 were completely lacking in easily obtainable reference measures. These figures do not include flagpoles at such identifiable locations as roof apexes, but only such as are on flat-roofed buildings. True, at present the majority of these are steel poles (but were they so twenty-five years age?), long-lived when cared for, but they can not be rightfully considered "Recovered" unless relocated by triangulation. A small amount of additional work would have guaranteed each of these stations for future recovery, whereas now, assuming that replacements may have been made at

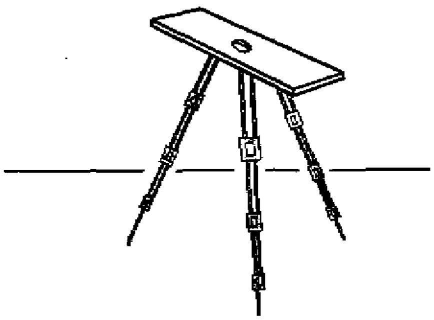
GADGETS — N.Y.CITY CONTROL SURVEY



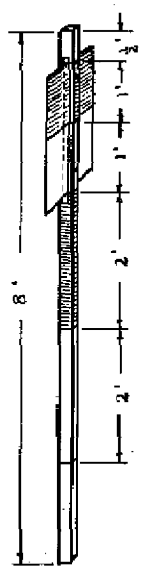
ROOF MONUMENT — using a cast-iron. Griswold dutch-oven, with bottom cut out, as a form. Several other ordinary kitchen utensils tried, a heavy aluminum form being desired, but none found of the requisite shape.



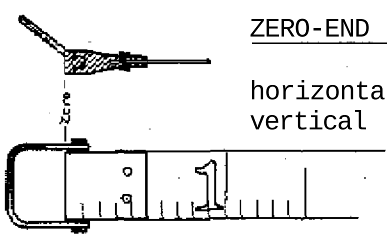
GROUND MONUMENT — using an inexpensive hard fiber-board form, mode of flat stock copper-riveted along a leveled lap-joint.



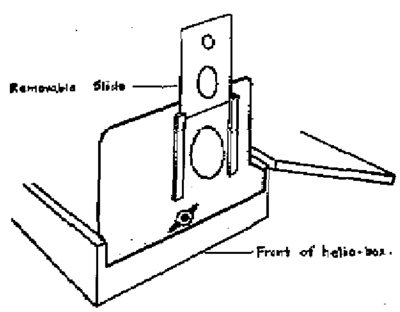
HELIO-LIGHT TRIPOD — adapted from heavy camera tripod. Extends to 5½ ft, Detachable legs fold to 20 in.



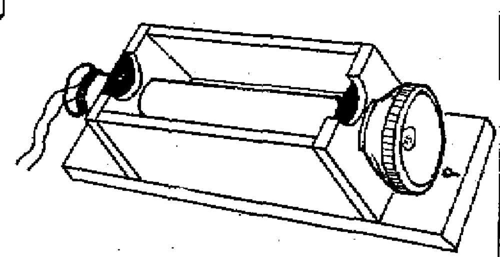
TARGET SIGNAL — a. 3x3x8 ft. pole, with centralized sheet-metal target readily removable for stowage,



ZERO-END TAPE — for accurate horizontal measures to vertical surface



REDUCED HELIO — with variable-aperture shield and colored-glass filters.



DAY SIGNAL-LIGHT — using a 5-cell focussing flashlight adapted for use with large dry-cells.

R.W.W.

C.& G.S.-419

entirely different locations, each of these unreferenced flagpoles must needs be classified as "Uncertain" on the recovery note.

Center Marks - The brass bolt type center mark used extensively to mark waterfront stations of the 1903-08 survey has been eminently more satisfactory than the standard "brass triangulation station discs used to mark subsequent C. & G.S. stations accessible to beach comber's activities. The standard C. & G.S. disc set in concrete apparently offers a too tempting target for the beach-comber, to judge from the number of concrete triangulation monuments recovered minus brass center-marks. These discs are comparatively simple of removal with cold chisel and sledge. Several reasons might be assumed for this vandalism - the "$250 fine or imprisonment for disturbing this mark" aggravating the beach-comber's sense of personal liberty, or tantalising souvenir-collecting youngsters; even, possibly, the small value of the metal itself, judging from the care usually evidenced in removing all the brass shank. Ten concrete monuments, established during the period 1913-26, have been recovered in place, but lacking their original brass discs, some few retaining the brass shank. To date but two 1930 reference marks are to be added to this same list. All of these stations are along the marsh or undeveloped waterfront where the beach-comber, with his penchant for minute salvage, is encountered daily. Even the 1903-08 stations consisting of brass bolts lead-set in 6" x 5" granite posts have been worked on with malicious intent, but, in the main, have discouraged extensive destruction, especially as the 6" x 6" x 3' granite posts were imbedded in three-foot concrete masses. It has been noted in these same localities that U. S. Engineer monuments of concrete with iron center bolts are not tampered with, nor are their monuments using an inconspicuous 1½-inch bronze disc.

For triangulation stations liable to this form of destruction it is now the practice of this party to mark the center with ¾-inch rod brass of ample length cut off inch above the concrete surface and having a 1/8-inch center-hole drilled to extend below the concrete. Standard disc reference marks are still used, risking the loss of these discs rather than possible confusion if crosses, holes, or similar marks were used as reference. To further insure the recovery of the true center-mark monument, especially with the center and reference marks all monuments of the same form, it has been the practice to cap the center monument with the same dome-shaped form used on roofs. As a secondary method of identification it is planned to use a colored cement for the center-mark monument. These devices are used to overcome a condition already encountered at several old stations, where only one concrete monument sans brass disc) was recovered where three (1 center and 3 reference) had originally been established. As, at these stations, the three monuments were identical in size and method of placement) with no witness-mark tie-ins possible in the swamp area, the station could not even be classed "Recovered, suitable for hydrographic or topographic control" through the inability to identify the surviving monument as center or reference mark.

Ground Monuments - To reduce the time, risk of breakage, and considerable, effort entailed in transporting the heavy 12" x 3" tile pipe used throughout; 1950-31 to uniformly mark all ground stations (both center and three reference marks), it is planned to use truncated conical forms of heavy fiber board. These can be secured at a nominal figure, since verbal prices elicited from one New York firm are only slightly in excess of tile pipe cost. These forms will have a bottom diameter inside of 18 inches, top diameter inside of 12 inches, height of 3½ feet with a heavy circumferential scoring 12 inches from the bottom to permit ready shortening of the farm if found necessary. The 3½-foot lengths, a foot greater than can usually be obtained in tile pipes, will permit sufficient height of monument above the ground surface to facilitate recovery in grassland areas.

A sample on hand of 3/32-inch hard-fiber stock is quite satisfactory, but is to be improved by the use of 3/16-inch material and a beveled overlap seam secured by copper rivets. Any tendency towards deforming (though none is anticipated) as concrete is poured can readily be prevented by dropping a metal ring over the top of the form. The same statement concerning standard roof-station monuments also applies to this form. If such a form were desired as stock equipment, it need not be limited to this simple form, but could be made over a truncated pyramidal mold. Rounded top edges could likewise be secured with the special mold. This long form, scored 7 inches from the top, would serve two purposes - the top knocked off to furnish, a roof-station form, the remaining long form for reference mark usage. Heavy shellacing and copper rivets should render this form safe for damp storage, their compact nesting would take up little room.

SIGNALS

To assure second-order accuracy over the short line triangulatioan schemes projected for the many waterways of the Greater New York vicinity, it was early realized that extra care must be taken with signal establishment, especially as an excess of haze, smoke and heat waves from chimneys is encountered almost daily. With this in mind, the following special equipment has been devised and made standard for all observing parties operating on this project.

Target Signals - These are used whenever feasible for all distances up to four miles. Helios are generally used over lines of greater length to combat the haze. Pole signals only have been erected, always with. single banners to obviate possible phase from cross-banners, with the banner faced directly to the observer. Colored cloth and painted canvas banners have been successively discarded in favor of painted sheet metal targets, following is a description of the standard target signal used during the 1931 season:

Eight-foot lengths of 3" x 3" grade A clear grade cypress poles are sturdy enough to retain their straightness under continued guying. When purchased these are ripped centrally (with a circular saw) for 28 inches near the pole top, this slit admitting the metal target. The poles are banded black and white (1/8" rubber bands make good paint stoppers). Three size targets are stocked - 12", 18", 24" widths - which are parti-colored black and white to match the banded pole (flexible enamel paint is used). Some few red and white combinations are made up for certain localities where black merges into the background. Heavy G.I. sheet-metal of the most desirable gauge is not stocked by metal smiths, but is readily obtainable in the exact target sizes on special order. With the target in place on the pole two slots along the target's center line meet two holes drilled along the pole center-line. Common wire nails, of the same diameter as the pole holes and target slots, run through and clinched, efficiently pin target to pole with no side play. The nails are readily withdrawn when desired to knock down the signal for stowage in a truck.

The pole is generally stepped directly in a 5/32-inch drill-hole marking station center in the standard brass disc. Four #12 G.I. wire guys secured to the pole top are each set up with 6-inch G.I. turnbuckles. Once having used the turnbuckle method of signal-guying, with its ease and rapidity, and the longevity of signal plumbness afforded by the properly tautened guys, hand setting up of guy wires is forever and thankfully discarded). An 18-inch length of #l G.I, chain passed through an eye of the turnbuckle and permanently connected with an "S" fitting to form a strap efficiently secures guys to stake or other guy point. Using a 6-foot mason's lavel perfect pole plumb is quickly obtained. The long level is fully as accurate as a plumb-line for 8-foot signals and has a decided advantage over a plumb-line for windy day usage. These levels can be obtained in wood or aluminum frames, and, it is believed, in still longer models if desired. For the 1932 season it is planned to use 30-foot lengths of the same #l G.I. chain in place of the wire guys, these lengths to be permanently secured to each side of a small square iron plate which will have a central drill hole for nailing it to the pole top. It is thought that the light weight chain guys will materially simplify and expedite signal erection. A few spare lengths of chain equipped with shackles will be carried for any over length guys found necessary. Each truck always carries an ample supply of poles, targets, and guys ready for instant assembly. This type signal lends itself to one-man erection, a number having been so erected during the 1931 season.

Since taller signals have not been necessary on this survey, and the 8-foot poles are readily shortened if so desired, only the 8-foot pole size is stocked as standard party equipment. With the centralized target, the signal need not be faced directly to the observer to insure central pointing over short line distances. The observer must, however, take care not to point on the target if the lighting is such that the pole casts a shadow completely covering one side of the target. The parti-colored pole and target has often permitted continued observing where a solid color target or unpainted pole would not have. It is not uncommon during one stations occupation for the observer to point on all sections of pole and target, as sun, overcast sky, haze, smoke, or heat dictate. Although no longer as scrupulously observed as earlier in the season, if time and party personnel permit, it is well worthwhile to reface targets to the particular station occupied, installing whatever width target is best suited for the length of line. Abstracts of directions indicate the best pointings on targets subtending approximately l/2 the theodolite vertical hair spacing. For H-313, the new second order direction instrument, a target width in feet equal to l/2 the distance in miles, has been used.

The major trouble anticipated with the use of this type signal has not materialized - since none of the 1931 signals were molested. It had been expected that metal targets and turnbuckles might prove fair prey to youngsters and beach-combers.

During the season of 1930 it was found necessary to secure target signals to the tops of several tall and inaccessible steel flagpoles. This was successfully accomplished by securing the slats of an ordinary cloth banner signal to the pole by loose-fitting metal hoops, then, by means of the flagpole halyards, hoisting the signal to its desired location. Trailing guys from the two metal hoops, and from the four corners of the banner, permit tightening hoops to flagpole and facing the banner as desired.

Reduced Helios - To accomplish efficient triangulation of second order accuracy over the New York area has required helios for lights) on 40% of all lines observed in order to combat the impaired visibility caused by haze, smoke, and chimney heat-waves, and also to provide efficient signals where conditions of background do not permit the use of target signals. This haze is the principal observing handicap, one of almost daily occurrence. A signal, visible to the eye, or with a low powered field glass, when observed on with the theodolite is often so blurred in outline or merged into the surrounding haze and background as to make accurate pointing uncertain or impossible. With the helio's-ability to penetrate thin haze or smoke, observing facilities are materially increased. Since a full power standard helio in a clear atmosphere gives off a beam too intense for good pointing at distances less than six miles, and since 75% of the lines to be observed in the New York survey were under 3 miles in length, it became necessary to damp down the helio beam as distance, atmospheric conditions, and sunlight dictated. Various methods were tried in the effort to attain a satisfactory reduced helio.

Early in the 1931 season, 18 lines, averaging 2.3 miles in length, were successfully observed using colored glass helio mirrors in place of the standard clear glass mirrors. Of various colored glasses tried, the color depths of which dictated their useful distances, an olive green glass was adopted and used. This threw a clear white beam of low power, affording excellent pointings for 1½ to 3-mile distances. Like all colored helio mirrors, this had one fault to prohibit its too general usage - the reduced shadow cast on the forward sight ring, though ample with a full sun, required a skilled and conscientious operator to maintain a helio with a partially diminished sun. Next, a helio shield with variable apertures and using a clear glass mirror was used over a few lines. Later this device was improved by the addition of colored filter glasses. The modified helio resulting has proved ideal for any lines down to 1 mile in length, as it permits the operator to vary the intensity of the helio beam to suit conditions. All helios are checked to bring sights, mirror, and plumb-line hole in alignment. The 3/8-inch plumb-line hole, necessary when establishing a helio box directly atop a station mark, is notched front and rear to hold the plumb-line true center for other type set-ups. The shield, constructed of heavy gauge hard brass stock, is readily stowed in the standard helio box and is quickly attached to the front of the box by a single wing-nut screw so set as to bring the shield aperture into proper alignment. The shield, numbered for its particular helio, is of box width, overlapping the box edge to completely cut out the objectionable stray light commonly noticed with unshielded helios on the shorter distances. To vary the helio's intensity three circular apertures are provided - the largest of the same diameter as the mirror, the next of one-half this area, the smallest 5/8 inch in diameter. The largest hole is in the shield itself - the smaller aperture and a clear sight-line are provided by a removable slide. To obtain still more latitude in the helio intensity, and to permit it's use on the shortest lines, colored glass filters may be inserted in the paerture slide guides. These shielded, colored helios make excellent pointings, are the equal of lights for definition, and have effectively solved the problem of short range helios.

Day lights - During latter July a long period of completely overcast days, prohibiting helio use, accompanied the worst conditions of "seeing" encountered during the 1931 season - an excess of smoke, haze, and heat waves practically make impossible the use of target signals in the area between Newark and lower Manhattan. With helios sorely needed, but "no sun", electric signal lights were adapted for day use. These have since proved far more successful than the most optimistic estimates as to their probable usefulness, having gone through on 46 lines with but one failure. These lines, averaging 1.9 miles in length, have ranged in distance from 0.9 to 3.1 miles (nautical). The foregoing figures do not include the extensive use of these lights on the Jamaica Bay triangulation, where it is understood they were successfully used over even greater distances. These lights, at their best on overcast or dully days, are believed to allow an effective observing range of 3½ statute miles on even the brightest day. If a black background, not necessarily over 3 feet square, can be given the light, its effectiveness is increased. Their disadvantage lies in the fact that, on the longer lines, the observer must have a good approximation of the light's position to enable its initial picking up. These day lights effectively substituted for operators on several days' observing when so short-handed on personnel as to require one or more lights to be established then left untended during the day.

The ordinary 5-cell, focusing flashlight was adapted for use with large dry cells and permanently mounted in a sturdy open box frame atop a 6" x 18" base. Eight-foot wire leads attached to binding posts on the flashlight are ready for instant clip attachment to the batteries. Peep rear, and knife-edge front sights were cut from heavy guage brass and mounted in protecting semi-circles cut out from the top of each wooden tube-stock. The sights were simply aligned with the flashlight tube at equal heights, with no attempt made to adjust than to the center of focus. Of eight flashlights so adapted, only one required this adjustment, after its light had failed to get through under perfect conditions. Undoubtedly, with a simple adjustable rear sight permitting alignment of sights to actual light beam, the observing range of these lights would be increased. It is thought that day lights might prove feasible over distances greater than those already observed, given a larger reflector and increased light intensity in a lamp not requiring an excessive number of dry cells.

Light-Helio Combination - To compact equipment for the 1932 season, and to obviate the necessity for frequent changes from light to helio, and vice-versa, a major nuisance on partially overcast days and always a chance for eccentricity of signals on windy days when plumbing is difficult, it is planned to combine the light and the helio in the same box (one very little larger than the present standard helio box). If this can be accomplished as desired, the conversion from light to helio will be a matter of seconds only, with no chance for the disturbance of the signal's centering.

Existing Observing Structures - As an item of interest indicating the possibilities of economizing on time and personnel, it may be related that, to date, no observing towers have been found necessary for carrying through the New York City triangulation. Existing structures have enabled line clearance even through the most congested city districts - apartment houses, banks, bridges, cemetery chapels, chimneys, churches, factories, flagpoles, grain elevators, hospitals, hotels, lighthouses, office buildings, post offices, radio masts, railroad signal towers and terminals, schools, statues, shot towers, and tanks all having granted the essential station and set-up facilities. With the many natural signals afforded by the aforementioned structures, only one signal exceeding the standard eight-foot pole signal was required.

SET-UPS (ECCENTRIC AND OTHERWISE)

City triangulation apparently necessitates a greater variety of theodolite set-ups than are the usual lot of a C.& G.S. observer, including some few in locations so unstable that, at first inspection, they appear impossible of usage. A record of New York City stations occupied during the past season shows only 40% as originally offering excellent set-up facilities. The remaining 60%, though practically all suitable set-ups for third order observing, does include a number of stations only made sufficiently stable for satisfactory second order occupancy through the use of special equipment and precautions. A comparative list of 1931 set-ups might be of interest to others encountering city triangulation for the first time:

1) Stable Set-ups

15% - Firm ground - normal tripod set-ups
11% - Concrete bases - "
7% - Iron, lighthouse platforms - normal tripod set-ups
7% - Parapet set-ups, sans tripod
40%

2) Set-ups Rendered Stable through Special Precautions

Slippery footing on stable structures
31% - Tar and gravel roofing, tar paper roofing
5% - Metal roofing
2% - Soft tar roofing
2% - Rubber composition roofing
40%

Stations with Unstable Locations
8% - Marsh
3% - Wooden buildings
1% - Railroad fill
1% - Grain elevators
13%

Odd set-ups (not so stable)
4% - Tank and lighthouse railings
1% - Tank platform floors
1% - Church cross
1% - Bridges
7%

Special Precautions:

Lead Blocks - Roofing materials of all kinds were at first a major cause of instrument instability, permitting slip, particularly the tarred roofing constituting one-third of the stations. As it was not desired to cut through roofing to establish tripod legs on the concrete roof itself, set-ups were, perforce, atop the former. Even during "below freezing weather", when roof tar was of rock-like consistency, and using a braced tripod, the instrument level could rarely be maintained for a fifteen-minute period. At first the small "off-level" amount was scarcely noticed, corrected after each position with the direction instrument, until it was noted that a half-day's observing had allowed the theodolite to "walk" 1/2 inch off center. For a while thereafter, sand bags (small money bags of approximately 35# weight) were used to chock in the tripod legs. On a few particularly slippery roofs a triangular wooden frame was used in combination with these weights. These various makeshifts aided materially, but were not wholly satisfactory. Not until the use of lead blocks were the roof set-ups rendered entirely stable. These blocks - 55# each and approximately 7" x 9" x 2" in size - are laid flat on the roofing surface and chocked if necessary to give a firm base. The tripod legs are then set directly atop the lead blocks, a man's weight securely sinking each leg point in place on each block. Set-ups of this type, prohibiting all tripod slip, have rendered all roof set-ups satisfactory for second order accuracy. The same method is used satisfactorily on thick tarred roofs and those covered with rubber composition - the combined weight of blocks and instrument causing the blocks to sink into the material to a stable footing with 1/2 hour.

Stands - Marsh and unstable wooden building set-ups were all made to yield good results by use of the customary support stands. All marsh stations (chiefly U.S. Engineer tie-ins) required both tripod and observer's stands, also, while observing, a complete lack of movement within 20-30 feet of the instrument. The few shaky wooden buildings found necessary for occupancy (old first order station tie-ins) required similar precautions. Wooden buildings - liable to excessive vibration from traveling cranes underneath - and ancient churches - the towers shaken by every passing vehicle - are not condusive to perfect results, but can be occupied when necessary and made to produce second order accuracy.

Railroad Fill - Two stations, of necessity established on railroad grades, were found quite satisfactory except with passing trains. Although the fast trains passing on tracks only 5 feet distant would send the instrument level entirely "out", the jarring did not necessitate any re-plumbing. Hence, the short periods required with a direction instrument permitted the obtaining of observations between the passage of trains.

Grain Elevators - Two concrete grain elevators were utilized to obtain line clearance and visibility scope over the Upper Bay. The sturdy construction of both provided excellent set-ups except with the elevator machinery in motion (which was practically all times save Sundays). However, it was found entirely feasible to observe with the machinery in motion, especially using a braced tripod to damp down the vibration. By occupying these stations on days free of haze it was found quite possible to obtain satisfactory results, extra care being taken with the pointings on the vibration blurred signals.

Tanks, Lighthouses, etc. - Since this 5% of the stations was limited as to occupancy, prohibiting normal tripod set-ups because of extremely narrow platforms, railing stands seemed indicated. Such construction was avoided, however, by use of a railing set-up method in vogue with the party of H. E. Finnegan. On the narrow circular platform common to water tanks and a number of the smaller lighthouses, the tripod legs are draped over the waist high rail - two within and chocked against the tank or cupola base, the other lashed to a rail stanchion. This set-up works equally well with two legs outside or with the tripod draped over the rail and all leg points outside the platform rim with the legs firmly lashed to rail and stanchions.

High winds prevented, use of the ball-apex set-up recommended by W. H. Bainbridge for steel water tank occupancy, in which a 7" theodolite is firmly strapped to the large ball capping the conical tank's apex. One day's observing, planned for this type occupancy, was almost prohibited by a prevailing 40-mile wind which also prevented a railing set-up until the observer thought to establish the theodolite directly on the narrow platfom floor. Although the snake-like observing attitude entailed is not recommended for any but slim and flexible observers, this particularly uncomfortable form of set-up can be made to yield results - for, on this day of a 40-mile wind atop a 125-foot spider legged steel tank, 3 sets of 4 angles bach showed a maximum variance of but l.4 seconds. Slim observers may avoid rail set-ups on some lighthouses by establishing the theodolite tripod in the cupola doorway with one leg inside the cupola and two on the narrow platform without.

The 6-inch square top of a church cross furnished a set-up point desirable as to height and instrument support for getting a main scheme line into Jamaica Bay. This same ridge line location required too much tight rope ability, however, for a second observer visiting this station at a later date to obtain intersection directions. He, prefering a modicum of personal safety, abandoned the skyline center set-up for a safer eccentric location nearby.

To get a main scheme through the flat northerly section of Arthur Kill necessitated a station atop the high and apparently stable Goethals Bridge. Authority granted and the station established on the concrete sidewalk, occupancy was attempted. Until then the springboard attributes of the bridge flooring had not been fully realized. With the heavy direction instrument and tripod in place on the sidewalk, it was found impossible to keep the tripod legs in their respective small holes during the passing of solid tired heavy trucks. Only by diverting traffic to the opposite side of the bridge, requiring all heavy vehicles to pass at the slowest possible speed, and chocking in of the tripod legs with 100# sand bags (a 50# bag weighting down the tripod cross braces), were satisfactory observations finally secured. This same station also has characteristics rather peculiar to a second order main triangulation station in that it is not located on a fixed structure, as the central span of the bridge rolls freely with four expansion joints. However, inasmuch as this station was established at the apex of the arch of this floating span, equidistant from the four expansion joints (two on either side), with series of expansion measurements secured each day of station occupancy (either with instrument or helio light) proving the daily expansion to be from the center and equal on either side of the center, any doubt as to the station's lack of fixity was dismissed.

Eccentricities - With a decided distrust of abnormal eccentric set-ups, the writer was delighted during a brief 1930 season by having 18 of 24 second order stations eccentric from 1 to 60 meters. Of the various things learned concerning eccentric stations, the outstanding knowledge gained was a loss of respect for their potentialities for trouble. Regarding this mild boast there are offerred the average triangle closures obtained during 1930-31, when, with 42 eccentric stations (many of which presented peculiar difficulties in the obtaining of center directions and distance), the main schemes (second order) mean was less than 2 seconds and the supplemental schemes (third order) less than

3 seconds, with no triangle closure exceeding 5 seconds. These figures are from the original observations, unimproved by later reobservations over certain weak directions. One-third of these stations were eccentric in excess of 10 meters - three of the same over a tape length - with a maximum eccentricity of 90 meters. This last named distance was required to tie in a line of 1915 triangulation, one station of which had become partially obscured through the subsequent construction of a railroad bridge and approach fill. Fortunately, with the station 40 feet below the elevation of the fill upon which the eccentric set-up was necessary, it was found possible to obtain the eccentric distance by observations from the extremities of two measured bases - one along the railroad grade and a chock base along the level ground at the same elevation as the station.

Numerous other <u>eccentric distances</u> not possible of direct measure were also obtained from measured bases - several to inaccessible flagpoles where accurate bases were laid down along building parapets and gun parapets - four to tall beacons, where close-in set-ups required the use of an <u>astronomical eyepiece</u> for the almost vertical pointing to the apexes (the eccentric distances as obtained from 2 separate bases checked to 0.003 meters or less at all four stations). Judging from the triangle closures previously quoted there need be little fear concerning the perpendicularity of lighthouse structures. A dozen eccentric stations were used on lighthouse platforms, from 10 to 30 feet below the apex station, none of which permitted direct pointing or measurement to center, neither did they permit the dropping of center with plumb line or instrument. Some few of those had central pipes assumed to be directly under the light cupola apex; the majority had round cupolas and platforms, the <u>tangents</u> of which were assumed equidistant from the center; some were blessed with 6, 8, and 10-sided cupolas and platforms where tangents were seldom feasible. Where the stations were centrally located but inaccessible to pointings, with tangent directions impossible, center directions on several circular platformed lighthouses were obtained as the means of directions to <u>equidistant points on the platform rims</u>. Other center directions were obtained from a <u>single tangent and the measured radius</u>. Almost all such set-ups required <u>pointings short of the telescope focus</u>, where <u>white string</u> extended from the set-up point past cupola tangents often afforded excellent pointings; a <u>yellow pencil</u> sometimes permitted sightings in dark areas; the <u>open sights</u> mounted on the telescope barrel of the new second order theodolite were life savers for several extremely close-up pointings, where, heretofore, the only method of securing such directions would have been aligning the telescope by means of a <u>string stretched taut from cantor mark to instrument</u>. (This method has been utilized with double the number of directions taken, but is not to be heartily endorsed for further usage). Several eccentric set-ups on flat roofed towers, where the center was easily accessible to measurement but hidden for pointings, required the eccentric direction to be obtained from a direction to any measured point and the measured distances from this base to the center, computing the center direction from the <u>3 known sides of the triangle</u>.

A number of roof apex stations (spires, cupolas, etc.) necesitated dropping of the center to set-up points on open towers below. This was usually accomplished by intersections obtained from two or more ground set-ups, and soon proved how little trust could be put in the verticality of a majority of such structures and the absolute necessity for this plumbing even in supposedly symmetrically structures if good second order closures are desired.

Helio and Light Set-ups - Much lost time in constructing helio light stands to meet the varying clearances required at different stations indicated a need for adjustable tripod supports. Without doubt, the sight of a stepladder helio support adopted by an ingenuous operator to clear a 5-foot bridge rail furnished the necessary initiative for securing adequate support stands, for, admitting the stepladder achieved its purpose most admirably, as a survey instrument it looked like h---!

Heavy grade Eastman camera tripods (extending to 5½ feet, but folding very compactly) were secured and adapted for survey use by substituting a 12" x 24" x 1" board for the original small round tripod head. A 1½-inch center hole was drilled for plumbing, and all brass fittings blackened to prevent sun glint. This tripod gave excellent satisfaction throughout 1931, permitting ready establishment of light or helio to meet the clearance needed for railroad tracks, marsh grass, lighthouse and tower railings, bridge railings, building parapets, etc. (Helios must clear railings formed of closely spaced vertical members, even though the existing gaps apparently afford clear passage for the helio beam. Helios shown through such railings do not get through to the observer!) As adapted the tripods have been sufficiently stable, but are being rendered more so by discarding the original 6-inch head-legs fitting for brackets permitting the legs to be secured across the full width of the 12-inch board.

Thinly tapered wooden wedges (of helio-box width), as a part of the tripod equipment, are handy for fine elevation adjustments of the helio or light. A 6-foot length of wide duck is furnished each helio-light operator as a wind screen for plumbing.

Tapes - Reference tie-ins on city triangulation necessitate great numbers of measurements to vertical surfaces - building walls, lighthouse cupolas, chimneys, etc. The ordinary steel tape with its zero not at the end can not be satisfactorily used to obtain such measurements. The necessary bending of this tape tends neither towards accuracy nor long life for the tape. To supply the desirable zero-ended tape, one (already broken short of the zero) is now being fitted with a ½-inch hard metal sleeve, its zero end of l/8-inch thickness fitted with the usual "U" shackle. This loope may be flipped back along the tape to clear the zero for measures to vertical surfaces, or, for normal measures, serve as the usual finger-hold when long distances require considerable tension. This sleeve and shackle will not add to the folded compactness of the original tape.

Personally, I should like to see similar tapes made up and stocked as standard C.& G.S. equipment. With the heavy butt end of a stainless hard metal the accuracy of the tape itself would not be impaired by wear in a tape's normal lifetime; and, of first importance, accurate measures are made possible with longer life for the tape.

IN CONCLUSION.

These various"tricks of the trade" are the usual run of practices devised and used by a C.& G.S. field party - devices to increase accuracy, to save time and labor - to fit the particular project on hand. It is realized that certain of these contrivances may have bean previously used, but, if so, knowledge of such had not come to the writer (except as mentioned in the text). Any possible future-usage will be chiefly with other city surveys of similar scope. For the work on hand (Project 67) - the establishment of adequate waterfront control over all the waterways of Greater New York and vicinity - these various practices have proved decided factors towards successful accomplishment.

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CARNEGLE INSTITUTION OF WASHINGTON
Geophysical Laboratory
Washington, D. C.

11 August, 1931.

Dear Mr. Deetz:

Many thanks for the copy of the new edition of your publication on Projections (Doetz and Adams., S.P. No. 68, U.S.C & G.S.). As you know, it gave me much pleasure and profit to read the former editions of the book. I have been interested to read the new material you have added in the last edition. I am quite certain that your book has been of great aid to many students and has made clear to them the essential features of the different important projections and also the principles on which their construction is based.

I wish also to express my indebtedness to you for putting me in touch with Mr. Zeskind who accomplished the task I put up to him exceedingly well. He took much interest in the work and produced a remarkably fine chart. The new lunar projection chart will soon be in use at Mt. Wilson where I hope in the next two months to complete the first series of photographic maps of the moon. The topographic maps with 1,000-foot or 500-foot contour lines over the central portion of the moon (45° out from the center) will take several seasons to complete. I can work on them only two months each year.

With best regards, I am

Yours sincerely,

(Signed) Fred E. Wright

TRIANGULATION EQUIPMENT FOR MOUNTAIN WORK IN ALASKA

Extract from report of W. M. Scaife
H. & G. Engineer, U.S.C & G. Survey

The nature of the mountains on both the Taku and Stikine Rivers was such that when an observing party made the climb it was essential that they be prepared to remain until the completion of observations. As the observing parties usually consisted of an officer and three men (sometimes two), and as instrumental and camp equipment and provisions for several days had to be backpacked in a single trip, it was essential that every item packed provide the greatest possible value for its weight. With the outfit used for backpacking trips into the mountains, it was possible for four men to go to a station, packing instrumental, camp and mess equipment, and food and all other necessary articles for staying out 10 days, each man packing a total of approximately 80 pounds.

The Nelson packboard, consisting of a canvas bag on a canvas covered wooden frame, was used for all except the instrument packs. Special "Sourdough" packboards were made for packing the theodolites. Such a packboard consists of canvas tightly stretched over a wooden frame on which the pack is secured. The tightly drawn canvas acts as a pad against the back. The theodolites were placed in parafined canvas bags and secured to the packboards with straps. The tents were of ballon silk, with mosquito curtains under the flaps. For base camp, 10' x 12" wall tents, and for mountain camps, 10' x 10' pyramidal tents, were used. A mountain tent weighed 13 pounds, and accommodated four men comfortably, furnishing complete protection from rain and mosquitoes. Alpine stocks were used for climbing. These stocks served many useful purposes aside from their primary purpose, such as uprights for windshields, extension to umbrella, etc. Two of them lashed together served as the tent pole for a mountain tent. Ordinary street umbrellas were used for sun shades, and the windshields were of balloon silk. It is believed that in several instances Alpine stocks saved men from fatal falls. For bedding, each man was furnished a sleeping bag filler of wool batting covered with sateen, an outside waterproof bag of meta cloth, and a double wool blanket which could be sewed into an additional bag.

Optimus kerosene stoves were used for cooking in camps above timber line. These stoves burn vaporized kerosene, weigh 2-3/4 pounds, and a gallon canteen of kerosene furnishes fuel for thirty-two hours of steady burning. Cooking for four men can be done very nicely on one stove. Dehydrated foods were purchased from Schwabacher Bros. & Company of Seattle for use on mountain trips.

For transportation on the salt water inlets, Coast Survey Launch No. 67 was used and proved to be very satisfactory. A 32-foot shovel nose poling boat of shallow draft, borrowed from the Alaska Road Commission, proved ideal for river transportation. A 14 Seahorse Johnson outboard motor used on this boat was found to be very satisfactory. The Johnson outboard motor is highly recommended for heavy duty on silt-laden waters.

The equipment was designed to give the greatest amount of comfort and utility for the weight which could be packed and fulfilled this purpose admirably. No small part of the success of the season was due to the fact that the men could be reasonably comfortable and well fed, even when camping above timber line in bad weather with what they could pack on their backs, thereby saving their strength and morale for the pinch hitting which was often necessary. Light, concentrated equipment made it possible to operate two mountain observing parties on the Stikine River at times when two or three men were incapacitated for field work by wrenched knees and ankles.

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HOW NOT TO DESCRIBE A SURVEY

(Description of some land conveyed in 1812 in the State of Connecticut; copies from Probate Court Record in Hartford, Conn., in 1905)

147 acres, 3 rods and 19 rods after deducting whatever swamp, water, rock and road areas there may be included therein and all other lands of little or no value, the same being part of said deceased's 1280 acre colony grant, and the portion hereby set off being known as near to and on the other side of Black Oak Ridge bounded and described more in particular as follows, to wit: Commencing at a heap of stone about a stone's throw from a certain small clump of alders, near a brook running down off from a rather high part of said ridge, thence by a straight line to a certain marked white birch tree about two or three times as far from a jog in the fence going around a ledge nearby, thence by another straight line in a different direction around said ledge and the Great Swamp so called, thence in line of said lot in part and in part by another piece of fence which joins onto said line, and by an extension of the general run of said fence to a heap of stone near a surface rock, thence as aforesaid to the Horn, so called, and passing around the same as aforesaid, as far as the Great Bend, so called, and from thence to a squarish sort of a jog in another fence and so on to a marked black oak tree with stones piled around it, thence by another straight line in about a contrary direction and somewhere about parallel with the line around by the ledge and the Great Swamp, to a stake and stone bounds not far off from the old Indian Trail, thence by another straight line on a course diagonally parallel or nearly so with Fox Hollow run, so called, to a certain marked red cedar tree out on a sandy sort of a plain thence by another straight line in a different direction to a certain marked yellow oak tree on the off side of a knoll with a flat stone laid against it, thence after turning around in another direction and by a sloping straight line to a certain heap of stone which is by pacing just eighteen rods and about l/2 rod more from the stump of the big hemlock tree where Philo Blake killed the bear, thence to the corner begun at by two straight lines of about equal length which are to be run in by some skilled and competent surveyor so as to include the area and acreage as hereinbefore set forth.

SHORT COUNTER-WEIGHT BUOY FOR USE IN SHOAL WATER

C. A. Egner, H. & G. Engr., and Ensign E. F. Hicks, Jr., Aid
U. S. Coast and Geodetic Survey.

In the survey of Pollock Rip Channel by the party on the NATOMA, C. A. Egner, Commanding, it was necessary to establish at least three floating signals.

The best locations for these signals showed a charted depth of from twelve to eighteen feet at mean low water; hence it was necessary to use a type of buoy with a short counter-weight. This eliminated the first type described in Special Publication No. 93, page 74.

Material at hand made it inadvisable to use a buoy of the second type also described in the same section of that Special Publication, though the one constructed was similar in several respects. Car couplings were not available in Nantucket, which is isolated from railroad facilities.

Four buoys of this type were planted and only one was lost before the work in that vicinity was completed. On this one, the cable between the leader buoy and the signal buoy gave way and only the signal buoy itself was lost. Three of these were placed in strong tide rips and one was on a sixteen-foot shoal where breakers were seen at times, yet it remained intact throughout the season.

Some question has been brought up that the buoy would probably be more stable if the cable was fastened below the drum instead of above; there probably would be a greater stability, but no trouble with the present method was encountered in a two knot current.

The chief advantage of this buoy is its use in shoal water, since it extended only about five feet below the water line. Another desir able feature is the small storage space required for the completed buoy, where deck room is limited.

The anchor shown has been in use for some time, being originally introduced, I think, by Lieutenant-Commander F. S. Borden in 1925 while on the BACHE.

Five old automobile tires serve the double purpose of making a convenient form and providing a "rubber upholstered" outer surface which facilitates handling on deck, injuring nothing with which it comes in contact. These anchors will vary from 600 to 1000 pounds depending upon the size of tires used. In no case has movement of these anchors been detected; it is believed they bury themselves readily in sandy bottom.

In the present case, 2 fathoms of light chain at the anchor and 5 fathoms of steel cable to the leader buoy were sufficient. A small swinging radius, very important on this survey, resulted.

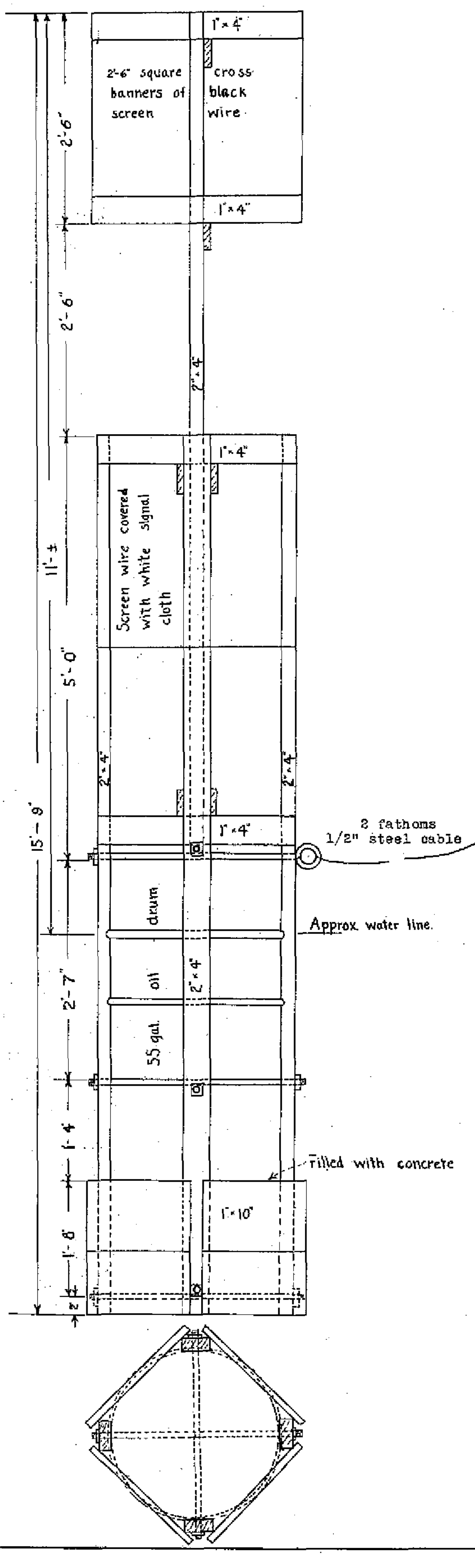
BILL OF MATERIAL

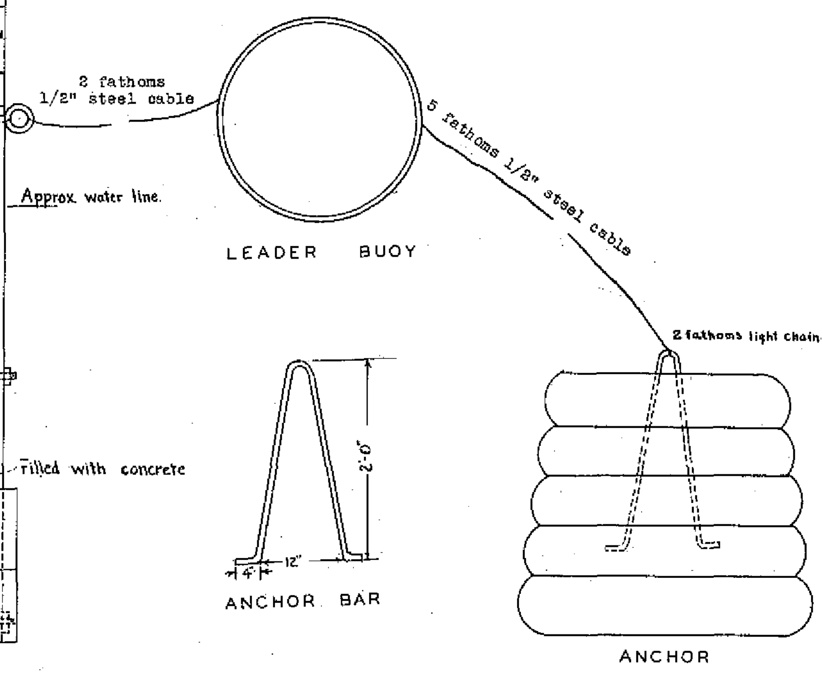
BUOY

2 55-gallon oil drums
4 pieces 2" x 4" x 10'-9"
1 " 2" x 4" x 9'-10"
4 " 1" x 4" x 2'-6"
8 " 1" x 4" x 2'-4"
10 " 1" x 10" x 1'-8"
5 bolts 3/4" x 30" threaded on both ends
1 " 3/4" x 30" " " one end 2" eye on other end
4 yds. 30" black screen wire
2 1/2 yds. white signal cloth
Nails
Anchor cable, shackles and swivels
Approximately 2 bags cement
" 4 cubic ft. sand
" 8 " " gravel

ANCHOR

5 old automobile tires
1 3/4" rod bent as shown
Wire for reinforcing
Approximately 4 bags cement
" 8 cubic ft. sand
" 16 " " gravel





SHORT COUNTERWEIGHT BUOY
FOR USE IN SHOAL WATER
USED BY SHIP NATOMA 1931

REPORT ON ECHOMETRE

K. T. Adams, H. & G. Engineer, U.S.C. & G. Survey.

In accordance with your orders of November 4, 1931, I made arrangements with the agent of the Cie. Generale Transatlantique of San Francisco to join their S.S. OREGON at Wilmington, California, and make passage from there to San Francisco for observation of the operation of the Echometre. I therefore left San Francisco Wednesday evening, Nov. 11, joining the OREGON at Terminal Island Thursday, Nov. 12, and sailing at five P.M., the OREGON arriving at San Francisco Bay Friday evening at nine P.M.

The greatest cooperation was shown by all officials and officers of the French Line in giving me full information and operating the instrument as much as desired by me. Although the master and most of the officers of the OREGON spoke rather good English, the difficulty in language when discussing a scientific instrument was quite pronounced. I therefore, in some minor details, may not have been able to receive full information.

On the passage from Los Angeles to San Francisco, the Echometre was operated for me from the dock at Terminal Island, past Point Fermin, until at about 300 meters the instrument failed to record and the radio operators started making adjustments. They found some resistance burned out and had to eliminate one stage of amplification for the remainder of the trip.

The Echometre was operated for me off Ana Capa Island, again off Point Conception, again off Point Sur and entering San Francisco Bay through the Golden Gate and up to an anchorage. I was rather disappointed in not being able to obtain more observations at greater depths, but the master of the OREGON and other officers insisted that they regularly get soundings up to 600 meters. Thus it would appear that the recording device has about the same limitations as the fast speed on the Fathometer.

In rendering this report no attempt will be made to give complete description of this instrument as such is obtainable in various published pamphlets. The Echometre was invented by two Frenchmen, Langevin and Florrison, and, as I understand, patented by them. However, the machine is manufactured by Marti, in a subsidiary of the French Steamship Line, this subsidiary being the Societe de Condensation et d'Applications Mecaniques, of 42, Rue de Clichy, Paris (9^e).

As compared with the Fathometer, the points of similarity in construction are that the instrument consists of three parts:

(a) A sound producer and receiver
(b) An amplifier
(c) A time measuring device.

The points of dissimilarity are:

(a) The sound producer and receiver are one unit instead of two as in the Fathometer, this unit being a quartz crystal which both emits the sound wave and receives the echo.

(b) The wave emitted is of the order of 50,000 cycles and is ultrasonic or inaudible.

(c) The time measuring device, in addition to giving a visual record of the depth, gives a permanent record on paper and this device can be connected to a clock, making a time record.

(d) The recording device records one sounding in three seconds instead of four soundings per second as in the Fathometer.

(e) In order to obtain a graphic record it is necessary to shift the point of contact for each 200 meter change in depth.

The points of similarity in operation are:

(a) Electrical disturbances may cause strays.

(b) The pitching and rolling and vibration of the vessel are detrimental to good reception.

(c) Double and sometimes triple echoes are obtained.

(d) In common with the Fathometer, no soundings are obtained during the backing of the vessel after the wash of the propeller is under the sound producer and receiver.

Points of difference in operation are:

(a) No audible sounds of any nature whatsoever can produce strays.

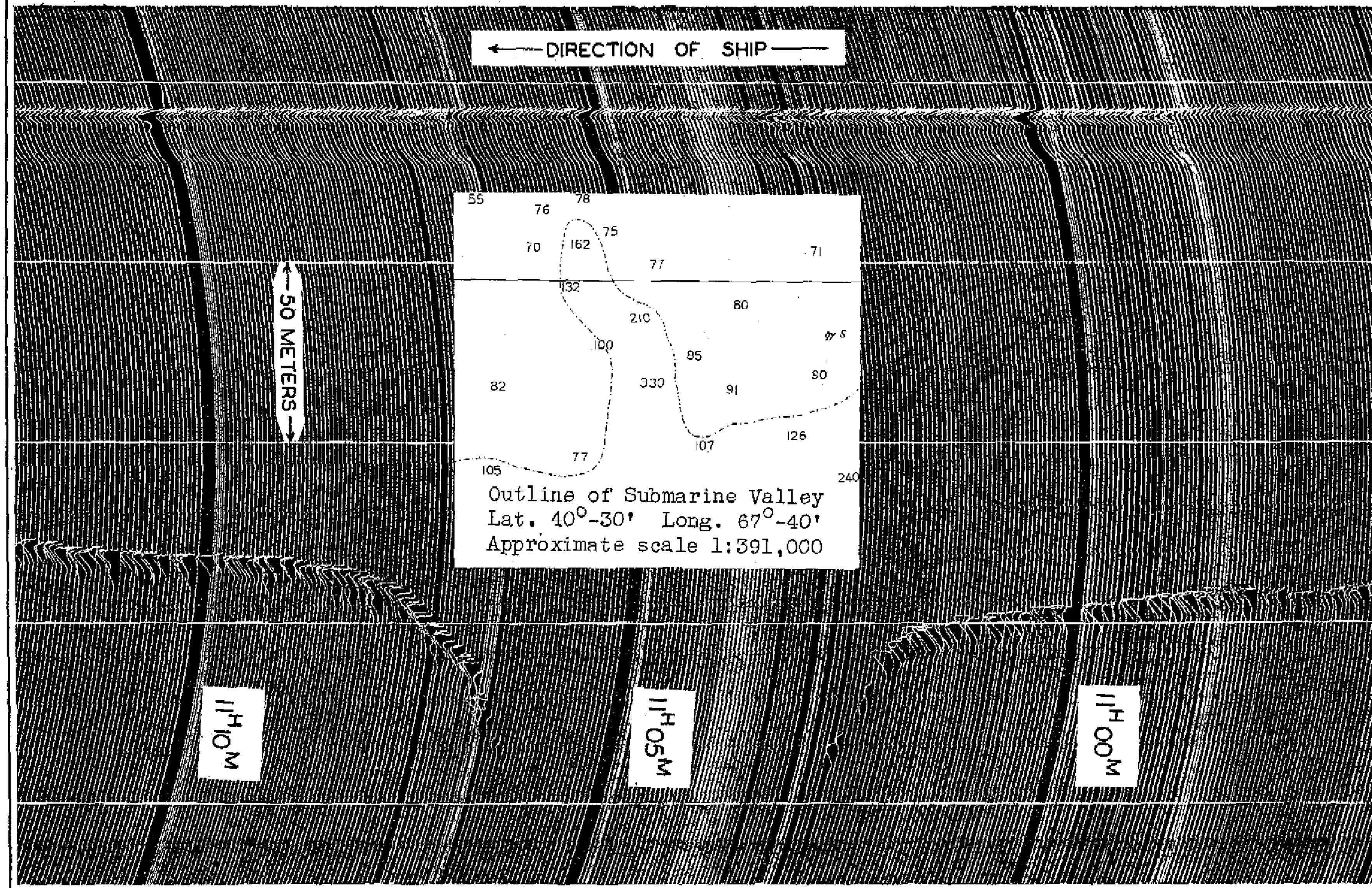
(b) A change of sensitivity or amplification does not change the depth.

In my opinion and from my limited inspection and observation, I should list the following points as being of advantage over the Fathometer:

(l) There are no permanent strays. While the Echometre was in operation in both shallow and deep water, I could not obtain anything on the record which could be mistaken for the sounding. As mentioned above, electrical disturbances do produce strays, such as might be caused by a loose connection or turning a switch on or off; but these could not cause any confusion.

(3) A permanent record is obtained. This is accomplished by a six-inch strip of bank paper passing over a series of rollers at the rate of about one meter per hour. This paper is smoked by a small acetylene flame just before it passes under a roller, which roller makes the scale on the paper. The sounding is obtained by an arm with a stylus traveling across the smoked paper, which stylus is disturbed both by the outgoing sound and by the echo, giving a record to be measured similar to our chronograph tape record. As mentioned above, one sounding in three seconds is obtained, the paper moving at such a rate of speed that about thirty soundings in each linear inch of paper are obtained. This paper then runs through a fixing bath which fixes the record permanently. Before going through this bath any notes whatsoever may be made on the paper.

ECHOMETRE RECORD OBTAINED BY S.S. DeGRASSE CROSSING SUBMARINE VALLEY SURVEYED 1931 AND SHOWN ON INSERT.



CARS-419

(3) It can be readily seen from the above description that it would not be necessary to have an officer reading the instrument constantly, as at present with the Fathometer. It is even possible that it would not be necessary to scale off the depths, except to put then on the smooth sheet, and the paper records themselves could be sent in as the final record. The fact that this could eliminate the necessity of one additional officer on the bridge would mean that the instrument would soon pay for itself in saving of officers services.

(4) The principal advantage of all, to my mind, is that it is not possible for an ordinary sound to make any record on the instrument. This is the principal advantage of the super-sonic or ultra-sonic principle.

(5) The manufacturer of the instrument claims that it is directional to such an extent that slope corrections are never necessary. Of course, my observations could not check this statement. I thought it possible that if this were so the instrument would not work satisfactorily on steep slopes. However, I made a special effort to satisfy myself that it apparently worked as well over steep slopes as the Fathometer does.

(6) There is an advantage in obtaining a direct measurement between the initial and the echo. On the Fathometer the record from the outgoing signal appears on the dial variously from three to five fathoms, depending upon the distance between the oscillator and the hydrophone, and no direct measurement between the two can be made. On the Echometres since the transmitter and receiver are one unit, the distance between the initial and the echo is the direct measurement of the depth from the quarts crystal to the bottom.

(7) There is no error or distortion in any part of the scale, such as is in the Fathometer from 0 to 35 fathoms, due to the necessity of the hydrophone being placed some distance away from the oscillator.

(8) The operation of the Echometre in shallow water is very satisfactory. While the Fathometer on the GUIDE has given consistently good results in shallow depths, it has been reported that other vessels have had considerable trouble with depths below 30 fathoms. I saw the Echometre on the WINNEPEG operating alongside the dock in nine meters of water and I saw the instrument on the OREGON in quite shallow water on leaving Los Angeles, and in entering San Francisco under way, and in all cases the operation was very satisfactory. I tried especially in shallow water to note any variations in depths due to increasing the amplification, but could detect no change whatsoever.

(9) I have been told that a small model of this instrument is available for fishing beats, and while no other information regarding this model is available, the possibility of its use on our launches should be investigated.

The disadvantages in operation of the Echometre are:

(1) The equipment as at present installed is considerably more complicated than the Fathometer. Of course, this is partially due to the apparatus for making a permanent record, which the Fathometer lacks. However, in spite of its apparent complications, I have suspicions that less trouble in operation would be encountered than is encountered with the Fathometer. The equipment is very ruggedly constructed and the masters of both the WINNIPEG and OREGON report practically no trouble.

(2) I was told that in much greater depths the recording device fails there is a secondary method for obtaining soundings by ear. This equipment either was not on the OREGON or they did not know how to use it and I could not get much of an explanation regarding it. However, I feel reasonably sure that the supplementary method there is not as good as the Fathometer or sonic.

(3) One rather serious disadvantage is the smallness of the scale. On the Fathometer we have 100 fathoms per revolution, the circumference of our scale being 25 inches, which gives a scale of four fathoms to the inch. On the Echometre one width of the paper accommodates about 200 meters in a linear distance of 4-7/8 inches. This makes a scale of about 2/11 of the Fathometer's scale. You must not suppose that the soundings on the Echometre can be read with only 2/ll of the accuracy of the Fathometer, however, because, due to the positiveness of the mark, these readings can be scaled very much closer than the red flash can be read on the Fathometer. My judgment is that soundings can be scaled to the nearest half motor, with a probable error of three-fourths of a meter, but this is only after the record has been removed from the instrument. During the period of operation it is necessary to estimate between the ten meter marks which probably could be done to the nearest one and one-half meter only.

(4) Another serious disadvantage is that the present width of the paper will only accommodate soundings up to a depth of 200 meters. The instrument overcomes this deficiency by an arrangement whereby the contact for the outgoing signal can be mechanically advanced to 200 meter intervals, thus the echo can always be made to appear on the paper, but above 200 meters there is no record of the initial or outgoing sound. It appeared to me when this mechanical change was made that the depths after and before the change did not check very closely. However, this is a mechanical operation which should be absolutely accurate, and it may be no real but an apparent discrepancy.

I understand from various sources that the company manufacturing the Echometre makes a special instrument for hydrographic surveys and I should consider it desirable to obtain, directly from the company in Paris, all possible information regarding this instrument, and also the small type used in fishing boats. I furthermore recommend that at least one of these instruments be obtained by our bureau for test purposes in comparison with the Fathometer, and with the possibility in mind of combining the best features of the two methods, if that can be done.

A CHECK ON FATHOMETER SOUNDINGS

T. J. Maher, H. & G. Engineer, U.S.C. & G. Survey.

Conversation with lieutenant-Commander Adams and the captain of the S.S. OREGON convinces me that investigations along the lines of the supersonic are desirable, even with no other object in view than for soundings. It appears to me that the adoption of the Fathometer marks one of the great steps in hydrographic work; it also marks a change from the direct, positive method to an indirect one without any checks on the soundings except confidence in the accuracy of the work, which, however, is well supported by check lines and comparisons with the direct measurements. Anyone who has had experience with the instrument knows that occasionally there have been erratic indications which are termed "strays". Sometimes these "strays" have been found to indicate pinnacles. Reliance must be placed on the judgment of the observer for a decision as to what these "strays" mean. The supersonic sounder operates on the same basic principle as the Fathometer, though in a field of frequencies so far removed that it would be extremely unlikely for the same set of electrical or mechanical defects or disturbances to produce erratic readings in both instruments, and it might be considered as a different method.

It might be desirable to have in each of our survey ships a supersonic instrument as well as a Fathometer, both operating at the same time while on the working grounds. It might even be possible to have two tubes on the same dial in the recording apparatus, one operating from the supersonic receiver, the other through the Fathometer receiver. This arrangement, of course, rests on a determination of whether the induced field accompanying the flash of one tube would cause the other to flash and whether this could be avoided by shielding or by using tubes of different voltages. If this arrangensnt could be perfected, a flash of one tube and not the other would indicate a "stray", while an erratic flash from both tubes would be an indication that further investigation was required.

From conversation with Lieutenant-Commander Adams and the captain of the S.S. OREGON, I believe that only a slight mechanical change is necessary to permit a ready and accurate change in the recording device for depths of over 300 meters. It appears to me that the most important hydrographic work lies within the 10-fathom curve, while that between the 10 and 100-fathom curve is far more important from the commercial standpoint, at the present time, than any work in greater depths, and it is Within those limits that every precaution should be taken to secure the most accurate soundings; it would therefore be desirable to have a check on all indirect measurements of depths.

The audible signal produced by the Fathometer is preferable, as the navigator knows that his apparatus is working, though his attention may be fixed elsewhere. The visible, red flash is superior to any recording apparatus, as at night the navigator can ascertain the depth without being temporarily blinded by the illumination necessary for reading a record.

The recording apparatus is simply a mechanical detail and should have no bearing on tests of the instrument. The main point for determination being whether the two types are sufficiently different to serve as independent checks, one on the other, and if each type is or is not affected by the same adverse factors.

To maintain the high position which we hold in hydrographic work, the value of any new method, which has passed the experimental stage, should be tested, particularly when it has received the endorsement of the Hydrographic Department of another nation; also that of the Merchant Marine.

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EXTRACTS FROM "THE NEED FOR SPEECH TRAINING FOR ENGINEERS"

By J. W. Parker
The Journal of Engineering Education, November, 1931

"If there is no natural law that decrees that an engineer shall be incapable of expressing his thoughts in public, to his fellow professionals or to associates in the larger community in which he is living, one is at least tempted to think there is. Long years experience with engineering reports, made in writing with graphs - oh many graphs - and tables and drawings, or made verbally before even small groups, calls to mind many a good story spoiled in the telling and much good engineering data mishandled through poor presentation. And there were highly trained, competent engineers suffering from a lack of training in systematic thinking and logical presentation of the work they had done. Every engineering executive, every engineer of matured experience, knows these things and knows they should not be.

"If the student in college appears indifferent, it is not the result of a mistaken contempt for such accomplishments. It is rather that he gives his chief attention to what appear to him to be the most practical courses offered him, because it is on these practicabilities that he finds chief emphasis placed. If he believes that it is in the applied science courses that his principal interest lies, 'there will his heart be also'. If the trouble arises from his too tardy realization of the values of things, was it not the part of a sound education to forewarn him, to compensate for his own lack of experience?

"The difficulty runs deeper than a mere lack of facility with spoken words. It is rather an indication of a more fundamental fault in the very backbone of his education. Nor does it appear that just training in English composition and in debating supplies the entire remedy. The fundamental teaching policy of the college is involved."

NEW SYSTEM OF CONDUCTING MAGNETIC SURVEY

E. W. Eickelberg, H. & G. Engineer, U.S.C. & G. Survey

Prior to 1889 the magnetic data of the United States consisted of scattered observations taken chiefly along the coasts. Since that time the making of observations has been systematized so that, at present, there is a magnetic station in practically every county seat in the country. These "stations are reoccupied at intervals of five years to determine the changes in direction and strength of the earth's magnetic field.

The reason for selecting a point at the county seat for a magnetic station was principally from a viewpoint of giving good distribution, but also because, in many cases, the local laws for making compass surveys specified the standardizing of the surveyor's compass at the county seat.

However, due to the changing conditions and growth at these centers of population, the magnetic station frequently becomes useless, through being surrounded by such disturbing agencies as steel buildings, direct current car lines, and automobile dumps. This causes frequent renewals of such stations.

With the modern methods of transportation and good roads there is no particular objection to locating stations at some distance from these towns, as they will still be quite available. This at once increases the permanence of the point and the magnetic conditions are likely to be superior. It also becomes apparent that such a system of points is becoming available in our first order triangulation nets, which ultimately are to be so spaced that no point in the country will be more than 50 miles from a precisely determined triangulation station. Furthermore, the modern first order work requires the placing of an azimuth mark at a distance of approximately 1/3 mile from the station mark. By furnishing a well marked station with latitude, longitude, and azimuth, the triangulation station accomplishes half of the magnetic observer's work and makes his progress more rapid, as he is not dependent on clear weather. By adding magnetic information, the triangulation station becomes more valuable to the local engineer as he at once has all necessary information in the one point, namely, position, azimuth and compass variation. By furnishing recovery notes at regular intervals, this system helps to keep the triangulation station record up-to-date.

The new system, therefore, is to follow along any given net of triangulation stations, observing declination approximately every 50 miles and making complete magnetic observations at the triangulation station which is closest to the former county seat station.

It is, of course, not expected that the triangulation stations will in every case survive, but it is thought that by proper selection of stations, the present mortality of magnetic stations can be greatly reduced and the new work accomplished with greater economy.

DETERMINATION OF VELOCITY OF SOUND IN SEA WATER IN CAPE COD BAY

I. TEST LINE FIXED FROM SHORE OBJECTS

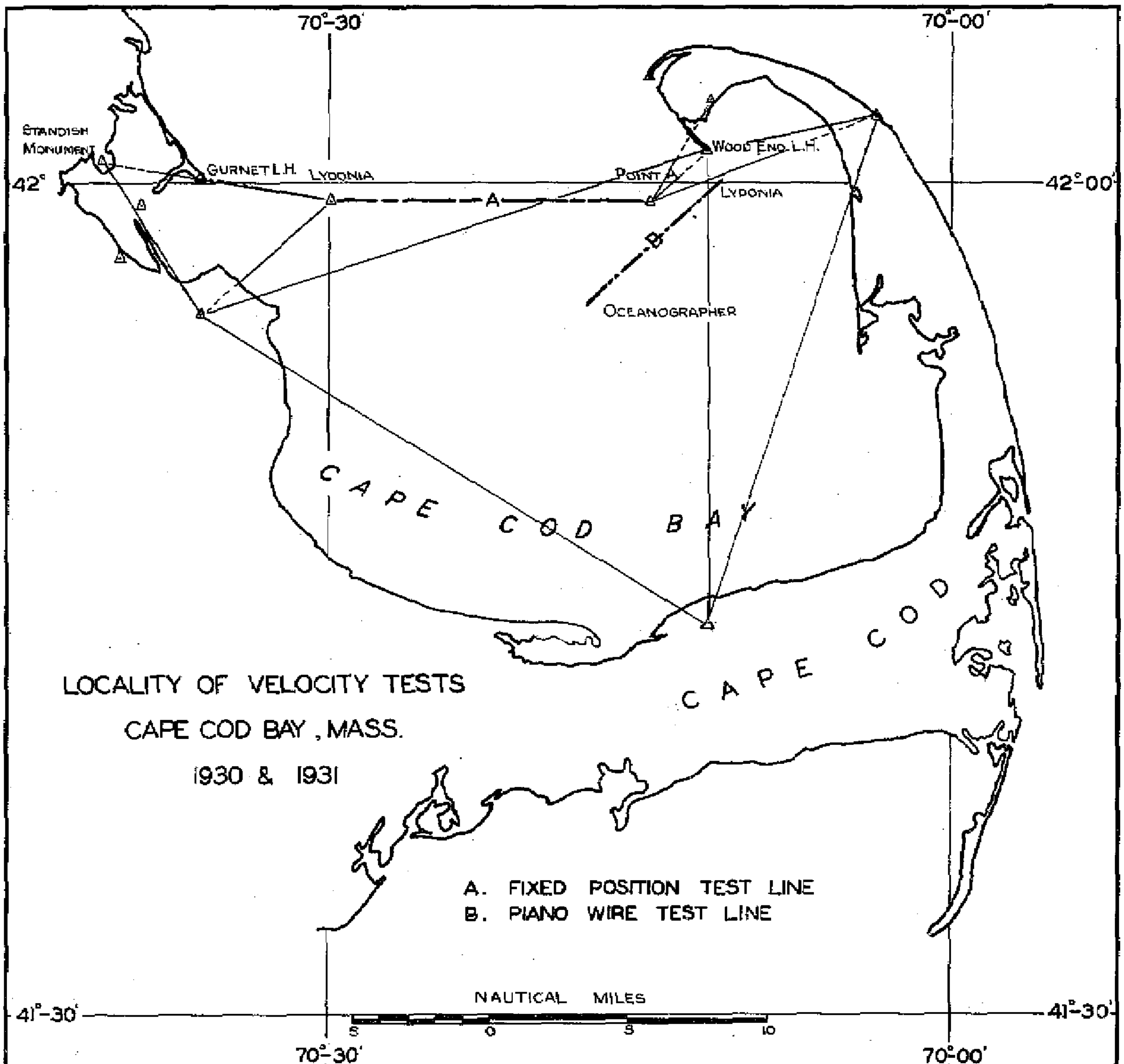
G. D. Cowie, H. & G. Engineer, U.S.C. & G. Survey.

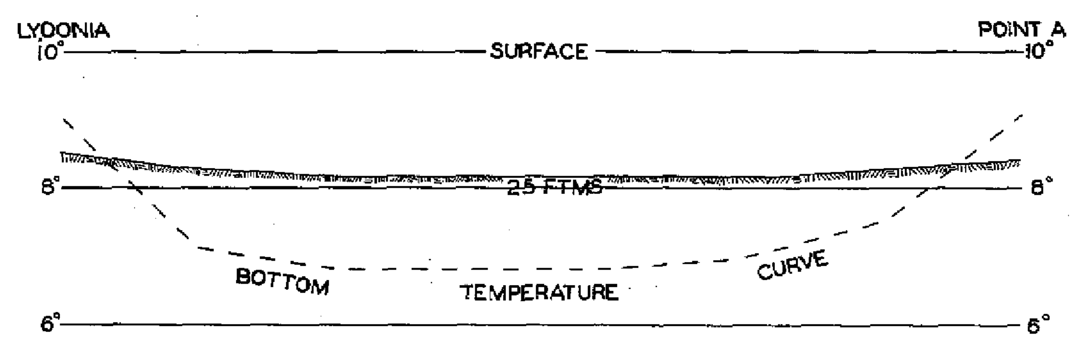
The velocity of sound in sea water was determined in Cape Cod Bay the latter part of September, 1930, by the following method: One ship, the OCEANOGRAPHER, fired the bombs while cruising near the eastern shore of Cape Cod Bay. She determined her position by sextant fixes on triangulation stations on shore each time a bomb was fired. The observers took their angles over the spot where the bomb was dropped. The other ship, the LYDONIA, acted as hydrophone station, while anchored near the western shore of Cape Cod Bay. She determined her position by sextant fixes on triangulation stations on shore each time she received a bomb. The position of the hydrophone was determined, each bomb, by measured angles and distances from the spot on the ship where sextant angles were taken to the magnetophone.

The OCEANOGRAPHER plotted the position of the bombs on a 20,000 scale projection, constructed on an aluminum sheet and a point, "A", was assumed near the average position of the bombs. The LYDONIA computed the positions of the hydrophone and a point, "B", was assumed near the average position. The distance between points "A" and "B" was computed. The component of the difference between each position and the assumed position "A" or "B" along the line between "A" and "B" was determined and added or subtracted to the line "A"-"B" for each bombed distance. Each distance divided by the elapsed time in seconds gave the velocity per second. The average of all good values was 1474.6 meters per second.

Temperatures and salinities were measured at both ends of the line and averaged. Using the mean temperatures and salinities, the theoretical bottom velocity is 1481.7 meters per second. This is 7.1 meters per second greater than the test velocity.

Using the means of temperatures and salinities at each end of the line, however, does not take into consideration the fact that the temperatures are lower in the deeper water between the two ships. During the tests taken in the fall of 1951 along the same line, temperatures and salinities were taken all along the line while the tests were in progress. The temperatures at the ends of the lines were about the same as those of the year previous. An average of all the temperatures along the line gave a temperature 2.6°C. lower than the means of the temperatures at the ends of the lines. Applying a correction of -1.73° C, determined by using a bottom temperature curve averaged from the 1931 curves, to the means of the temperatures at the ends of the line for the 1930 test gives a theoretical bottom velocity of 1475.0 meters per second. This is 0.4 meters greater than the test velocity.





PROFILE OF FIXED POSITION TEST LINE
AND BOTTOM TEMPERATURE CURVE

GEM

(PLATE I)

C.&G.S.-419

II. WIRE BASE TEST LIKE
T. B. Reed, H. & G. Engineer, U.S.C. & G. Survey.

The purpose of the test was to establish data fop the determination of a velocity of sound to be used on Georges Bank during the present field season and to enhance the experimental data on the speed of sound through sea water by a comparison between actual and theoretical velocities.

The test was made May 31, 1931, in Massachusetts Bay off Provincetown on the course shown on the attached sketch.

Since this is thought to be the first successful determination of the velocity of sound by the above method, a detailed description of the methods employed will be given:

The LYDONIA have to, heading directly into the wind and having the end of the piano wire from the sounding machine of the OCEANOGRAPHER attached to their bow by a spring, and drifting their magnetophone astern at a constant distance on a float.

The OCEANOGRAPHER steamed directly into the wind at a speed of about six knots paying out the piano wire from the sounding machine over a registering sheave. Tension on the wire was kept constant at about 50 lbs. by watching the marks on an accumulator spring set horizontally at the forward end of the sounding been and applying the brake of the sounding machine accordingly.

The OCEANOGRAPHER was kept on the same course, 226° true, during the entire run. Bearings taken on the LYDONIA at each bomb were consistently 180° off the bow, showing that the ship was not set to either side of her course by wind or current during the run.

All bombs were thrown overboard from the same position at the rail of the quarter deck, and at as near as possible the same distance and direction from the ship, and the registering sheave was road at exactly the instant each bomb hit the water. Since the fuse interval was nearly the same for all bombs, it was assumed that the effect of the current on them before their explosion would be the same for all bombs.

From previous experiments on the LYDONIA it was determined that bombs of this type sink about 5-1/2 feet per second. This would give an average depth of explosion of all bombs at about 10 fathoms.

To eliminate all uncertain corrections such as the scope of the magnetophone of the LYDONIA, etc., it was not intended to use the portion of the wire from the LYDONIA to the first bomb and no attempt was made to measure this distance. It was intended that the computations be made from a combination of differences between bombs and it was assumed that the magnetophone floated at the same distance from the LYDONIA during the bombing.

Thirty bombs were fired at intervals of about two and a half minutes along the line. The first four bombs did not go through, were not numbered end were omitted from the computations. All bombs were half pints. Bombs were numbered consecutively from 1 to 35 and the numbers in the bomb record correspond with numbers used in the computations. Bomb No. 12 was omitted as there was no sheave reading on it. Abstract of bombs, times and sheave readings is given below.

A mean of the accepted velocity determinations from the test gives 1476.5 meters per second. The theoretical bottom velocity is 1476.1 meters per second, or 0.4 meters less than the test velocity.

CONCLUSIONS: The following conclusions might be mentioned as derived from the foregoing test:

1. It is a comparatively simple method of making velocity tests in remote localities where the visual fix method is not possible.

2. This method might easily be employed by one vessel using a launch equipped with a portable R.A.R, set as one end of the base.

3. It is believed that, under good conditions, the wire could be laid out and recovered without loss.

4. This method is not dependent upon good visibility for seeing shore signals.

5. It is felt that the mean of a large number of bomb differences, even though taken over a short base, Will be more accurate than a few bombs over a longer base which depends upon sextant angles and graphic plotting for its determination.

6. The large number of rejections of bombs during this test was probably due to the fact that this was the first R.A.R. work of the season for the two ships.

7. The results of this test seem to be further evidence supporting the theory that the sound wave travels at a rate corresponding to the theoretical velocity of the mean bottom temperature.

ABSTRACT OF BOMBS, TIMES AND SHEAVE READINGS

Bomb No.	60th meridian time	Bomb time	Sheave Reading Fathoms	Fuse Interval secs.	Bomb No.	60th meridian time	Bomb time	Sheave Reading Fathoms	Fuse Interval secs.
1	15-11-30	1.26	1026	20	7	15-25-09	2.96	2393	15
3	15-13-10	1.47	1208	20	8	15-26-33	3.15	3530	22
3	15-14-24	1.69	1338	21	9	15-28-16	3.54	2674	19
4	15-17-17	2.00	1618	18	10	15-30-04	3.61	2826	19
5	15-18-33	2.32	1753	19	11	15-32-45	3.56	3144	18
6	15-23-04	2.72	2189	19	12	15-34-00	4.70	R	20

Bomb No.	60th meridian time	Bomb time	Sheave Beading Fathoms	Fuse Interval secs.	Bomb No.	60th meridian time	Bomb time	Sheave Reading Fathoms	Fuse Interval secs.
13	15-36-06	4,29	3488	18	20	15-52-55	6.40	5161	22
14	15-41-27	4.96	4033	18	21	15-54-44	6.63	5332	18
15	15-43-30	5.26	4237	21	22	15-56-40	6.83	5515	17
16	15-45-17	5.46	4417	18	23	15-59-29	7.03	5681	13
17	15-47-12	5.70	4607	21	24	16-04-06	7.69	6217	15
18	15-19-14	5.94	4804	25	25	16-07-09	8.06	6505	20
19	15-51-00	6.03	4976	18					

Sheave read by TBR
Chronograph operated by CAB

Tapes scaled by CAB
Scaling checked by TBR

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EXTRACTS FROM REPORTS ON HYDROGRAPHIC SHEETS

I. Sheet H-4993 - Point Reyes to Havens Anchorage, Calif. - F. B. T. Siems, Commanding Ship DISCOVERER - Fathometer Soundings and R.A.R. Control - Reviewed by A. L. Shalowitz.

"In concluding this report it should be stated that this sheet is perhaps one of the finest specimens of work executed by the new methods that has come to the attention of the writer. With lines running 70 to 80 miles offshore and in depths well over 2000 fathoms, the sheet presents the appearance of a well planned and orderly survey such as would be expected when operating close to shore. That a tremendous step forward has been made in adopting the acoustic method of surveying is almost axiomatic at this late date, nevertheless 2100 statute miles of soundings (consisting of 6600 soundings) in 26 days in depths ranging from 20 to 2100 fathoms and comprising an area over 3000 square nautical miles, including a large scale development of an important offshore tank, is still an enviable record which should not pass unnoticed. The Chief of Party is to be highly commended for the splendid results obtained."

II. Sheet H-5037 - Gardner Pinnacles, Hawaiian Islands - K. T. Adams, Commanding Ship GUIDE - Fathometer soundings and buoy control (sun azimuths and full speed double run distances) - Reviewed by E. P. Ellis.

"This sheet is a very fine example of two phases of hydrographic surveying: First, the excellent results obtained by the modern buoy control system; second, the consistent results obtained by the fathometer in depths of 15 to 25 fathoms."

PROGRESS ON THE WEST COAST

(Prepared in the Division of Hydrography and Topography)

I. PACIFIC COAST: The GUIDE, Lieutenant-Commander K. T. Adams, Commanding, continuing operations on the Washington coast, has completed the outer coast surveys of that state by extending work northward to the U. S. Canada "boundary and offshore to the 1000-fathom curve. The detailed development of the banks, shoals and submarine valleys in this region, as well as the exceptionally long distance of the 1000-fathom curve from the coast, required that radio acoustic ranging shore stations be placed on Vancouver Island, permission for the establishment of which was granted by the Canadian Government.

The configuration of the bottom with its characteristic depth variations was found to be well adapted for fixing a ship's position from soundings. When the results of the surveys are applied to the charts, shipping bound for Juan de Fuca Strait should have little difficulty in "making" this important waterway even in the thickest of fogs, particularly if equipped with echo sounding apparatus.

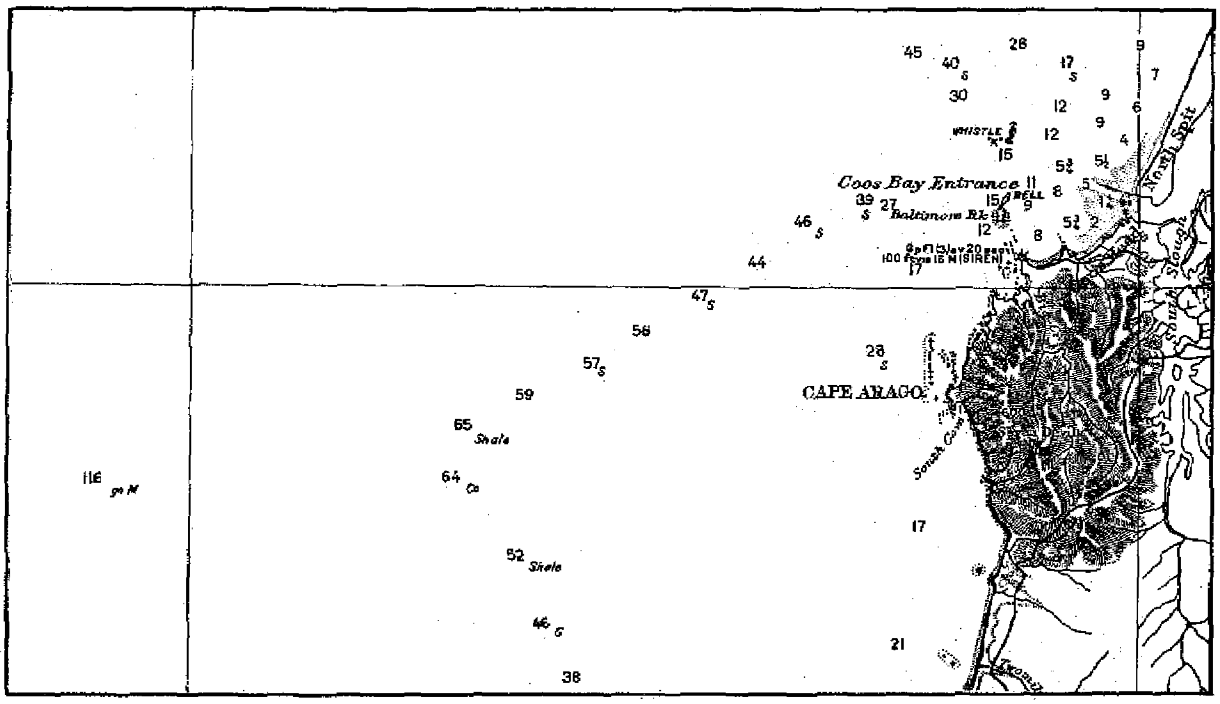
In connection with this project a second order scheme of triangulation was carried from the entrance to Juan de Fuca Strait westward to Barkley Sound on Vancouver Island where it connects with the Canadian Geodetic Survey scheme across Vancouver Island. This will be used in the adjustment of the triangulation through Juan de Fuce Strait and along the Olymphic Peninsula. Also in connection with this project, a special investigation of the nature of the bottom on Swiftsure Bank was made for the U. S. Lighthouse Service in an endeavor to find better holding ground for the lightship stationed there. Current observations, each of 52 hours' duration, were made at two stations in the center of the channel in Juan de Fuca Strait. As the station in the entrance was in a depth of over one hundred fathoms, the observations were made from the ship's launches with the GUIDE standing by and sounding fog signals during the greater part of the series.

A shore party in charge of Lieutenant G. C. Jones operating in the southern part of San Francisco Bay completed new surveys to the head of navigation. The topography on this project will be obtained from air photographs made for the Bureau by the Army Air Corps with the new five lens camera. So much triangulation is available in this area that it will furnish an ideal proving ground for the new camera. The value of the fifth chamber toward increasing the accuracy of the plotting will be determined as well as the suitability of the camera for mapping on the 1:10,000 scale to be used. Preliminary plots indicate that a considerable increase in accuracy of plot is possible with photographs from the new camera.

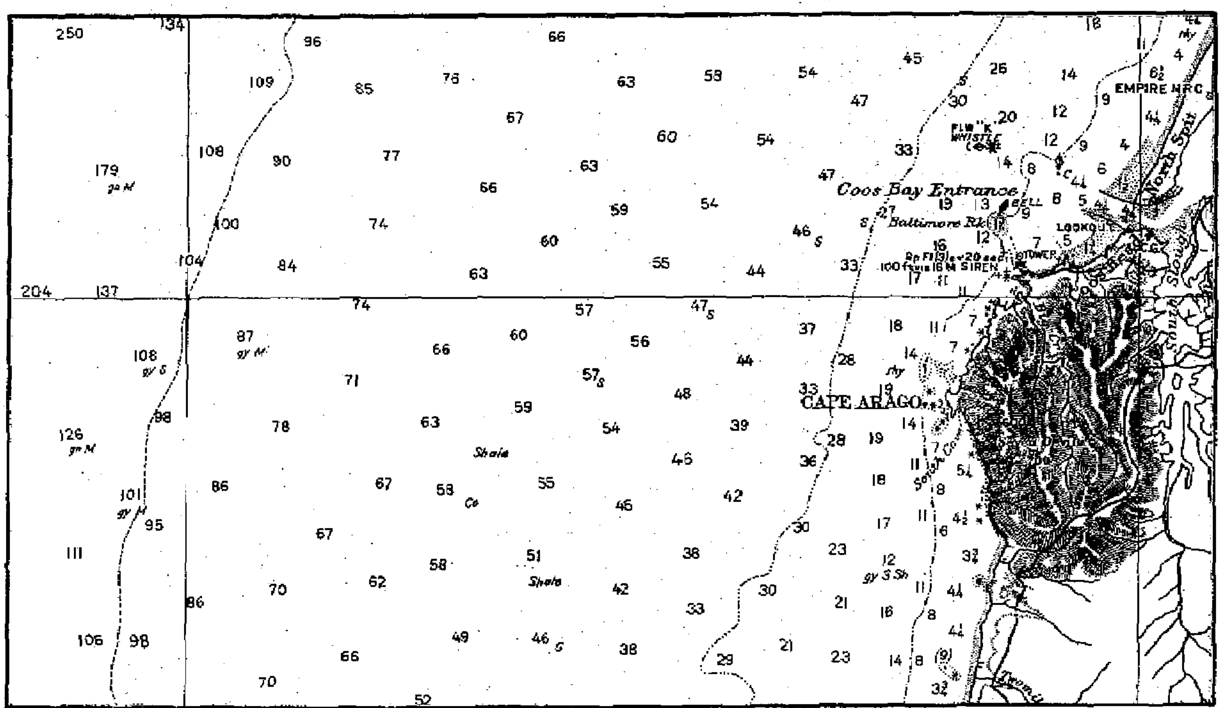
Closer development than is usual of the extensive flats on each side of the main channel was made for the purpose of determining by comparison

SECTION TYPICAL OF THE OREGON COAST

BEFORE AND AFTER COMPLETION OF MODERN HYDROGRAPHIC SURVEYS



1918



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with the previous surveys the rate of silting that is taking place in the bay. This information is especially desired at this time in connection with San Francisco's salt water barrier problem.

A launch party in charge of Lieutenant (j.g.) L. C. Johnson operating on the outer coast of California extended new topographic and inshore hydrographic surveys southward to Point Reyes. These included resurveys of Bodega and Tomales Bays. This work, together with a small project in the same locality, which the GUIDE is now engaged upon, will complete the surveys necessary to furnish field data for the construction of modern charts of the outer coast from the Canadian border southward to the southern approaches to San Francisco Bay. Continuation of the field work southward will be taken up in 1332 by the party on the GUIDE. In anticipation of this, a second order scheme of coastal triangulation has recently been carried to Monterey Bay by a shore party in charge of Lieutenant C. D. Meaney and will be continued from there in advance of other operations.

II. ALASKA: The work accomplished in Southwest Alaska during the 1931 season is given in a separate article in this issue of the bulletin.

In Southeast Alaska, the EXPLORER, continuing the survey of Behm Canal, the northern arm of which was completed in 1930, extended work down the southern arm, practically completing the project. Detailed surveys of the many tributaries, some of which are frequented by excursion boats because of the scenic beauty of this region, were included in the project. A dangerous rook was found in Shoalwater Pass. Magnetic observations made in connection with the surveys revealed considerable local attraction in that locality.

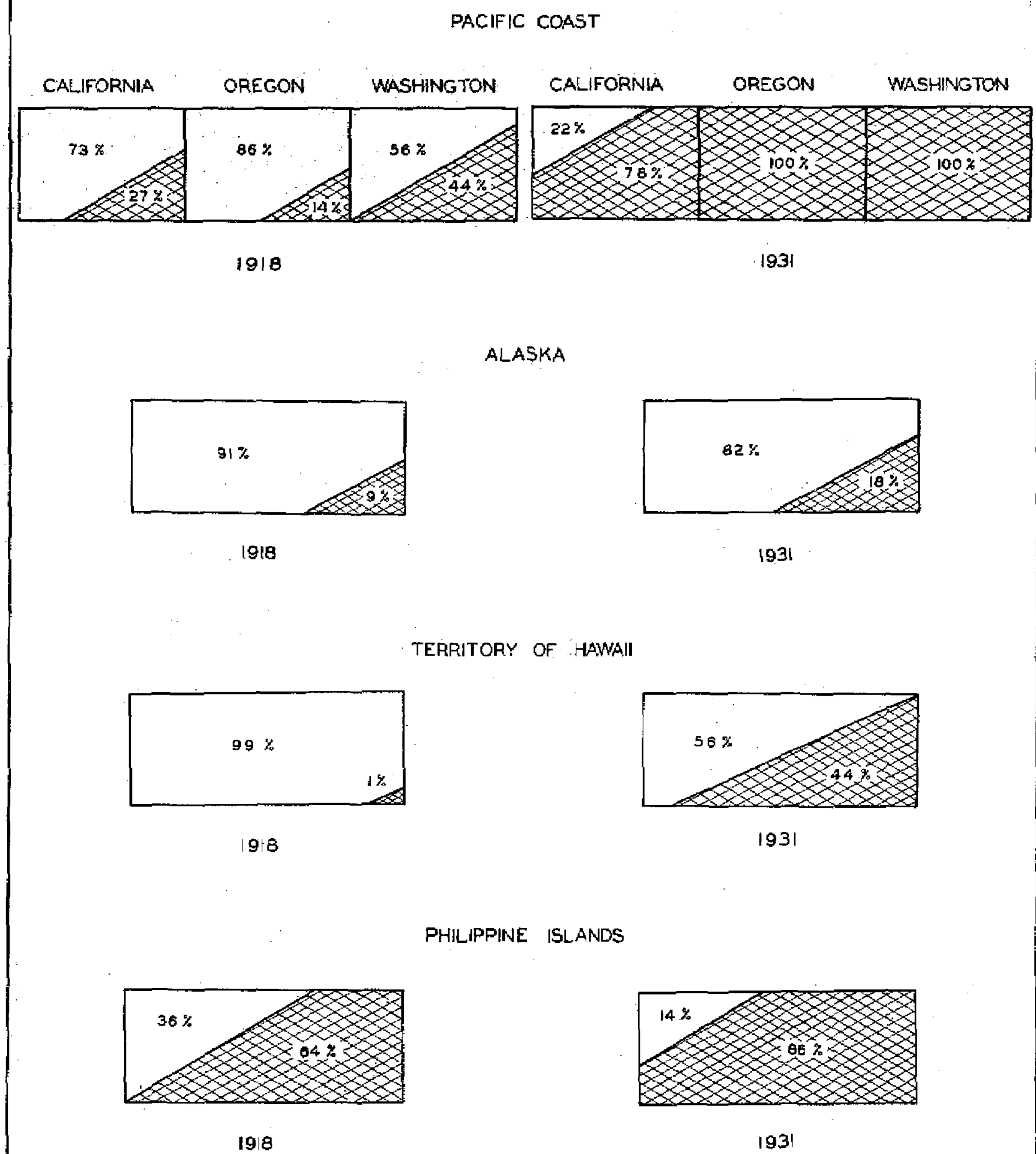
III. HAWAIIAN ISLANDS: The PIONEER, continuing the extensive project of surveying the chain of reefs, shoals and islets which extend 1100 miles westward from the main group of islands to Midway Island, carried the project to and including the survey of the plateau around Lisianski Island. The work is now several days' run from Honolulu, the base for supplies. Advantage is taken of the run to and from the working ground - once a month - to sound the deep water areas adjacent to the chain. For this class of work, sounding lines are spaced 10 miles apart as the depths are over 2,000 fathoms.

IV. PHILIPPINE ISLANDS: The PATHFINDER, FATHOMER and MARINDUQUE, the latter two owned by the Philippine Government, continued operations on the north and east coasts of Luzon Island, on the west coast of Palawan Island, and in the Sulu Archipelago. As a result of the now boundary treaty, considerable more area will have to be surveyed in the Sulu Sea. For this reason, the party on the MARINDUQUE is extending triangulation to the Bornco coast just off of which the new boundary line passes.

CONDITION OF WATER SURVEYS

BLANK AREA REPRESENTS UNSURVEYED WATER AREAS

SHADED AREA REPRESENTS SURVEYED WATER AREAS.



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THE 1931 SEASON IN SOUTHWEST ALASKA

I. The SURVEYOR, F. B. T. Siems, Commanding.

The SURVEYOR, continuing on the extensive project which calls for complete charting of the coast of Kodiak Island on a comparatively large scale, extended work along the southwest coast from Sitkinak Strait eastward to a junction with previously completed surveys in Sitkalidak Strait. This included detailed surveys of Three Saints, Shearwater and several other bays. (See accompanying plate). The season's accomplishment furnishes data for charting the greater portion of the areas embraced by new charts Nos. 8536 and 8537, scale 1:80,000.

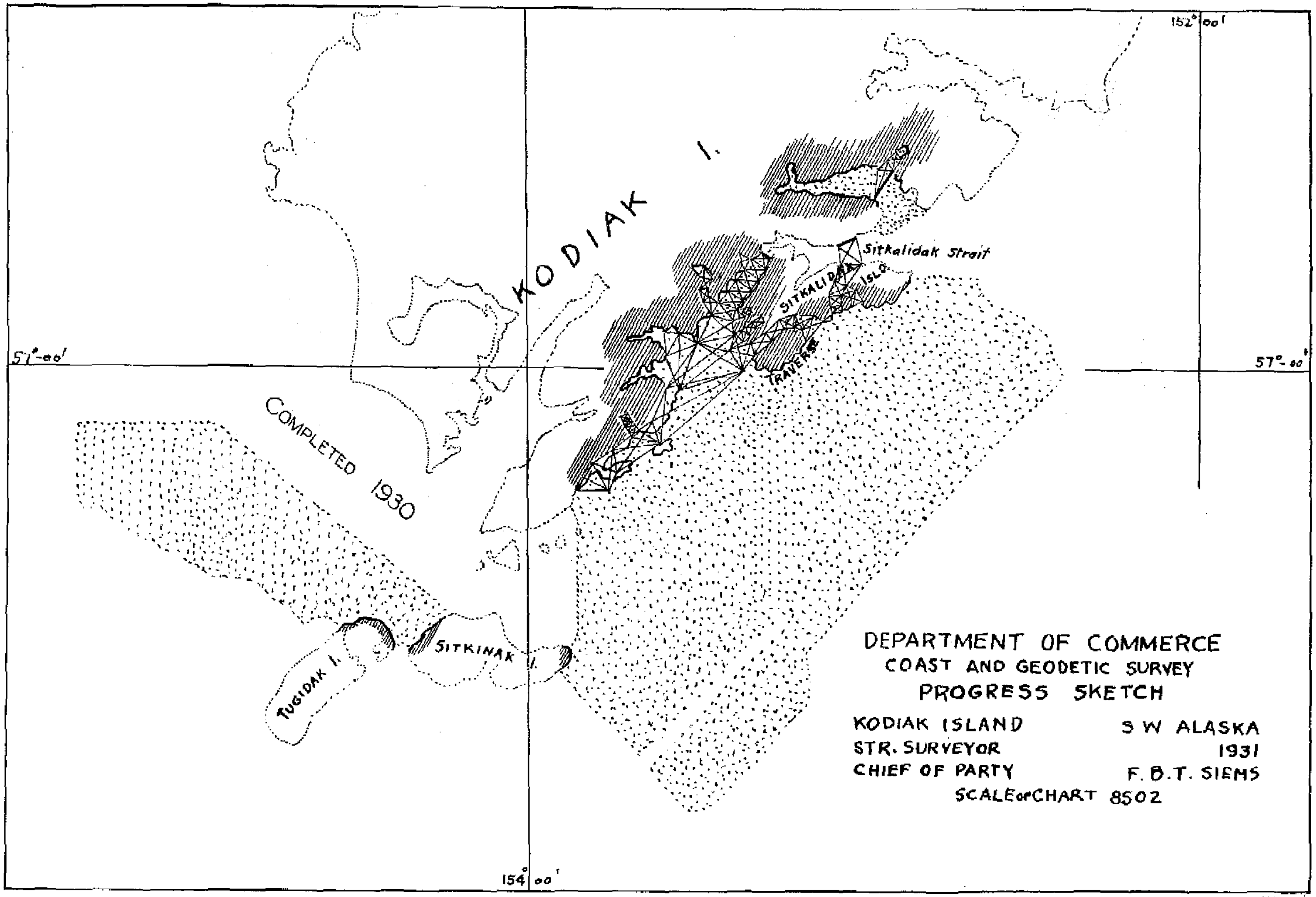
Albatross Bank near the edge of the continental shelf roughly parallels the southeast coast of Kodiak Island and is about forty miles offshore. There are depths of 15 fathoms on the bank, and irregular areas of 30 to 100 fathoms between the bank and Kodiak Island.

The party on the SURVEYOR was equipped to use R.A.R. control for the hydrography of the area described above. However, extension of the main scheme triangulation from the south end of Kodiak Island to a detached scheme in Sitkalidak Strait and overland extensions of the latter scheme to the outer coast of Sitkalidak Island were not completed until near the end of the season. This made it impossible to locate the R.A.R. station that would have been required on the northeast end of the work during the season.

Extended clear spells of weather in southwest Alaska usually occur during May and June and from the middle of August to the end of the season. During the intervening period, it is generally misty. The 1931 season off Kodiak was marked by considerable haze, particularly during the latter part of the season when northwest winds would fill the atmosphere with volcanic dust from the Katmai volcano region. The clear weather during May and June was used in extending offshore hydrography along the southwest part of Kodiak Island, where peaks had been located in previous years.

The offshore hydrography along the southeast coast of Kodiak Island has been extended to Albatross Bank on the southeast end of this work and about midway to the bank from Sitkalidak Island. Having the peaks located in this region, it is probable that the remaining offshore hydrography can be completed at the beginning of next season by visual fixes. Closely spaced sounding lines being required in this irregular bottom, the necessary degree of accuracy can probably be obtained only by visual fixes. Interference in transmission of sound by intervening shoals will very likely be encountered to a great extent.

Three schemes of triangulation were carried overland along divides on Sitkalidak Island to terminate on the outer coast for control. A scheme following the outer coast was impracticable. A theodolite traverse was run on the outer coast between two triangulation stations about


KODIAK I.
Sitkalidak Strait
SITKALIDAK ISLD.
TRAVERSE
COMPLETED 1930
SITKINAK I.
TUGIDAK I.
152° 00'
57° 00'
154° 00'
DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
PROGRESS SKETCH
KODIAK ISLAND S W ALASKA
STR. SURVEYOR 1931
CHIEF OF PARTY F. B. T. SIEMS
SCALE of CHART 8502

six miles apart. The distances between traverse stations were derived from measured offsets and distance angles. Beginning with the instrument mounted on one triangulation station, the forward traverse station was selected, an offset station was established in direction normal to the direction to the forward station, its distance from the occupied station was measured by tape (the offset distances were in the neighborhood of 30 meters), and the angle to carry azimuth forward was measured. The same procedure followed in occupying subsequent traverse stations, but in addition thereto, the distance angle between the back station and its offset station was measured. A discrepancy of four meters in position resulted in carrying the traverse to the second triangulation station.

To obtain the inclination correction to the measured offset distance, the difference in elevation between a traverse station and its offset station was determined by bringing the eye in the plane of one station and the visible horizon and noting the elevation of the other station above or below the plane on a graduated pole. With normal offsets, the log distance between traverse stations is simply the difference between log offset distance and the log tangent of the distance angle.

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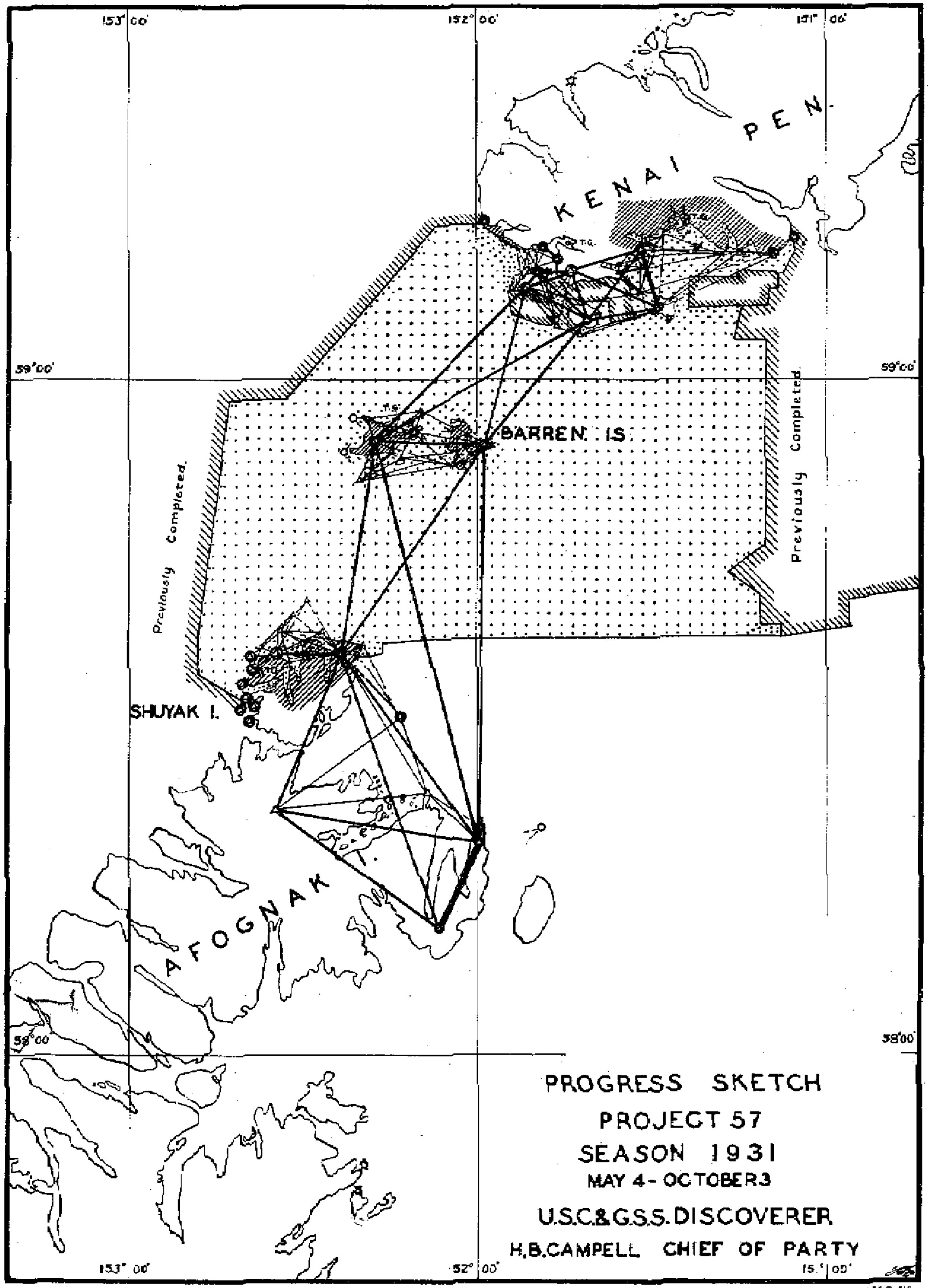
II. The DISCOVERER, H. B. Campbell, Commanding
The WESTDAHL, L. D. Graham, Commanding

The DISCOVERER and WESTDAHL, continuing on the project along the south side of the Kenai Peninsula, extended surveys westward to a junction with previously completed work in the vicinity of Chugach Islands and across the Strait to Shuyak Island. The season's work furnished the field data necessary for the construction of proposed chart No. 8532, scale 1:80,000. Detailed surveys of Port Dick and Windy Bay, the area around the Barren Islands and of the north coast of Shuyak Island were included in the project. (See accompanying plate).

Second order triangulation was carried from the south end of Kenai Peninsula to Afognak Island. Several supplemental schemes were observed and a large number of intersection points determined. The control is in very good condition for going ahead next season.

The party completed 297 miles of shoreline topography. A comparative field test of topographic sheets was made in the Barren Islands. One officer surveyed Ushagat Island using standard Whatman paper, while at the same time another officer surveyed Amatuli Island using the new aluminum mounted paper. Distances between fixed points on the sheets were scaled daily. The aluminum mounted sheet was found to remain constant. Full report on the test will be given later.

The party ran 8206 miles of sounding lines. Both ship and launch work required unusually close spacing of lines because of the very irregular bottom and foul ground in this locality. Numerous dangers to navigation were found while several reported dangers in the Strait were


153° 00'
152° 00'
151° 00'
59° 00'
58° 00'
KENAI PEN.
BARREN IS.
Previously Completed.
Previously Completed.
SHUYAK I.
AFOGNAK I.
PROGRESS SKETCH
PROJECT 57
SEASON 1931
MAY 4 - OCTOBER 3
U.S.C.&G.S.S. DISCOVERER
H.B.CAMPELL CHIEF OF PARTY

cleared up. The bays on the portion of Shuyak Island surveyed during the course of the season were all found to be foul and could not be entered with the ship.

Tidal observations were made at five stations and magnetic observations at eight stations. Observations at a current station east of Elizabeth Island showed the maximum current on spring tides to be 3.6 knots.

On the whole, it was a good season - an unusual season in many respects chiefly because of the importance of the straits, previous sounding in the region and the many evidences of pinnacle rock formation. The weather was probably better than usual. A congenial and willing complement contributed much toward the success of the season.

North Shuyak is good ptarmigan country. There are also two good trout streams on Shuyak. One camp party caught more than 4,000 "rainbows" in one creek. The record "rainbow" this season, measuring 30 inches "overall", was gotten by Lieutenant Bean. Members of the crew killed a bear near Red Fox Bay. The crew of the WESTDAHL got another one north of Rocky Bay.

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THE ECHO SOUNDING RECORDING GEAR

V. H. Robinson
Nautical Magazine, December, 1931.

The addition by Messrs. Henry Hughes & Son, Ltd., of a recording apparatus to their well-known British Admiralty echo sounder has marked the greatest step forward in the history of sea-sounding since the introduction of the echo sounder itself.

* * * * * * *

The echo sounder is no longer a luxury; it is a necessity. Here we have a new line of position, ready at hand in all weathers, at the turn of a switch.

* * * * * * *

IT IS ONLY A MATTER OF TIME, BEFORE EVERY SHIP WILL LEAVE THE BUILDER'S YARD INSTALLED WITH A RECORDER ECHO SOUNDER AS A MATTER OF COURSE. THE POSSIBILITIES IT PRESENTS FOR INCREASED SAFETY AT SEA ARE TOO GREAT FOR ITS UNIVERSAL ADOPTION TO BE LONG DELAYED. SURVEY SHIPS WILL, BY ITS MEANS, BE ABLE TO COVER MORE GROUND WITH GREATER ACCURACY. TRAVELERS WELL FIND IT INDISPENSABLE.

EQUIPPED WITH THIS INSTRUMENT AND A DIRECTION FINDER, NO SHIPMASTER NEED BE LONG IN DOUBT AS TO HIS POSITION, AND SLEEPLESS NIGHTS - EVEN IF THEY DO NOT BECOME A THING OF THE PAST - WILL AT LEAST BECOME LESS FREQUENT.

NOTES ON FATHOMETER OPERATION

(I) F. B. T. Siems, Commanding Ship SURVEYOR.

(The Fathometer on the SURVEYOR has given excellent results and practically no time has been lost on account of failure to operate satisfactorily. There are Forwarded herewith notes concerning the operation of the Fathometer, F. B. T. Siems, Commanding)

Fluctuation of the Fathometer neon flash has been materially reduced by using a low oscillator frequency and certain Combinations of settings embracing the elements of hydrophone current, bias of amplifying tubes and oscillator voltage.

It has been found that a frequency considerably lower than the Fathometer standard frequency of 550 cycles produces a steadier flash than obtained by the standard frequency with any combination of the other elements. This is very noticeable in depths of ten to twenty fathoms.

If the oscillator diaphragm is designed to have a natural period in resonance with the electrical impulse of 550 cycles, it would appear that the signal will build up its intensity during the duration of the impulse. The duration of impulse corresponds to a length of signal measured in depth gradations along the Fathometer dial (about 2½ fathoms was found to be a satisfactory length of signal). It is the beginning of the signal that should register; however, with a weak hydrophone current, an intensified part rather than the beginning of the signal would apparently be detected. This can be demonstrated in shoal areas of uniform bottom. With the standard frequency the minimum hydrophone current, at which the neon tube can be made to flash, will indicate a sounding deeper than that registered by a greater current and, as the current is increased within a certain range, the registered sounding is gradually decreased. This tendency is greatly modified by using a low frequency. The current then necessary for registering is confined to a smaller range and the weaker hydrophone currents will not detect signals as before. It is considered that with low frequency the signal is of more or less uniform intensity throughout its duration since it is not in resonance with the impulse; the beginning of the signal would therefore be detected, except that there is also a tendency for the end of the signal to register.

An arbitrary scale graduated 0 to 100 for resistances controlling the bias of the amplifying tubes was used, "100" representing high negative potential and "0" low negative potential of the grids of the amplifying tubes. The following table gives the settings for bias for various depths that caused least fluctuation of the neon flash:

DEPTH (fms.)	BIAS	DEPTH (fms.)	BIAS
10 to 20	100-90	35 to 50	60-40
20 to 25	90-85	50 to 70	40-30
25 to 55	85-60	70 to 100	30-0

Oscillator voltages used for shoal depths were somewhat less than those used for deeper depths. Not having a voltmeter, these voltages had to be gauged approximately in terms of resistance used, for which there was a scale. In this respect care was taken to have the ship's line kept at the standard voltage of 100. Insufficient oscillator voltage apparently plays a part in causing the end of the signal to register, the flash for the beginning of the signal being blanked entirely or registering only occasionally. The end signal at times would come in so regularly that at first it was mistaken for the sounding. This was experienced mainly in depths around twenty-five fathoms and around seventy-five fathoms; around seventy-five fathoms the flash would, however, be appreciably more than the length of the signal beyond the correct depth. By increasing the oscillator voltage as well as the hydrophone current it was generally possible to cause the beginning of the signal to flash, if only occasionally. The correct sounding was then readily recognized as the two sets of flashes would be registering apart by a more or less constant amount. At no time, however, do both flashes register for the same revolution of the disc. It might be mentioned here that also in shoal depths where the direct signal from the oscillator to the hydrophone and the return signal from the bottom are close together, only one or the other of those signals will register for the same revolution of the fathometer disc.

New hydrophones ("K" or tuned) require only a fraction of a milliampere to detect signals. After a hydrophone is in use for a length of time currents as high as five milliamperes may be required. Apparently some change in the condition of the carbon granules of the hydrophone takes place, reducing the resistance and allowing more current to flow. If the used hydrophone is removed the granules will change their positions and the resistance is increased, but its original sensitivity is not recovered. Current for the hydrophone was derived from two dry cells in series or in parallel instead of from the ship's line. It is thought that a more uniform current is derived in reducing effects of polarization of the batteries by the parallel connection. By shutting off the hydrophone current between soundings when considerable hydrophone current was required, as for used hydrophones and deep soundings, it was possible to register depths which would not otherwise be obtained. When the fathometer is not operating satisfactorily there is a tendency to apply large hydrophone current instead of looking for trouble elsewhere. It should be realized that the heat produced in the carbon granules is not proportional to the current alone but is a product of the current, voltage and time, reduced, of course, by the radiation factor. The fathometers are not equipped with voltmeter to determine hydrophone voltage. Perhaps there is sufficient heat produced to cause carbon granules to change their delicate structure and thus lose their effectiveness. There seems to be no other reason for the loss of sensitivity.

The length of red light fathometer signal was adjusted by turning the lock nut on the shaft of outer contact plate of the oscillator contact assembly, causing it to be at a definite distance from the inner contact plate actuated by the cam on the fathometer disc. The length of signal was measured by noting the flash at the beginning and end of signal while revolving the fathometer disc clockwise by hand in its neutral position. The inner plate is on an unsupported end of shaft which has its sole bearing near the other end where the cam strikes it with a lateral thrust. Examination of this bearing shows excessive wear and prevents the two plane surfaces of the contact plates to meet properly, as evidenced by the spark wear that takes place along the lower edges of both plates. At first the signal was shortened to 1 1/4 fathoms in order to decrease the distance between the contacts so as to provide a minimum lateral movement before contact is made; however, deep soundings would not register with this short signal. The two contact plates were ground smooth by using grinding compound between them in place and revolving the outer one (lock nut released) against the other. Later in the season the unsupported shaft end was secured in various radial directions by rubber bands to the frame of the contact assembly and arm attached in order to reduce the lateral movement; incidentally, this also increases releasing tension. This produced a more regular flash than ever before. As a more permanent improvement it is recommended that the unsupported shaft end be secured by a rubber plate of required thickness to prevent lateral movement but allow motion in the direction of the shaft. As this shaft is broken by insulation material between the cam and contact ends, the two parts could be joined to either side of the rubber plate which at the same time may provide part or all of the insulation necessary.

A cam designed to effect a more gradual break after contact of the contact plates may eliminate the registering of the end signal. This would prolong the signal considerably, but apparently this is an advantage in obtaining deep soundings (400 fms.) by red light as reported by the GUIDE and PIONEER.

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(II) Dr. H. G. Dorsey
Principal Electrical Engineer, U.S.C. & G. Survey.

When you make improvements in Fathometer operation, please let the office know about it so that your method may be put to work on the other ships and thereby advance the art of better depth measurement. The Fathometer was developed as a commercial aid to navigation rather than as a precision depth measuring instrument for surveying, and for our use many improvements can be made in all parts, including the sender, receiver, indicator and associated circuits.

Especial interest in improvements for depth measurements has been shown in the last few months by Commanders Maher, Siems, Swainson, Campbell and Adams.

The following notes are written in some detail to try to explain some of the points which may not be generally understood. Commander Siems' article especially brings up much of interest, and Commander Adams has started something which will no doubt go a long way towards increasing the accuracy of echo soundings in the shoal depths.

In the 312 type Fathometer, the oscillator as originally made was supposed to have a natural frequency of 1050 cycles per second when in water, its frequency being higher when in air. It was found, however, that after being mounted in the hull casting on the ship the frequency was often lower than when tested outside the hull casting, and sometimes the frequency when mounted was as low as 950 cycles. The oscillator consists of two vibrating systems; the diaphragm with its attached laminations forms one vibrating system and the back part with the coil of wire and laminations forms the second vibrating system. When the alternating current from the motor generator is sent through the bindings, only the diaphragm system is supposed to vibrate. As a matter of fact, however, the back also vibrates, and having the greater mass, has a lower natural frequency than the diaphragm. What is called the natural frequency of the oscillator is the result of the two. When two vibrating systems of different frequencies are connected, as these two are connected where they are bolted together at the rim, energy maty be transferred from one to the other and back again several times. This is a well known phenomenon and is illustrated in physics lectures by two pendulums of different lengths hanging from the same support. One is set vibrating and as it gradually transfers energy to the other, it will stop vibrating and then start up again as energy is transferred back. The practical effect of this in the oscillator is that on short signals the diaphragm may vibrate, stop, and then start again after the circuit has been opened. The time for this effect to occur is about 25 thousandths of a second, the time required for an echo from a ten fathom depth, so it might produce a stray at 10 fathoms or an extra echo 10 fathoms after the real echo. The only case I know of on our ships where this effect was bothersome was on the LYDONIA when surveying off the New Hampshire coast. If the depth was, say, 60 fathoms, there would quite often be another indication at 70 fathoms and the worst part was that the deeper indication seemed to be louder than the echo itself. "Turning the hydrophone control from zero to where the echo just began to show on the red light would generally start flashing at the deeper, erroneous indication before it did at the real depth. This effect was eliminated by changing the circuit in the amplifier.

The easiest method of finding the natural frequency of the oscillator is to listen to its sound while standing on deck or in the fire room near the place where the oscillator is mounted. Then have someone vary the speed of the motor generator up and down until the position of maximum loudness is reached. This tuning should be quite sharp, and the amount of energy emitted by the oscillator will be far greater at the point of resonance than it will be 5 or 10 cycles either side. For great depths it is quite essential that the frequency should be close to the resonant frequency or else there will be insufficient energy sent into the water to bring back the echo.

Besides the tuning of the oscillator, the tuning of the receiving circuit has a great influence on the strength of the ultimate impulse which operates the neon tube. Originally I used four stages of tuned audio frequency for the receiver. This could be tuned by means of variable condensers to the maximum signal given by the oscillator. About the time I left the Submarine Signal Company they changed from my tuned circuit to untuned audio frequency amplification preceded by a sharply tuned filter which passes a maximum of energy at 1050 cycles and very little either side. The reason for this change was primarily due to conditions on the LYDONIA. The electrical firing of the ship circuits was old and there was a vibration of the ship when running due, I now believe, to the 3-bladed propeller. These vibrations caused slight slipping in the wire joints producing electrical noises which were picked up by the amplifier and were thought to be water noises in the hydrophones. When the ship was rewired in 1926-27 and all electrical joints soldered, nearly all such strays were eliminated proving that they were not due to water noises. No filter was needed and nothing was gained by it, so it was left out of the circuit, as was done on all of the ships.

When fixed tuning is used in the amplifier, it should be close to the frequency of the oscillator or no energy will get through from a weak echo. For instance, suppose the oscillator is giving a signal of 1000 cycles and a filter is used, tuned sharply to 1050 cycles, so that very little energy is passed by it at 1000 cycles. Then a weak echo from the oscillator would not to heard at all. In a similar manner, if you vary the speed of the motor generator and listen to the signal through a tuned amplifier with frequencies of the two as given above, the loudest note you could hear would be at 1050 cycles whereas the maximum sound energy emitted by the oscillator being at 1000 cycles the oscillator would be operated at a low efficiency and you probably would not be able to get extreme depths with it at all. On the other hand, if you could change the tuning of the amplifier to fit that of the oscillator, you would be working both efficiently and get better results.

For convenience, assume that the natural frequency of the oscillator is 1000 cycles per second, which means that the diaphragm makes, a complete to and fro movement in one thousandth of a second. There is no permanent magnetism in the oscillator, as in a telephone receiver, nor is there any direct current in a polarizing coil such as is used in the Navy type oscillators on the GUIDE and PIONEER. Consequently, the diaphragm of the oscillator will be attracted by every current which is sent into its winding. This attraction produces a rarefaction in the water. When the pull on the diaphragm is released, by opening the circuit or by the alternating current passing through zero, the diaphragm does not just stop at its position of rest but moves somewhat beyond it because of its inertia. With alternating current there will be a pull for each half cycle and also cessation of the pull, movement of the diaphragm beyond the position of rest and then another pull for the next half cycle so that the frequency of the diaphragm will be double that of the applied alternating current. Consequently, when the motor generator is run at such a speed that it generates 500 cycles per second, the oscillator will give a note of 1000 cycles per second.

So great are the effects of this characteristic of natural frequency that if the diaphragm is struck it will vibrate at its natural frequency just like a bell having a certain tone. If the frequency of the alternating current is not 500 cycles, but is higher or lower by, say, 50 cycles, the diaphragm of the oscillator would be forced to vibrate at 1100 cyeles or at 900 cycles.

When the circuit is opened, however, there will always be energy in the diaphragm, either kinetic or potential, and this energy will cause the diaphragm to continue to oscillate, but it will now oscillate at its natural frequency instead of at the frequency of the applied alternating current. The greater the amplitude of vibration when the current is cut off, the greater will be the amount of stored energy and, consequently, the longer the diaphragm will continue to vibrate at its own frequency. The note omitted will consist of two parts, one due to frequency of the applied alternating current and the other will be its own natural frequency note.

Besides the tuning of the oscillator, the electric circuit comprising the motor generator, contactor and oscillator coil is tuned by means of a 5 microfarad condenser placed in series. This tunes the electric circuit at half the frequency of the oscillator and its effect is to raise the voltage applied to the oscillator to about 400 volts instead of the 110 produced by the generator itself. If the frequency of the alternating current is different from what it is tuned to, the voltage applied to the oscillator will be much less and, consequently, the sound emitted will not be nearly so great as when the circuit is resonated.

In Commander Siems' discovery that a low frequency reduced the wandering of the echo, it seems possible that the frequency he was using, 440 cycles, was so far below the resonant frequency of the circuit and the half frequency of the oscillator that the amplitude of vibration of the diaphragm was too low to have any after effect at its own frequency, so that a short highly damped note was emitted. It may also be possible that, due to pitting and corrosion, the diaphragm does not have a very strong characteristic frequency of its own. I tried the experiment with an oscillator in air, and for a short signal at any frequency the oscillator gave only a note at its own frequency, about 1100 cycles in air. I think it quite worth while trying the method on the different ships, when surveying in shoal areas. When facing the switchboard, clockwise motion of the right hand rheostat will lower the frequency. It is well to mark the present position of the rheostat before changing so that it may be reset for deep water.

Ordinarily the circuit is closed from about 0.0025 to 0.005 seconds or the equivalent of from about 1 to 2 fathoms. Assuming it the latter, there would be 5 half waves of the alternating current or 5 complete oscillations of the diaphragm. If the oscillator had a natural frequency of 3000 cycles instead of 1000, there would be 15 complete oscillations, and for a super sonic oscillator having a frequency of 50,000 cycles per second, it would make 250 complete oscillations. Furthermore, at such high frequencies the circuit is so sharply tuned that no frequency except its own can operate it except by shock excitation, like static in radio reception. The selectivity is still further enhanced by using a heterodyne circuit.

With the indicator and motor generator running as independent units, the instant of closing the circuit may be at any point of the alternating voltage wave With the circuit resonated the current will be in phase with the voltage and there should be the minimum of fluctuation of the echo. When the frequency is higher or lower than resonance, the current will not be in phase with the voltage. Consequently, the time between the closing of the circuit and the emission of a sound sufficiently loud to produce an echo may be as much as a whole cycle or 0.002 second, nearly a fathom, and both the direct signal and echo may jump around by this amount due to this one cause.

If the frequency were 3000 cycles instead of 1000, the corresponding jumping would be only l/3 fathom and with a super sonic frequency of 50,000 cycles the wandering would be only one and four tenths inches. It is very apparent that the frequency should be higher for precision work and we expect to try both the 3000 cycles and the super sonic in the next few months. With the higher frequencies, there are so many cycles per second that even if a few cycles are skipped the amount of time lost is so slight that the depth measurement is not appreciably changed.

If the indicator and motor generator are synchronized, this wandering could be largely eliminated as the circuit could then be closed at the same part of the cycle each time. I am now experimenting along this line to see if it is easily possible. Another method of decreasing the variation, in shoal water is by using condenser discharge into the oscillator. This looks very promising in laboratory tests and Lieutenant Paul Smith made a trial of it on the LYDONIA which indicates that we could use it to 50 fathoms without much extra equipment.

To a lesser extent the reception of the echo is also affected by the frequency in that the higher frequency will make the circuit respond quicker, furthermore, if the water noises are less, greater amplification can be used at all times as nothing has to be cut out either by filters or by grid bias. The only reason one does not get apparent shift of depth with the 413 type is because of the larger amount of energy delivered to the water by the striker than by the oscillator. However, on the HYDROGRAPHER last summer, I could easily get a shift of 2 fathoms by varying the amplification when we were drifting in 57 fathoms. At this depth the echo is not so strong as in shoal water and, consequently, its intensity can be varied sufficiently in the amplifier so as to give the changes ordinarily noted only with the 312 type.

While the striker type appears to give a steady indication, the results of the past season show that it is unsuited for precision measurements due to the difficulty of knowing just how to apply corrections. The comparisons with vertical casts vary in a few hours by some unknown law. Some progress has been made by watching the initial flash and using its reading as a method of applying the correction. Part of the time the OCEANOGRAPHER would take the reading of the 312 type with which to correct the 412 striker type. Several of the officers now believe that the 312 type is more reliable and that the average of its fluctuat ing reading is more accurate than the apparent steady reading of the other.

In shoal depths it is necessary to have a short signal or else the echo would return before the signal is completed. Since perfect shielding is impossible, the direct signal, i.e., sound from the oscillator going to the hydrophone without reflection, will mask the echo unless the signal is shorter than the time required for the echo. There are some Fathometer installations in which the echo is stronger than the direct signal, in which case it is not necessary to use such a short signal.

In deep water it is necessary to have a longer signal; some of it is lost somewhere. The ideal condition would be to have the signal length quickly and easily adjustable. It has not been done on the Fathometer because it adds a complication, but I have tried it on the LYDONIA, and some method may be made standard at a later date.

Whatever adjustment is found to make the best length of signal should be locked so that the signal length will not gradually change itself and cause a change in the time at which the signal is started, thereby changing the index corrections and introducing an error into the depth measurement.

Whatever the setting may be, it should be noted daily in the sounding record, giving the reading when the circuit is closed by rotating the disc clockwise, and then reading again when the contacts touch with the disc rotated counter-clockwise. The difference between the two, of course, gives the actual time the circuit is closed.

Carbon granules in a hydrophone deteriorate by having their corners burned off and the carbon electrodes gradually lose their highly polished surface, which also produces inferior quality. The greater the hydrophone current, the faster the corners burn off, due to microscopic arcs forming which cause the carbon to heat and do what is technically known as "pack". This temporary "packing" can be removed by a slight mechanical shaking of the hydrophone itself and it has been observed that three R.A.R. bombs will decrease the hydrophone current from 15 milliamperes to 3. The current should not exceed 10 milliamperes in the Submarine Signal Company hydrophones or their deterioration will be rapid. I believe that carbon button hydrophones are one of the weakest parts of the Fathometer equipment. Present experiments are so encouraging that I hope we may be using hydrophones without carbon within a few months.

The thyratron was introduced into the bathometer primarily because of its convenience in the coincidence method. It obviated the use of a relay in putting the artificial echo into the receivers and also is capable of handling considerable energy for the neon tube. It has some peculiarities which, when known, may stabilize results which may have been erratic. The thyratron is photoelectric and its sensitivity is somewhat dependent on its temperature. Its operation in bright sunlight is very different from what it is when not illuminated. Although it will be in darkness when the amplifier box is closed, yet you may find it advantageous to make a covering for it of asbestos paper. This would be fireproof, keep the light out, and allow it to warm up quickly so that operation will probably be more uniform. The thyratron does not fatigue, as some have thought, but unless the circuit is quiet the grid will remain positive and the condenser fail to charge sufficiently to operate the neon tube.

The greater sensitivity of the circuit, attained in this circuit, makes the use of the coincidence method unnecessary as the red light times 6 method has been used to well over a thousand fathoms on several of the ships, and to 3000 fathoms by the PIONEER. The coincidence method is probably not used at all and the circuit will be removed in the near future. Meanwhile if the slow red light method is used and the reading multiplied by six, an error is introduced amounting to 10 fathoms if the draft setting is 2 fathoms. Let draft setting = d, initial reading = i, echo reading = r. Then, neglecting correction for temperature and salinity,

$$\text{depth} = 6\,[\,(100 - i) - d + r] + d$$

If the length of signal is not changed, and if the cam or dog which closes the contacts is not changed, 100 - i will remain constant and since the draft setting will also remain constant, (100 - i) - d = constant, = k, which may be either plus or minus, but will usually be positive. Then, depth $=6\ (k + r) + d = 6\ (k + \frac{d}{6} + r)$. Since d is assumed constant, $\frac{d}{6}$ will remain constant so that

$$\text{depth} = 6\ (k + r)$$

If a pointer is used, such as Commander Swainson has devised, the constant K can be taken care of by the setting of the pointer so that the instrument becomes direct reading, except for temperature and salinity corrections.

Commander Swainson has noticed that he gets better echoes in great depths on calm days. While calmness of sea itself may have something to do with it, to me it seems more likely that in a calm sea there will be fewer air bubbles in the upper layers of water and, consequently, the passage of the sound will be easier both in going and coming; the acoustical resistance of the water will be less because of the freedom from air bubbles.

Since all of our Fathometers are not calibrated for the same velocity of sound, the following table is given to have all the data collected in one place:

	Type and Serial No.	Velocity fathoms	Motor R.P.M.	Dial Speed Shoal	Dial Speed Deep
SURVEYOR	31210 D	800	1800	240	40
DISCOVERER	31211 D	800	1800	240	40
PATHFINDER	31218 MP	820	1800	246	41
MARINDUQUE	31224 MP	820	1800	246	41
PIONEER	31226 M	820	1800	246	41
GUIDE	31227 M	820	1800	246	41
FATHOMER	31228 MP	820	1800	246	41
LYDONIA	31249 P	820	1800	246	41
"	41227 H	810	3640	182	none
OCEANOGRAPHER	31268 S	820	1800	246	41
"	41225 H	810	3640	182	none
NATOMA	41214 E	810	3640	182	none
HYDROGRAPHER	4322	810	3790	194.4	48.6
GILBERT	412 -	810	3640	182	none
WESTDAHL	412 -	810	3640	182	none

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"The more we study the depression, in so far as it affects the American Merchant Marine, the more clearly we perceive that if American shippers and travelers would give a fair share of their business to American ships, prosperity for American shipowners would appear over-night. We must drive this point home to every American citizen. We must make it plain that if Americans would cease to show preference to foreign lines, our merchant marine would have no difficulty in weather-ing not only the present storm, tut any similar storm that may arise in the future."

Hon. T. V. O'Connor, Chairman,
United States Shipping Board
Middle West Foreign Trade and
Merchant Marine Conference.
Louisville, Ky., October 27, 1931.

APPLYING SURVEYS, NOT ON THE NORTH AMERICAN DATUM, TO THE CHART

A. M. Sobieralski, H. & G. Engineer, U.S.C. & G. Surrey.

In the compilation of a nautical chart, the Bureau assembles data from many sources. The facility with which these can be applied varies, of course, with the amount of dependable information furnished. Our field officers should know something of the problems that arise. They should have definite knowledge of what is required in applying surveys made by other Federal bureaus and agencies.

In general, there are two classes of such surveys: (1) Those having a rectangular coordinate grid and (2) those that have neither a projection nor a rectangular coordinate grid.

In the latter case, two or more U.S.C. and G.S. triangulation stations on the blue-print so located as to furnish a good base for determining the distortion of the blue-print are adequate. For example, one triangulation station near each end of the print would be adequate for control of a blue-print showing details of a stretch of a canal. If blue-print covers a large rectangular area, three stations forming a triangle with its apexes near the limits of the blue-print would be desirable, so that distortion in more than one direction can be determined.

A blue-print with the rectangular coordinate grid lines on it will furnish sufficient control even if no U.S.C. and G.S. station falls within the area of the blue-print, provided the geographic and rectangular coordinates of the initial point of the coordinate system (that is, the point from which the initial azimuth or bearing was taken) is given on the blue-print, and the rectangular coordinates of the U.S.C. and G.S. stations which were tied to the system are given.

Some confusion arises when coordinates other than 0,0 are given to the initial point. The initial point is the point where the x-axis coincides with the true meridian. If, for convenience, this point is given coordinates of, say, {10,000 S, then the x-axis at the point
(40,000 W
0,0 is not true north, and this point is not the true initial point, as would be assumed unless it were specified on the blue-print that the initial point of the coordinate system is U.S.C. and G.S. triangulation station Gray 10,000 S Lat. 35°53'01'.75
40,000 W Long. 86°47'52".22.

The minimum requirements for converting rectangular coordinates into geographic positions, or applying a blue-print with rectangular coordinate grid to the chart, are therefore:

1st - Both the rectangular and geographic coordinates of one of the stations of the system,

2nd - The initial point of the system, that is, the point where the meridian or the true north and south line is parallel with the axis of the rectangular coordinate system.

Three examples of notes taken from various U. S. Engineers blue-prints which give explicit information regarding the origin of coordinates follow:

1. "All bearings, azimuths, distances and coordinates are taken in the rectangular coordinate system with axes perpendicular and parallel to the meridian passing through U.S.C. and G.S. station 'Bogart' and the origin so chosen as to make 'Bogart' S. 20,350 ft. and W. 20,250 ft."

2. "The map is based on plane surveying, the chosen meridian being that through U.S.C. and G.S. station 'Old Tower', hence azimuths here used, determined from the coordinates given, are 6 1/3 seconds per 1000 feet of departure greater or less than true azimuths, according as the location is west or east of the 'Old Tower' meridian."

This note is followed by a tabulation headed "Coordinates, in feet, referred to U.S.C. and G.S. station 'Old Town'".

3. "The zero of coordinates of the rectangular coordinate system is U.S.C. and G.S. station 'Memorial Church' and the northerly axis of the system is parallel to the meridian through that point."

In each of these cases a U.S.C. and G.S. station is used as the initial point, hence it is not necessary for our purposes to give the geographic coordinates. It is customary to give rectangular coordinates of all the U.S.C. and G.S. stations tied into the rectangular system, either on the blue-prints where the stations appear, or in a separate tabulation.

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MISTAKES WE MAKE

From "The Nautical Magazine", December, 1931.

* * * * It is a remarkable fact that there is often great difficulty in convincing some candidates for examination that the pressure on the bows of a vessel steaming with the tide is precisely the same as if she was steaming against it. Many of them insist that the velocity of the tide exerts a pressure at one end or the other. This strange belief is not confined to the younger men but extends through all ages. A week or two ago a man told the examiner that there would be less strain on the log line when a ship was going in the same direction as the tide. Another man said he could tell whether the tide was with or against the ship by the strain on the engines. These men are in the same category as the man who told an examiner that a ship would travel faster if she were loaded by the head - because she would be going down hill all the time!

TIDE AND CURRENT SURVEY OF BUZZARDS RAY, MASSACHUSETTS

G. E. Boothe, H. & G. Engineer, U.S.C. & G. Survey

A tide and current survey of Buzzards Bay and vicinity, Massachusetts, was made by the combined parties on the Launches ECHO, ELSIE III, RODGERS and MITCHELL. In addition to one officer, each launch had a complement of an engineer, a coxswain, a cook, and three observers. Field work commenced on June 30 and was completed on September 29. New Bedford, Massachusetts, was used as the base.

TIDES.

One standard automatic tide gauge was established at Mew Bedford, Massachusetts, to be operated by a tide observer for about a year. This was used as the control station for reducing to mean values the results derived from the short series of portable automatic tide gauge observations at various locations on the working ground.

Six portable automatic tide gauges were operated at twenty-two stations with records from one week to two months. At practically every town in the area tidal observations were made and a sufficient number of standard bronze disc bench marks established to bring the total number in each locality up to three. Fourteen old bench marks were recovered and connected to the tide staffs in addition to the sixty-three new bench marks established.

In order to secure tidal observations in Quicks Hole, it was necessary to build structures on which to secure the portable automatic tide gauges and staffs. A very hard sand and rock bottom made it difficult to erect platforms. There was also the difficulty of working from a small boat in an area where there was a current of from one to two knots and no slack water. Three platforms, built with "four by fours", braced with eight "two by fours" driven into the bottom at an angle and nailed to the uprights above the high water line, were constructed. The tide gauge and pipe were fastened with U bolts to a sixteen-foot "four by four" driven in the center of the structure and plumbed by bracing to the structure.

In erecting the platforms, the small boat was moored from three directions to prevent movement. The four timbers (sharpened and banded with galvanized wire) were worked into the bottom simultaneously. A temporary platform was nailed around the top as soon as the uprights would stand alone, and from this were driven in with a maul. If not driven down quickly, the current would wash out the sand around the bottom and overturn the structure. The structures were built in about six feet of water at low tide, with a maximum range of about four feet, leaving the platform about three feet above the high water line. The structures, when completed, were very steady and would stand considerable rough weather.

CURRENTS

Current observations were started in the vicinity of the Hen and Chickens Lightship and made at stations throughout Buzzards Bay, including three stations in the Cape Cod Canal; one station each in Woods Hole, Robinsons Hole, Quicks Hole and Canapitsit Channel; two stations in the Sakonnet River, Rhode Island, and two in the Seekonk River, Providence, Rhode Island.

Observations with good results were taken up to and including a velocity of four knots using the single point contact (Price Current Meter). A twenty-five pound meter weight was used.

During the season a total of 94 current stations were observed comprising 39 25-hour, 45 50-hour, and 10 75-hour stations. Currents were observed with both pole and meter at half hourly periods. At each station the surface velocity and the direction were determined with the standard current pole using a current line marked for a sixty second run. The subsurface current velocity was determined each half hour with the Price Current Meter at two tenths, five tenths, and eight tenths of the depth. Density and temperature observations were made at the same depths as the meter observations.

MISCELLANEOUS

In returning after removing a portable tide gauge at Marion, Massachusetts, the small boat swamped, within about two hundred feet of the launch, with the chief of party and two men and a portable automatic tide gauge and gear for removing the tide station aboard. Two things were found from this experience - that a portable automatic tide gauge in its box would not only float, but would support a man as well, and that two hundred feet can be swum against a moderately heavy swell and strong wind by a man dressed in khaki trousers and shirt, wool shirt, wool sweater, heavy rubber raincoat, and hip boots, and without even losing his uniform cap.

On the morning of July 25 Mr. Taylor, in charge of the Launch MITCHELL, and Mr. Hartzog, in charge of the Launch RODGERS, were running across to New Bedford from Quicks Hole when Mr. Taylor sighted a floating body, which proved to be the body of a girl who had jumped overboard from the Boston-New York steamer the night before. He picked up the body and Mr. Bartzog, coming up with the RODGERS, sighted the body of a man, which he picked up. This man had been in the water several months and was never identified.

WRINKLES AND SUGGESTIONS

WHITE LIGHT ECHO SOUNDINGS
O. W. Swainson

We have found on the PIONEER that a white light sounding can often be obtained by listening with a pair of head phonos connected in series with two or four dry cells and the hydrophone before the hydrophone circuit goes through the fathometer. The echo is not drowned out by the fathometer noises. We use it almost exclusively in deep water to determine the number of revolutions of the white light between the outgoing sound and its echo and where the echo is too faint for the FRx6.

COMMENT ON THE ABOVE
Dr. H. G. Dorsey

This method is practically the same as was made standard on the GUIDE when I rewired the fathometer at Oakland in January, 1930. A Navy type oscillator has been heard 60 miles this way. Not more than two cells or three volts should be used on any of the Submarine Signal Company's hydrophones, although six volts are satisfactory on the Navy type.

IMPROVED CLEARNESS IN THE "CLICKS" OF PRICE CURRENT METERS.
Glendon E. Boothe

The '"clicks" of a current meter are clear and distinct in the air, and even in shoal depths, but may fade out completely at deeper depths because salt water, being a good conductor, causes the meter to short.

The tide and current survey party working in Buzzards Bay, Massachusetts, this season found that the clearness of the "clicks" of the Price Current Meters could be greatly increased by covering the two terminals of the meter with balls of hard oil.

Keeping the contact chamber full of a medium heavy grade of engine oil (being careful to see that not a single drop of water is left) and the teminals and wire connections carefully covered with hard oil will produce better results.

SERIAL TEMPERATURES
O. W. Swainson

As the six deep sea thermometers furnished us for obtaining serial temperatures have no inner thermometer for measuring the temperature of the inner column of air, experiments were made to determine the length of time required after bringing the thermometer to the surface for this column of air to become the same temperature as the atmosphere. The results showed that it took from fifteen to twenty minutes.

Therefore, in taking serial temperatures, the thermometer should be left twenty minutes before reading. Then by taking the temperature of air, the proper temperature correction can be made to the reading.

COMMENTS ON THE PRECEDING
F. S. Borden

It is believed that considerable time can be saved if, instead of waiting until the inner air column reaches the temperature of the atmosphere, on arrival of the thermometer at the surface, it be placed in a bucket of surface water and allowed to remain until the column of air reaches that temperature.

As the thermometer is drawn upward through the water, it is probable that the lag in the temperature of the thermometer behind that of the water it is passing through is slight. Consequently, the air column will assume the temperature of the surface water in a comparatively short time, whereas, for it to assume the temperature of the air may require a considerable length of time.

Although it has no direct bearing on the manner in which corrections are applied, it may be of interest to our engineers to know that in preparing correction tables for deep sea thermometers the Bureau of Standards actually makes only the three comparisons indicated in the table below by underscored values. The other values are computed.

B.S. No. 53025 - Makers No. W19482

Temperature when thread is detached:	Correction when temperature of detached thread is:		
	0° C.	15° C.	25° C.
0°C.	- <u>.04</u>	- .27	- .48
15	- .36	- <u>.01</u>	- .22
25	- .62	- .25	<u>.00</u>

AREA TRIANGULATION
H. C. Mitchell

One of the aspects of control surveying which the use of triangulation in city surveys has had much to do with developing relates to maintaining the strength of the triangulation figures in every direction. It might be characterized as <u>area</u> surveying, as contrasted with <u>arc</u> surveying, in which the effort is to maintain a certain standard of strength only in the general direction of progress, that is, along the axis of the triangulation.

In Special Publication No. 120, "Manual of First-Order Triangulation", page 15, this subject is covered briefly in the following words:

"If a more intensive development of the area is desired, instead of being concerned with distance angles only, and the R_1 and R_2 through the scheme, the observer should give attention to leaving lines of proper strength so located as to be of greatest value to topographers and other engineers."

Undoubtedly the needs of the city survey were in mind when the above was written, but to-day city planning is but a small block in the large field of regional planning, and to fully serve the needs of the regional (as well as city) plan, map must maintain a standard of accuracy in every direction - except possibly where some unusual feature interrupts the continuity of the region and isolates one section from another.

A simple method of applying the criterions R_1 and R_2 would be to compare the strength of every line which might have major use in detail surveys with the strength of a line midway "between bases and to require that for all such lines the values of R_1 ana R_2 computed from the nearest base line should not exceed one-half the values permitted between adjacent base lines.

EXTRACT FROM REPORT ON HYDROGRAPHIC SHEET 5085
Reviewed by A. L. Shalowitz, July, 1931

In closing this report I wish to recommend that a copy of the same be sent to the field party concerned for the purpose of acquainting them with the many details frequently connected with the disposition of a hydrographic survey. A survey is not complete unless it can be properly harmonized with existing data of equal accuracy. Where conflicting infomation is disclosed during the prosecution of a survey, an effort should be made, as far as practicable, to ascertain which is correct and a definite statement to that effect embodied in the descriptive report. Even in cases where, through the availability of original data, the office is in a somewhat better position to take the final decision, it will nevertheless be of invaluable assistance to the reviewer if in his decisions hs has the benefit of the positive statement of the surveyor.

TAKING OUT THE MEAN
Floyd W. Hough, Geodetic Engineer
Metropolitan District of Southern California

The following is a "suggestion" which I have found very helpful and which the editor may publish in the next bulletin, if he desires, giving due credit to Mr. E. P. Mbrton who passed it on to me a number of years ago:

Special Publication No. 91, page 38, gives a method for taking out the mean from a set of observations with the repeating theodolite. There is a much easier way and one having far leas chance for error, viz., simply take by inspection the mean of the initial and the final readings of the set. This mean is the theoretical initial and is then subtracted from the No. 6 reading, after which the result is divided by 6.

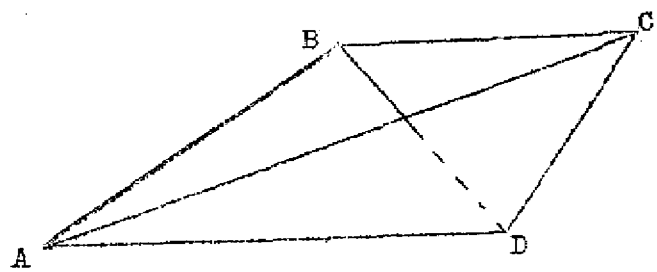
I believe anyone who will use this method with the repeating theodoliteS will not fail to appreciate its advantages over the older cumbersome method. Mr. E. P. Morton, a former officer of the Service, told me about this shorter method several years ago, and I have used it with great satisfaction ever since. I believe the method is not generally known

COMMENT ON THE PRECEDING
J. A. Bond

The method mentioned by Mr. Hough is, I think, in general use among the field officers.

WATCH THE UNOCCUPIED STATIONS
E. B. Roberts

Triangulation specifications allow, in the case of second and third order work, certain departures from the requirements stated for first order surveys. This is proper and makes, in many instances, for economies in the work. These privileges, however, must not be recklessly used. Recall that one is permitted to use, within limits, stations unoccupied of lines observed in one direction only. Consider the figure:



Note that line A-B is the known line, while C-D is to be determined. This is a pretty good quadrilateral. R_1 is desirably low and R_2, while larger, is within the limits. The specifications do not, in any event, stress the importance of R. It seems expedient, for various reasons, to leave the line B-D unobserved at D. That is permitted by the specifications. All in all, a fair figure to go ahead on.

The observations completed, it is noted that the closure errors of the two completed triangles are not too large. Not to be hasty, the triangle sides are computed and compared to be sure that the other two triangles are satisfactory. A very close check is seen to have been obtained between the two values of the length C-D, which makes everything apparently satisfactory. The rather large discrepancies in the different values for B-C and A-D are noticed, to be sure, but of course they are derived from the weak triangles of the R_2 chain, and it is not surprising.

The person who is anything less than very careful would go ahead on this basis - compute the positions of C and D, using the strong R_1 triangles, of course, and maybe a whole season's work might be based on that and succeeding work.

That particular bit of work probably would not come to mind again for perhaps years, until the mathematicians took up the least square adjustment of it. A surprise, then, to be told that large errors in position had been traced to this particular figure. It might even be that this weakness could have destroyed the usefulness of a whole arc of triangulation. Closer analysis would show that every geodetic position depended for its accuracy upon the single unsupported and unchecked direction observed over the line B-D, which, unfortunately, carried a very serious error due to refraction, obscure signal, or other cause. A little late, perhaps, to realize that pure chance had made the two sides of the figure so nearly parallel that, whatever value within reason might have been assigned to the direction of the line B-D, the two computed values of the forward base line C-D would necessarily be in close agreement.

Happenings of such nature probably occur far oftener than would be supposed offhand. It is therefore desirable that the use of concluded stations and single direction lines be made only with the greatest of circumspection.

COMMENT ON TEE ABOVE
P. A. Smith

Mr. Roberts has explained in detail a rather common occurrence in any triangulation, whether concluded directions are used or not, namely, occasional large side discrepancies. He states that "the use of concluded stations and single direction lines (should) be made only with the greatest of circumspection", but does not offer suggestions as to just what can be done to avoid these large discrepancies due to double errors on a line or errors in concluding a figure. Mr. Reynolds on page 208, Manual of Triangulation Computation and Adjustment, Special Publication No. 138, explains the use of the side equation test. Elsewhere in this edition of the bulletin is an example of the use of this test, somewhat abbreviated, and an explanation of the example.

The only satisfactory way to be sure triangulation is up to specifications and that no large side discrepancies exist is to keep the triangles computed strictly up to date, carefully noting the specifications as regards the sine differences per second of the smallest angle entering into the computations. With a little practice and experience, the side equation test can be used with ease and will prove very economical.

FROM REPORT OF JACK SENIOR, COMMANDING "FATHOMER"
Philippine Islands.

Floating signals were used with success for the offshore hydrographic control. Their use enabled ship and launch work to proceed without interruption. Had we been dependent on shore fixes only, this work would have been curtailed considerably, because of poor visibility, and launch development of the numerous of flying shoals would have been difficult of accomplishment. These signals were visible for eight nautical miles from the ship and about 4-l/2 miles from the launch. All signals were located by direct fixes, with check angles, on triangulation stations on shore, and their positions checked at various times during the season. There was no displacement whatever due to dragging of anchors.

FROM REPORT OF G. C. MATTISON, COMMANDING "PATHFINDFR"
Philippine Islands

An interesting observation was made while developing the shoals, regarding the apparent uniformity of growth of the coral on the heads in some particular locality, or those lying in a bolt parallel to the general shoreline or to the line of the submarine shelf. The least depth found on each shoal usually varied by only a few feet from the other shoals in the vicinity. For instance, On sheet #8, practically all coral growth in the belt lying from five to eight miles from the edge of the shelf has a least depth of between 6½-and 7 fathoms. Is this due to local conditions affecting the rate of development of the coral?

UNITED STATES NAVAL SURVEYS
Extract from "Military Engineer"
November-December, 1931

In carrying out the survey of the land bordering the Gulf of Paria it was found that the topography and general character is such that the main triangulation for controlling the hydrographic survey could not be laid out with all triangulation points situated on land or even in shallow water. In order to obtain suitable control it was necessary to locate certain stain triangulation points off shore in from 30 to 50 feet of water. This was successfully accomplished by building 100-foot towers at these points, the main parts of which were first erected on board the "Hannibal" and then dropped at the desired location. Wooden mattresses, weighted with railroad iron, afforded a good foundation for the corner posts of the towers. In less than three hours a tower was completed and ready to be occupied, thus demonstrating the efficiency of the Navy survey parties and the nature of the obstacles that have, to be overcome to carry out their missions.

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USE OF SIDEREAL CHRONOMETERS FOR STAR SIGHT OBSERVATIONS.

E. O. Heaton, H. & G. Engineer, U.S.C. & G. Survey

A sidereal chronometer has been in use on the PIONEER this season for recording star sight observations and it has been found that the computations are shortened considerably thereby. If other ships requiring astronomic control have not already made use of the sidereal chronometer, it is recommended as being worth while.

The time and longitude corrections can be combined into one value, which, when applied to the mean time of the observations, will give the sidereal time of the star set. This same correction is then used on all other star sights observed at this point.

The sidereal chronometer correction is obtained by comparing the chronometer with Greenwich Sidereal Time whenever a radio time tick is obtained.

GENERAL

A CENTURY OF SERVICE
Editorial from the Evening Star, Washington, D. C.
November 24, 1931.

Its work is not of a character that lends itself to spectacular portrayal, yet there are few subordinate branches of the Federal Government whose activities rival in importance the operations of the Coast and Geodetic Survey. Director R. S. Patton has just submitted to the Department of Commerce, under which the survey functions, its one hundredth annual report, giving a backward glance descriptive of the growing duties of this scientific public service bureau. It is a history of a century which has seen unceasing examination and studies of the earth and of the waters.

In that distant period during the administration of Andrew Jackson, when the Coast and Geodetic Survey was launched on its mission, surveying was limited almost entirely to the delineation of property boundaries. With land plentiful, property owners could not afford accurate surveys, even had methods of making them been available. The program proposed by the original head of the service, Ferdinand Hassler, and adopted, was for a survey of the entire coast; to be executed piecemeal, it is true, but with accuracy, continuity and fidelity, the whole fixed by a precise framework of geodetic control, every adjacent part correctly fitting.

Since the World War revolutionary changes and advances have been recorded in the fields the survey traverses. Based on the utilization of the velocity of sound in sea water, a surveying vessel while traveling at full speed is now able to compile a continuous profile of the bottom. Visibility of land or weather conditions are non-essentials. The rate of progress is multiplied and permits the definite completion of projects formerly expected to extend into the indefinite future.

In the realms of tide studies, geodetic control survey and mapping of new airways, Director Patton's report also records progress of importance. The Coast and Geodetic Survey maintains tide stations. Their continuous operation furnishes the basic data for the intelligent execution of engineering works along the coasts. As tides are caused by the attractice force of the moon and the sun, the layman, and indeed many engineers, think of the tide as a universal, unvarying world phenomenon. Science now makes it possible to predict with certainty the future daily occurrence of the ocean tide. Regional differences are the result of terrestrial rather than astronomical factors. In view of the rapid economic development America's shores are undergoing, there is need for a proper advance realization of the probable effect of contemplated projects. This effect today is definitely ascertainable.

There is at present in operation an expanded geodetic control survey program, to be completed in some fifteen years. Inasmuch as all engineering operations of any magnitude require accurate positions, directions, distances and elevations, this Federal program of geodetic control will furnish the framework for the engineer to place his surveys in their true geographic positions.

The Coast and Geodotic Survey is engaged in making a series of ninety-two sectional airway maps eventually to cover the entire United States. Thus a Government bureau originally charged with exploration only of the land and the adjacent sea has now, like the rest of the world, taken to the air.

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FOR BETTER SURVEYS AND MAPS
(Extracts from Civil Engineering)

* * * * "there is one point that needs to be brought before the profession (engineering) at this time. Many costly airplane surveys are in progress which can never yield their full inherent benefits because of the lack of accurate ground control. The American public has been educated to, and is convinced of, the need for accurate maps, and it is rather well sold on the use of the airplane in making these maps. It needs to know that control is necessary and that control must come first if it is to receive dollar-for-dollar value for funds expended in such work." * * * * *

C. M. Case, M. Am. Soc. C. E.
Associate Professor of Civil Engineering
Michigan State College.

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* * * * "Surveying cannot remain static. It must improve and it is reasonable to assume, judging from the past, that current geodetic practice includes instruments and methods which will sooner or later become part of current plane surveying practice. Actual figures show that at the present time surveying organizations seldom number college graduates among their field forces - one or two such men may be employed as office managers or field superintendents. It is going to be a long pull toward an improved situation in plane surveying but we certainly can never hope for progress if engineers and engineering schools are going to be satisfied with following old methods instead of keeping constantly alert for possible improvements. Much of the progress in civil engineering must come through the problems and experiences of actual practice." * * * *

J. K. Finch, M. Am. Soc. C. E.
Renwick Professor of Civil Engineering,
Columbia University.

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"A corollary of the article on "Modernizing Triangulation Practice", by William Bowie, in the December issue of "Civil Engineering", would be "Modernizing the Use of Triangulation Data". The general use of this important information has not kept step with the very rapid spread of the triangulation net shown by Major Bowie, excepting only in the field of topographic mapping and, to a limited extent, in making precise city surveys. An almost unlimited field exists, if we are to verify the geographic position of the land surveys and to control all large scale topographic mapping. All authorities concede that the geographic positions which are derived by triangulation establish the standard of precision to which all other surveying - topographic, cadastral, and aerial - may and should come for verification, adjustment, and comparison," * * * * *

Arthur B. Kidder, M. Am. Soc. C.E.
United States General Land Office.

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* * * * "Hence the millions of miles of highway, railway, transmission-line, pipeline and canal locations, and the many thousands of square miles of topographical and other area surveys, can scarcely be expected to serve any useful purpose other than that for which each was made. Thus, when viewed collectively, they represent only hopeless confusion. Had they been based upon a common origin of true meridianal coordinates and mean sea-level datum, they would, with their unchangeable bearings or azimuths, have served mankind for all time to come in many useful ways.

"Owing to the present scarcity of Government stations, it is not to be expected that all individuals or corporations would stand the expense of having their surveys tied into stations miles away except in the case of extensive ones, but where surveys are made by a state the matter is different.

"Consider, for example, the design of our several state highway systems. Had the locating engineers been required to base all of their surveys upon the Government stations and to secure a reasonable accuracy as well as to place at suitable intervals permanent monuments with geographical coordinates, azimuths, and elevations made available, the states would have amassed for themselves and for the public, at very little additional expense, data of almost unlimited value. Some engineers seem to regard the Government stations with a sort of bewildered awe. They do not realize that, so far as their jobs are concerned, the Coast and Geodetic Survey method may be just as simple and no more accurate than their own, and that its chief and exceedingly great advantage is that it correlates or coordinates all surveys into one uniform system, thereby making each survey permanent, usable for myriad purposes, and consequently something of very great value.

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"I would like to see a well organized, joint movement - embodying every civil engineering society, association, and club in America - petition Congress to appropriate sufficient funds to enable this bureau to complete its triangulation of the country within half the time now anticipated, in order that the country and the engineering profession might more quickly reap to the fullest the advantages offered by its achievements."

George F. Syme, M. Am. Soc. C. E.
Senior Highway Engineer
State Highway Commission.

* * * * "The first-order control survey forms the skeleton framework upon which is based, or will be based in the near future, all properly coordinated topographic and cadastral surveys of Federal, state, and municipal organizations, as well as important construction projects of more private nature." * * * *

Floyd W. Hough, Assoc. M.Am. Soc.C.E.
Geodetic Engineer, Metropolitan Water
District of Southern California.

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* * * * "The greater part of the topographic mapping that the U. S. Geological Survey does is in cooperation with the states so that the need for basic control is in many widely separated areas. Control surveys of the first and second order should be executed well in advance of any demands for topographic mapping. Past experience has shown that the topographic mapping of areas, which have suddenly acquired great economic or engineering importance to the State or Nation, has had to be postponed for a year because such basic control was not ready. Through close cooperation between these two organizations of the Federal Government, the Coast and Geodetic Survey is expanding its control net in areas where it will be of the greatest service to the Geological Survey.

"The lack of horizontal control surveys of the first or second order, in advance of topographic mapping, results in accumulations of error in horizontal position of magnitudes sufficient to cause serious difficulty in the proper joining of quadrangle maps. Such errors are known to exist at the present time in a number of localities and eventually will cause additional expenditures for the readjustment of third-order control and engraved quadrangle maps.

"While Major Bowie's paper and this discussion have been devoted to horizontal control surveys, practically the same situation exists in regard to levels or vertical control. The value of executing control surveys of a high order of accuracy well in advance of immediate needs can not, in my opinion, be too strongly emphasised."

J. G. Staack, M. Am. Soc. C. E.
Chief Topographic Engineer,
U. S. Geological Survey.

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* * * * "Although competent civil engineers realized that surveys should be made with such care as to serve all needs, regardless of real property values, those who provided the funds for field work were very slow to recognize the economies that follow in the wake of accuracy. Those who have been in contact with modern development realise that accuracy is the prime essential, and that carelessness, or what often appear as convenient approximations, generally lead to financial loss.

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"During the past twenty years there has been a rapidly growing demand by cities for triangulation control. This has been sufficient to warrant the organization of engineering firms which specialise in control surveys for municipalities. Engineers engaged in local practice should take advantage of the results of this public service. Local control, like local government, mast be supported by local people Engineering firms engaged in the location, design, and construction of large undertakings, such as industrial plants, long bridges, and tunnels, should retain engineers who are qualified to determine accurately distance and direction preliminary to design, and then to make precise final location surveys.

"The engineer who may consider himself a specialist, restricting his activities to design or construction, should be so familiar with the theory and practice of modern triangulation control that he may be satisfied that the distances and directions reported to him in connection with preliminary and final surveys are sufficiently reliable to completely support the work for which he may be held responsible. The training of the civil engineer should be balanced. His great responsibilities relate to location, design, and construction. Mr. Bowie's paper reminds us that modern triangulation methods involve no more specialization than is required in design and construction. He and others, who are frequently asked to recommend men qualified to participate in control surveys, realize the scarcity of talent of this sort. Surveys of the future are to be more exacting than those of the present. There are more men now engaged in surveys of all kinds than at any time in the history of the country. The specifications under which they work are more exacting than they were at any time in the past. Mr. Bowie reminds engineering firms and engineers generally that control surveys furnish the critical data governing design, final location, and construction."

Clarence T. Johnston, M. Am. Soc. C.E.
Professor of Geodesy and Surveying
University of Michigan.

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* * * * "The advantage of applying photography to mapping has been recognized for many years, but until recently progress has been slow, due to the limitation imposed by photographs made from ground stations. With the development of the aeroplane and stereoscopic methods of determining differences of elevation from aerial photographs, a new impetus was received; and the progress since that time has been so rapid that the method has, in a few years, established itself and will undoubtedly continue to grow as its advantages are more generally appreciated. The next few years may witness a radical change in methods of mapping, due to the general adoption of new photographic methods and instruments only distantly related to the mapping instruments of the past."

T. P. Pendleton, M. Am. Soc. C. E.
Chief Engineer,
Brock and Weymouth, Engineers.

WORKING WITHOUT MAPS

(From The Military Engineer)

The enormous increase in the use of the automobile and the airplane in recent years has added to the interest in maps. Most of the American public became map-minded as a result of the World War. One seldom goes more than a few miles from his home without taking along a map showing his route of travel, objective and salient points along the way.

We are extending our highway system at a rapid rate, existing highways are being improved, power lines are run like a spider web over the country. Much of this work has to be done without an accurate or complete knowledge of the terrain, such as can be furnished by the modern topographic map.

The drought during the past year has emphasized the importance of the fresh water carried in rivers and streams and held in the ground. Wells and streams have become dry. Some dams constructed for irrigation have no water back of them. Villages and cities have suffered from curtailed water supply. These settlements look with anxiety to their future growth and the necessity of securing increased water supply. The water situation is a serious one. It is a problem of first magnitude and it can be solved by the city, village, or individual farm only by an accurate knowledge of the terrain which is given only by the topographic map.

Wherever practicable, engineers are using topographic maps of the Federal Government to plan the location and construction of their projects. Where these maps are not available and, sad to say, this is true for the greater portion of the country, the engineers depend on some makeshift map, or they go to great expense to have adequate maps made. It is a wasteful process for each engineer working in an area to have to make a map for his particular job. The same area may thus be mapped a dozen times, for the work of one engineer is not available to the others.

If the federal map were completed for any particular area it could be used by scores of individuals or agencies, thus saving large amounts of money. The map users are waiting patiently for its completion. Surely this is a project of major importance although not one that requires an enormous expenditure of public funds. Probably from $60,000,000 to $75,000,000 would complete the topographic mapping of the country. This money should be made available as rapidly as the funds can be economically employed. At the present rate of progress the map will not be completed within one hundred years. It should be completed in the next fifteen or twenty years and it will be if its great importance as an aid to industry and as a means of eliminating waste becomes generally recognized.

UNFORTUNATE ACCIDENT TO PARTY ON THE SHIP FATHOMER

(From the report of Lieutenant (j.g.) E. R. McCarthy on the accidental drowning, on October 11, 1931, of three members of the crow of the FATHOMER attached to a sub-party under his charge while engaged on surveys on the southwest coast of Palawan Island, P. I.)

* * * * Before daylight on the 17th the wind died down and the sky cleared to the southward about 6:00 A. M. so it was decided to run to the ship at Sepangow Bay to report on progress and to obtain provisions for the following week, stopping en route to add a target to Station Fish and to put cloth on the tripod at Station Isle. The men were given their choice of returning to the ship or remaining in camp. Those who decided to return were Crispin Alandruque, Santiago Longalong, Gonsalo Senitara, Domingo Nualla, Domingo Rangasajo and Marciano Kasupanan.

The party left camp at 8:00 A.M., the launch towing the skiff, and arrived at Station Fish on the reef at the mouth of the Arapitan River about 10:00. The launch sounded its way in as the water was extremely muddy due to the discharge from the river (it was about low tide) and anchored in two fathoms about one hundred fifty meters west of the signal at what was thought to be edge of the mud bank. There was a light breeze from the southwest and small seas.

The skiff with Crispin Alandruque, Gonsalo Senitara, Domingo Nualla, Domingo Rangasajo and myself left the launch and rowed into the signal. On arriving there it was noticed that it had clouded up to the southwest, and so instead of building the target, the poles which had been cut at camp were left here and the skiff put back for the launch, with the four men rowing.

About one third of the way back a brief flurry of rain and wind was met but the skiff took no water and the flurry passed quickly. About half of the way back another flurry came and passed and the wind increased. The skiff shortly after began to take in water faster than it could be bailed out so the boat was turned around and headed for the reef to the north - the launch was nearer but the reef could be reached more quickly as the wind would be astern. Two men were rowing and two bailing.

About half way to the reef three or four short waves higher than the others came over the stern in succession, the water in the boat surged and it swamped, going down bow first at a sharp angle.

The men were left in the water. When I first noticed matters, Alandruque was leading toward the signal and was already some distance away. Senitara, Nualla, and myself were floating, expecting the skiff to come to the surface; Rangasajo could not be seen. Nualla and Alandruque had oars and one was floating nearby, which I pushed over to Senitara. The skiff remained on the bottom so I waved to the launch and had just begun to take off my shirt and trousers, as they were becoming very heavy when I heard three shouts from the direction of the reef seemingly some distance away (Nualla said later that this was Rangasajo, who went down immediately afterward). I had considerable trouble removing my clothes and went below the surface a number of times. Upon coming up, Senitara was gone, Alandruque was still going toward the signal and Nualla was floating easily, so I started to swim for the reef, which I barely reached. Upon getting to my feet, I could see Nualla coming in about twenty yards away and no sign of Alandruque. The launch arrived then and I was hauled aboard and went out in the area where the skiff swamped. Nothing could be seen of clothes or any floating objects so the launch went back to the reef to pick up Nualla and went aground in doing so (this was about 10:25). It remained aground until three Moros arrived in a banca an hour later and carried out the anchor, after which the launch was pulled off. I dived a few times about where the accident occurred and dragged in the vicinity with a weight on a large fish hook for about twenty minutes, but could find nothing.

It was now more than an hour and a half since the men were drowned and as nothing further could be done and the chances of locating the bodies was rather small, since the wind had picked up and the banca, which was large and heavy and unstable, could not be used, a note was sent to camp by the Moros informing the men there of the accident and instructing them to look for the bodies while the launch ran to the ship.

The launch got into Marasi Bay, and since wind and sea were gradually increasing, it could not get out and remained there the 17th and 18th. On the 19th, after an unsuccessful attempt to go to the ship, we succeeded in returning to camp. On the way, the body of Senitara was picked up offshore, taken aboard and buried near camp.

The weather cleared on the 20th but with a heavy sea running. The afternoon was spent in fruitlessly searching for the bodies.

On the 21st a Moro reported a body found in the mangrove, but it could not be reached until high tide the next day as the mud was too deep to wade there, the water too shoal for the launch and no small boats available. The launch returned to the ship on this day with the remainder of the party.

The wind at the time of the accident was no stronger than it had been many times during the preceding two weeks when the skiff was used in signal building and the area was partially sheltered by the point a mile to the southward so the waves were not high. All the men could swim, although the failure to remove their clothing probably pulled them down, as Nualla and myself succeeded in removing part of ours. The boat swamped - as close as could be estimated - about 50 meters off the reef.

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