

## RECENT UNITED STATES PROGRESS AND INTERESTING TECHNICAL DEVELOPMENTS IN CARTOGRAPHY

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### CARTOGRAPHIC PROGRESS

#### *Terrain Models.*

Mass reproduction of terrain models has become a reality in the United States, with the adoption of the principles of vacuum forming, and using thermo-plastic material as a reproduction medium. Opaque white polyvinyl chloride sheets of this material are printed lithographically from standard press plates used to print paper maps. These preprinted maps are then formed, by heat and vacuum, over a male mold, which has been reproduced from a terrain model constructed to correspond to the topographic detail of the map.

This new process laid greater emphasis on the accuracy of the original model and necessitated modification of old and development of new techniques, equipment and materials for model construction. Pantograph routers, of German design, have been adapted to cutting the three-dimensional contour base from an acetate laminate. Low expansion plasters are used for casting, from this base, a step positive mold. The landforms are developed by carving away the step edges. From this original model, a negative mold is cast and, from the negative, a positive mold which is used for the forming operation. An optical device, which permits orthographic projection of map information on to the model surface, has been developed specifically for checking the horizontal accuracy of the model. The vacuum forming equipment has also been constructed. These new processes make possible the production of tens of thousands of plastic relief maps annually.

#### *Geological Maps.*

The publication of aggregate geological mapping has progressed at an increasing rate. The primary objective of the United States geological mapping is to provide information for exploration and development of minerals, mineral fuels, and ground water resources, and to provide geological maps needed in planning and development of industrial and defense areas.

#### *Soil Maps.*

The first organized mapping of soils in the United States began in four widely scattered areas in 1899. From that modest beginning a continuing program has provided maps for approximately 1,647 areas during the past 55 years. Soil maps are used by planning technicians in soil conservation districts as a basis for sound farm and ranch conservation plans. In addition they are found to be useful

in the organization and synthesis of research, in agriculture extension programs, in land appraisals as bases for loans and tax assessment, and in supplying relevant soil information needed by engineers in highway and airport construction. About 350 million acres of land that are adequate for the above purposes have been covered by soil mapping. There is an additional area of 150 million acres for which maps are nearly adequate but which will require some reworking.

In the past two years 31 soil survey reports, consisting of map and text were published, bringing to 1,647 the total number of surveys published since the program was started in 1899. Published soil maps for this period include approximately 14,100,000 acres (57,047 KM<sup>2</sup>) of reconnaissance survey.

### *Hydrographic Charts.*

The United States continued its program for providing adequate nautical charts to U.S. merchant ships in all oceans of the world, giving special emphasis to coverage of areas with ports having significant volumes of U.S. maritime trade. With a view to meeting more fully its obligations to provide for the safe navigation of U.S. vessels, the United States extended its operations beyond its traditional broadcast and Notice to Mariners services into the fields of ice and ocean wave forecasting. Confined at present to military use, forecasting of this type has improved greatly as knowledge of the effects of the many oceanographic and meteorological variables increased. High-accuracy electronic navigation systems, of both governmental and commercial design, are being employed with increasing success to control new hydrographic surveys.

### *Aeronautical Charts.*

During recent years the United States has made significant progress in the field of aeronautical charting. The great expansion in aviation activities throughout the world and the rapid developments in increased speed and range of aircraft have placed a heavy burden on those who are responsible for production and design of aeronautical charts and related publications. The most significant progress of late has been the improvement of the quality of existing materials. Such improvements are represented by increased cartographic accuracy, better portrayal of information, and incorporation into graphics of more complete and accurate source information.

Maintenance continues on the following standard series charts, most of which afford world coverage :

World Aeronautical Chart, Scale 1 : 1,000,000

Pilotage Chart, Scale 1 : 500,000

Aeronautical Planning Charts, Scale 1 : 5,000,000

Pilots' Handbooks (conventional)

Pilots' Handbooks (Jet)

Radio Facility Charts

Supplementary Flight Information Documents

Jet Flight Information Manuals.

In order to develop a universal aeronautical chart series that would fulfill requirements of high speed, long range, and high altitude aircraft for radar, celestial, dead reckoning, and visual navigation, extensive research was conducted by the United States during the past two years. This has resulted in the development of the Jet Navigation Chart Series.

This series is being produced at a sheet size approximately 42 inches by 58.5 inches, on a Lambert Conformal Conic Projection (except in Polar Areas) and is designed to include topographic features, names, aeronautical information, and other information required for navigation of Jet aircraft. These charts are so designed that strips of 12 inches or more in width may be cut from them and used independently where operational space is limited. Preparation of complete world coverage is underway.

A number of changes have been made or are being made for the improvement of the V30 Aeronautical Charts. This program is designed to meet the specialized needs of high performance aircraft flying extreme distances at high speed, and to fulfill requirements of visual pilotage as well as standard and radar navigation. The Mercator Projection has been retained for both land and water areas. The charts show generalized contours and display elevation tints in subdued colors. Information on coastal water depths has been included.

To fulfill certain military requirements some aeronautical chart are being plasticized. This provides for continuing use of charts which require frequent annotations or markings since markings made can be easily wiped off.

### *Gravimetry.*

The United States is engaged in an extensive world-wide gravity program. Gravity data is being accumulated from all official and commercial sources possible, and, in as much as possible, being reduced to a common datum. In this respect, as many national gravity base stations as can be occupied are being tied together by means of standardized quartz pendulums, thus effectively establishing a basic instrument from which to compute all world-wide gravity values.

With this same set of instruments, many gravity bases are being established over the earth from which further more extensive surveys are being conducted by gravimeters, thus supplying us with very extensive gravity data. After this work has been accomplished, much more accurate figures for the undulation of the geoid can be determined, deviation from the vertical can be more assuredly established at any given place, thus geodesy can be further refined beyond its present accuracy.

In areas where no specific gravity information is available, the United States is sponsoring commercial contracts for determining the isostatic anomalies, insofar as possible, by computing average elevations and densities for  $5' \times 5'$  areas ( $5' \times 10'$  in the northern latitudes), and extrapolating from known gravity stations to obtain deviation from the vertical and undulation of the geoid over inaccessible areas.

Newly-developed procedures have been adopted to minimize temperature, magnetic, and flexure effects in observations with the Brown pendulum apparatus. A system of eleven gravity base stations was established in Alaska in 1952 using air transport. The gravity range in this territory was covered by five pendulum

stations and six additional stations were observed with a Worden gravity meter. Six key stations were re-observed by pendulum on calibration line extending from Brownsville, Texas to Winnipeg, Manitoba.

### *Geodesy.*

In 1952 the United States sponsored studies of solar eclipses for geodetic purposes. An expedition in Africa for this purpose in 1952 was undertaken, and in view of the fact that the use of solar eclipse data for geodetic information seemed feasible, another extensive expedition was organized to study the 1954 Solar Eclipse under contracts with the Ohio State and Georgetown Universities. Three systems were used to study this solar phenomenon: the minimum light or photoelectric method, utilizing the light intensity variation during the eclipse; the Bonsdorf method whereby the solar crescent is photographed before and after the total eclipse; and the Lindblad method in which a study is made of the flash spectrum just prior to and following 2nd and 3rd contacts, respectively. Preliminary results indicate that the use of solar eclipse data for geodetic purposes is highly satisfactory. When final results have been obtained, it is thought that the present probable error in long range distance and intercontinental ties will be reduced by approximately 50 %. It is felt that with this method, a geodetic tie can be made between all major geodetic data within about a 20 year period.

A long range occultation program in the Pacific is being planned to start in 1954. This program will include geodetic connections between various islands and island groups, with an ultimate connection to the Asian mainland and Tokyo Datum. It should greatly improve a serious navigational problem in the Pacific arising from the present inaccurate positioning of the Loran stations. It will likewise provide accurate positions of the islands with respect to each other and to the mainland.

The United States has been engaged in a gravity program that has been accumulating as much as possible of a world coverage of gravity observations for geodetic purposes. The broad objectives of the program are to gravimetrically determine :

- a. the flattening  $\alpha$  of the reference ellipsoid,
- b. the undulations  $N$  of the geoid,
- c. the deflection of vertical components  $\xi$  and  $\eta$  at any point in the world,
- d. a World Geodetic System by converting the existing geodetic systems to the same system,
- e. a reduction for the triangulation base lines from the geoid to the reference ellipsoid,
- f. a correction for triangulation stations in mountainous regions due to the effect of the deflection of the vertical.

Combining the gravimetric method with astronomical observations will produce :

- i. control for maps at a scale of 1 : 100,000 and at smaller scales in areas where adequate triangulation is not available. The error of the control points,

computed from gravimetric-astronomic data, is of the order of 30-45 meters, which is not larger than the drafting and reproducing errors of maps at 1 : 100,000.

ii. distances between any points *along the reference ellipsoid* with an accuracy of about 50 meters, regardless of whether they are 50 km. or 10,000 km. apart.

iii. geoidal distances from ellipsoidal distances.

iv. super geodetic control points which will control the accuracy of long range triangulation.

From the existing triangulation the correct dimensions for the reference ellipsoid can be determined. For this we need only to compare the differences ( $\xi_g - \xi_a$ ) and ( $\eta_g - \eta_a$ ) between the gravimetrically and astro-geodetically computed deflections of the vertical components  $\xi_g$ ,  $\xi_a$  and  $\eta_g$ ,  $\eta_a$  at astronomical points close to both ends of the triangulation chain. If these differences are not large, the chosen ellipsoid is satisfactory. If they differ systematically with the distances from the initial point, we have to correct the ellipsoid until these systematic differences disappear.

The accomplishments of the program to date are as follows :

1. Studied the various methods used in reducing gravity anomalies and adopted the isostatic Airy reduction with 30 km as the thickness of the earth's crust. However, for preliminary computations of the undulations of the Geoid and deflection of the vertical the free air reduction with condensation corrections is being used.

2. Accumulated vast number of gravity observations from geodetic and other interested institutions, as well as oil companies and individual scientists.

3. Prepared card catalogue of the principal facts of all available gravity observations by one degree squares.

4. Prepared a card catalogue of approximately 1000 gravity base stations.

5. Prepared mean gravity anomaly maps based upon average anomalies for 10'  $\times$  10' square.

6. Conducted studies on the feasibility of adapting isostatic reduction for high-speed computing machines.

7. Initiated preliminary gravimetrical computation of the deflections of the vertical.

## CARTOGRAPHIC TECHNIQUES

### *Production of Compilation Manuscripts.*

A method of employing a modified pull-up technique for the production of compilation manuscripts is now being used. Original pull-ups are prepared as color separated copies on plastics which are subsequently photographically reduced to scale. The resulting negatives are panelled to a format and contacted to vinyl bases to create « separation positives ». Each positive is processed by successive multiple exposure to a dyed stable plastic to produce a multi-colored compilation manuscript. As opposed to the final inking step required under previous methods, a considerable time saving and a clearer manuscript is realized.

### *Shaded Relief from Plaster Models.*

Continuing developments are aimed at the achievement of a practical method for obtaining shaded relief negatives by photographing plaster relief models. For this purpose a « Bench Camera » was erected. The direction of collimated light reflected from the copy onto the focal plane of the Bench Camera, makes possible true and accurate rendition of elevations. As opposed to air brush relief drawings, this photomechanical product minimizes human error, eliminates mis-interpretation by air brush artists, and results in more uniform portrayal of terrain.

### *High Altitude Photography.*

High altitude photography, scale about 1:60,000, is now being used successfully in precise stereo-plotting instruments for compilation of some geologic maps in western United States.

### *Gridding.*

A procedure of orthographically transferring small-mesh grids from aerial photographs to map or manuscript bases to provide for later transfer of geologic or other detail from photographs to such bases in lieu of plotting instruments of any type.

### *Photo Mechanical Production of Spherical Maps.*

Continuing developments are aimed at the production of multi-colored global maps with a high degree of accuracy. It is expected that the objective result will eliminate most inaccuracies inherent on existing spherical maps.

### *Negative Scribing.*

Considerable progress has been accomplished in the last few years towards the development of negative engraving (scribing) as a cartographic media substitute for ink drafting in color separation work. This process of engraving on specially coated plastic materials has proved more satisfactory than drafting. It saves considerable training and operation time, without loss of quality, and, since scribed sheets are in negative form, eliminates « the positive to negative » step required prior to reproduction. Great advancement has also been realized in the quality of coating emulsions and several commercial sources of pre-coated sheets are now available. The instrument design and development has generally kept pace and commercial sources of supply for all basic instrumental requirements are now available.

Most of the development work associated with negative scribing has been involved with its adaptation by the U.S. Federal mapping and charting agencies. Practically all of these agencies have converted or are converting their map and chart finishing operations from drafting to negative scribing. Some U.S. Federal Mapping Agencies are integrating procedures applicable to the topographic mapping program as a whole. This involves the application of scribing techniques to direct stereomapping delineations and to field intermediary manuscript inspection and revision operations.

### *Symbol Standardization.*

The various charting agencies of the U.S. Government have formed committees whose ultimate objective is the achievement of uniform and standard cartographic symbolization on map products. This effort is specifically aimed at

the determination of common symbolization for naval, air, and ground maps and charts.

#### *Use of Autograph and Stereoplanigraph.*

The Wild A-7 Autograph and the Zeiss C-8 Stereoplanigraph have been introduced in aeronautical charting operations to complement other stereoplotting instruments such as the Kelsh Plotter, Multiplex, and Mahan Wernstedt plotter. The high precision instruments are used in special stereophotogrammetric operations such as stereotriangulation and accurate position determination.

## CARTOGRAPHIC EQUIPMENT

#### *ER-55 Projector.*

The ER-55 projector was designed for use on either the Twinplex plotter with convergent low oblique photography or the conventional Multiplex frame. Testing of this equipment indicates that it will fulfill anticipated high performance standards.

#### *Variable-Ratio Pantograph.*

A precision variable-ratio pantograph was developed for attachment to either the Kelsh or multiplex instrument to permit compilation at or close to the publication scale rather than at model scale. The reduction that can be obtained with the new pantograph is continuously variable from 1.5 to 6.5 times.

#### *Alidade Improvements.*

Some of the most recent innovations in instrument design have been adopted for use in modernizing the standard telescopic alidade. The exposed, brass vertical-arc and its levelling bubble on the standard model were replaced by an enclosed, optical-reading glass circle which is automatically levelled by a pendulum device. The old clamp and tangent screw were replaced by an enclosed worm-gear assembly, packed in grease, and attached to the telescope with a friction clutch requiring no clamp.

#### *Stereotemplates.*

Triangulation utilizing stereotemplates is a recently developed method of achieving the horizontal scale solutions required in photogrammetric mapping procedures. A stereotemplate is a composite slotted templet that is a mechanical representation of the horizontal plot of a stereoscopic model. It is specifically designed for use in conjunction with stereoscopic plotting equipment and to exploit the advantages of the stereo-plotting technique. The stereotemplate method incorporates the precision and geometric strength of the stereoplotting technique with a templet system that contributes the favorable qualities of an area solution. This method may be of special value in areas where the amount and distribution of existing horizontal control is not suitable for effective stereotriangulation by individual flight strips.

#### *Kail Radial Planimetric Plotter.*

The Kail Radial Planimetric Plotter is a simple stereoscopic plotting instrument using radially intersecting arms to determine orthographic positions of geologic features seen on aerial photographs.

### *Multiplex and Kelsh Plotter.*

These precise projector-type stereo-plotting instruments, long used in topographic mapping, are now being used in interpretation and orthographic plotting of geologic features from aerial photographs.

### *Oblique Height Finder.*

An oblique height finder has recently been developed as a companion instrument to the photoalidade. This instrument was designed for use determining ground elevations in those portions of the oblique photographs nearest the flight line which cannot be determined by the photo-alidade. The instrument measures parallax of common points in such a manner that the parallax can be translated into differences in elevation.

### *Modification of Stereoscopic Plotter.*

A modification was effected on the stereoscopic plotter (Kelsh Type) to provide a stereoplotting capability for trimetrogon oblique photography. The modification involved major changes in the frame and a few minor changes in the projectors. The instrument can be easily converted for use with vertical or convergent photography.

### *Super Duper Dipper.*

The Super Duper Dipper is a recently developed instrument for determining apparent slopes in stereoscopic models of vertical aerial photographs.

### *Film viewers.*

Two models of a film viewer, designed for inspecting and indexing, have been developed and are now in use. These devices were designed specifically to be used with aerial cartographic photography (9" × 9" and 9" × 18") and differ from other models primarily in the separation of the light source from the film by two glass plates separated by a sealed air space. Six watt, daylight, fluorescent tubes are used as the light source in both models. For use during indexing, the 9" × 9" model is equipped with a desk stand that places the viewer at a convenient angle for the operator and permits easy rotation of the viewer through 360° for orientation with a map.

A 9" × 9" film viewer of the type described above has been combined with a commercial model densitometer for use as an inspection device for aerial cartographic photography. The densitometer and viewer are mounted together on a base and the film to be inspected is fed through a series of rollers, first across the film viewer and then through the densitometer and back to the take-up spool on the film viewer. Since the device is used primarily in the field its base is also the base of a sturdy oak chest, the top and sides of which are easily removed when the unit is in operation.

In order to determine differential shrinkage in aerial photographic film, a direct-reading scale has been designed. An 11-inch length of invar steel has been fashioned to permit two clear plastic inserts to be permanently affixed within the bar. One insert has a cross-line reticule etched on one surface, and the second



insert is graduated in 0.1 mm for a 1.5 cm. length. The inserts are positioned in the bar approximately 225 mm apart on centers. The inserts are flush with the bottom side to eliminate parallax, and each insert is viewed from the top through a magnifying device that can be folded down when the instrument is put in its case. The distance between the cross-line reticule and the middle line of the graduated scale is accurately determined and is used as the origin for film measurements.

#### *Charting Photoalidade.*

A new type charting photoalidade was developed, based on the Wilson Photoalidade, to afford more accurate and efficient determination of ground elevations from oblique photography. The instrument will be usable with a greater variety of photo sizes, focal lengths, and camera angles. The equipment can accommodate focal lengths of 6 to 12 inches, picture sizes 9" × 9" and 9" × 18" oriented in either direction with depression angles of 0 to 90 degrees. A Wild T-1 theodolite is used for the theodolite which is connected to a straight edge for ruling on a manuscript. The print is held on a vacuum plate. Provisions are made to adjust the instrument and make rapid changes in the setup when using the various types of photography.

#### *Variable Perspective Camera.*

A variable perspective camera consisting of a telecentric system composed of a spherical mirror of 30 inches diameter (focal length 180 inches), a camera with a 48 inch focal length process lens, and a tilting easel. This arrangement permits the accomplishment of an affine transformation of an image by holding one dimension fixed and reducing the other as desired. With this equipment any type of projection can be transformed into any other type of projection by photo-mechanical processes. Any large chart maintenance or compilation program can be accomplished with fewer highly skilled personnel in the compilation units.

#### *Aerial Mapping Camera, Type T-11.*

The T-11 Aerial Mapping Camera is designed to obtain aerial mapping photographs for use in the compilation of maps and charts. It is equipped with the 6 inch f/6.3 metrogon lens that has less than 200 microns radial distortion. Calibration curves for each camera are available. Negative number, barometric altitude, mission data card, camera serial number, fiducial marks and time of exposure are recorded on each negative. Format size is 9" × 9" and film capacity is 390 feet of 9 1/2 inch film. F/8.0 and F/11 Waterhouse stops are available for installation on the Rapidyne shutter. The camera operates from standard intervalometers and weighs 89 pounds loaded with 390 feet of film.

#### *Aerial Mapping Camera, Type KC-1*

The KC-1 Aerial Mapping Camera is designed to obtain aerial mapping photography from which photogrammetric measurements can be taken and utilized in the compilation of maps and charts. It is equipped with the 6" f/6.3 planigon lens that has less than 20 microns radial distortion. Calibration curves are available for all cameras. Negative number, barometric altimeter, mission date, calibrated focal length, lens serial number, fiducial marks, film shrinkage markers and time of exposure are recorded on each exposure. Format size is 9" × 9" and the film capacity is 390 feet of 9 1/2 inch film. F/8.0 and f/11 Waterhouse stops are available for installation on the Rapidyne shutter.

### *Aircraft Camera Mount, Type A-28.*

The A-28 Aircraft Camera Mount is designed to eliminate effect of aircraft roll when taking vertical aerial photography. It has a  $\pm 8$  degree freedom in the roll and pitch axis and is stabilized to  $\pm 30$  minutes or arc of the vertical. The mount can be rotated by remote control in  $\pm 40$  degrees of azimuth. The mount weighs 120 pounds and is operated on 115 volt 400 CPS power.

### *Modified Saltzman RP-6 Rectifier.*

In order to fulfill a requirement for an instrument to accomplish photo rectification of trimetrogon oblique photography on a production basis one Saltzman RP-6 Rectifier was modified. Modification to afford greater tilts included alterations to the easel, change in the position and location of the negative carrier, and movement of the lens closer to the negative carrier. While reasonably accurate rectification can be accomplished with the modified instrument, the resolution of the rectified prints is not as good as with other rectifiers.

### *Modified Polaroid Land Camera.*

A technique using a modified Polaroid Land Camera has been developed to permit accurate spacing of flight lines over uncharted areas. The camera is mounted in the aircraft in such a manner to take selected photos of check points on the flight line or the adjacent flight line. The prints are developed within the camera in less than 60 seconds. They are used by the photo navigator as a visual aid in the navigation of the adjoining flight line. The installation weighs less than 4 pounds and requires no power.

## REPRODUCTIONS TECHNIQUES

### *Vignetting of Open Water Areas.*

A photomechanical technique has been developed for vignetting open water areas on maps and charts using a reproduction negative of the line drawing of the drainage plate only. Through this technique it is possible to show deep blue for water nearest the shore with a gradual reduction of the intensity of the blue tint away from shore until only white appears a considerable distance from shore.

### *Step Processing Photo Copy Technique.*

A step processing photo copy technique was developed. Inferior photographic copy was formerly reproduced by photomechanical methods for distribution in order to preserve the maximum in definition. A method of progressive 3-step photo copying of originals has been devised which improves definition to the extent that it can be reproduced successfully by lithography.

### *Printing on Plastic.*

Considerable development has taken place in connection with printing on plastic media. Through the use of celluloid inks, anti-static compound ink driers, and modification of the press, printing on plastic media by normal offset lithographic methods is now being accomplished.

### *The Lac-Strip Method.*

A method is under development whereby reproduction negatives of contour line drawings are exposed on pre-coated lacquer stripping film in the preparation of gradient tint « open window » negatives. A solvent etch is utilized to clear desired contour lines. Remaining opaque coating between lines is then stripped off by hand. It is expected that this method will reduce the art room time for preparing gradient tint negatives to approximately 5 % of the time required by conventional methods.

### *Photomechanical Film Reversals.*

In developing photomechanical film reversals, procedures have been devised to permit the direct reproduction of positive copy from positive originals and negative copy from negative originals.

### *Open Faced Vacuum Frame.*

A new open faced vacuum frame which has a pliable transparent cover has been substituted for glass, which improves contact. This, in turn, improves the definition of fine detail. The open faced frame is used in combination with a contact screen for the production of tints over large areas. This eliminates the necessity of preparation by camera and improves the quality of the finished product.

### *Grainless Plates.*

The production and utilization of plates which are not mechanically grained has proved satisfactory in reproduction runs. Encountered variations prompt continuing development to establish standards for full-scale production. The grainless plates have unlimited re-usage, print a sharper image, and provide a substantial economy by rendering graining operations unnecessary.

### *Ink Distribution System for Printing on Plastic.*

The ink distribution system of the press used for vinyl printing has been modified to reduce the ink distance. The reduction of the long travel distance, normally a requisite for ordinary lithographic printing, was necessary for satisfactory inking with plastic inks. It is conceivable that the achieved development will influence future press design.

### *Production of Etched Plates.*

A photolithographic process has been developed for producing etched lines on metal plates for use in conjunction with the preparation of the step-laminate for relief model making. Heretofore, such plates were produced commercially by photoengraving. The new process makes practicable the production of relief models by military field units.

## MISCELLANEOUS MAPPING AND CHARTING EQUIPMENT

### *Oceanographic Instruments.*

A considerable amount of developmental work has been expended in an effort to improve oceanographic instrumentation. Instruments that have been developed include: Accelerometer Wave Staff, Submarine Photometer, Magnetic Wave Analyzer, Microthermal Recorder, Ship-borne Atmospheric Temperature

Lapse Rate Indicator, and Ship-borne Pyreheliometer array. In addition, programs have been conducted to improve the speed and accuracy with which data is recorded and analyzed, utilizing such devices as electronic counting mechanisms and magnetic tape recorders.

#### *Electronic Position Indicator.*

The use of the Electronic Position Indicator system for the control of hydrography continued. Some basic changes were made in the equipment to improve its reliability and with a view to making the ground stations function more nearly automatically. Accuracy and range remain about as in the original equipment. However no long runs were made to determine maximum range.

#### *Portable Depth Recorder.*

An improved small portable depth recorder is under development and should be available for use in a short time. One field test (2 weeks) showed that the instrument is well designed and that it should meet the requirements of a surveying instrument.

#### *Current Meter Recorder.*

To help reduce the cost of observing currents and thus make it possible to obtain more observations, a current meter recorder has been developed that eliminates the need for constant attention by an operator. When attached to a radio current meter this instrument automatically records the velocity and direction of the current continuously for 7 to 9 days before record tape and batteries require renewal. One of the principal features is that separate pens record time, direction, and velocity. It is operated by batteries and may be used in a buoy or directly on board an anchored ship where a meter is lowered over the side. When used in a buoy, a radio can be used to monitor its operation. With the proper radio hook-up, it can also record aboard ship the current signals transmitted from a radio current buoy. This instrument will receive its first extensive field tests during the year 1955.

#### *Echo Sounders.*

As a result of efforts of various government agencies private concerns are now producing a portable echo sounder of very satisfactory accuracy and dependability for coastal surveys. For deep water hydrography, efforts are directed toward improved utilization of existing high power echo sounders by means of accurate frequency control and scale expansion of recording devices.

#### *Electrical Analogue Computer.*

A new electrical analogue computer to permit rapid analyses of strong motion seismograph records has been developed.

## MAPPING AND CHARTING STUDIES

#### *Seismological Studies.*

A new correlation between ocean swells and microseisms as recorded on an ocean island has been developed and tried out on an oceanic island.

Several investigators are now using models and ultra high frequency waves to study the propagation of seismic waves.

### *Efficiency of Photogrammetric Systems.*

The United States has completed a statistical study of C-factors (defined as the flying height over the contour interval) that can be expected from given photogrammetric systems under various conditions. The study is based on accuracy checks of a large number of recently completed maps. The results obtained indicate that there is no constant C-factor value for a given photogrammetric system. Rather, the results are expressed in the form of probability curves.

### *Systematic Errors in Aerophotogrammetric Surveys.*

The United States has produced a paper examining the systematic errors in aerophotogrammetry. Conclusions are that in aerophotogrammetric surveys there are 3 general classifications of systematic errors: external errors, instrumental errors, and personal errors. Sources of systematic errors can be detected by a careful study of every phase of the aerophotogrammetric system. Further, that most of these errors can be evaluated in advance and steps can be taken to reduce or eliminate their effects.

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