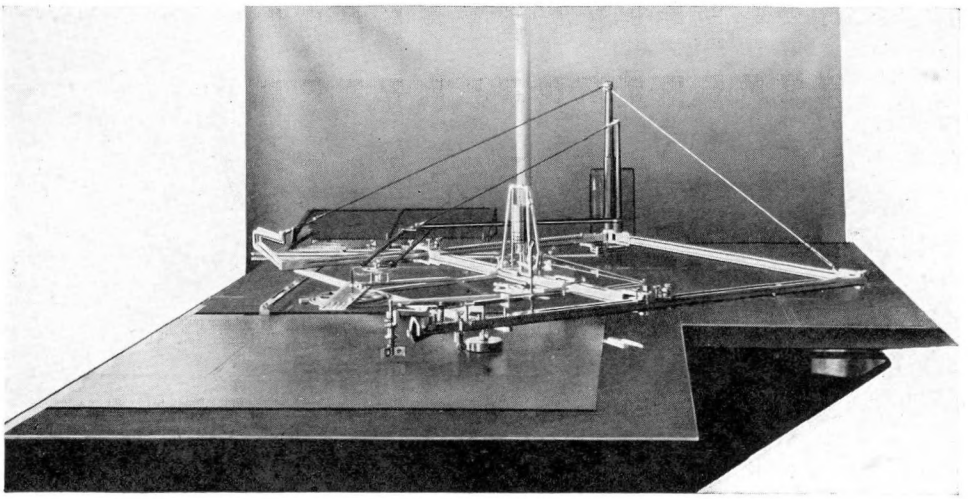

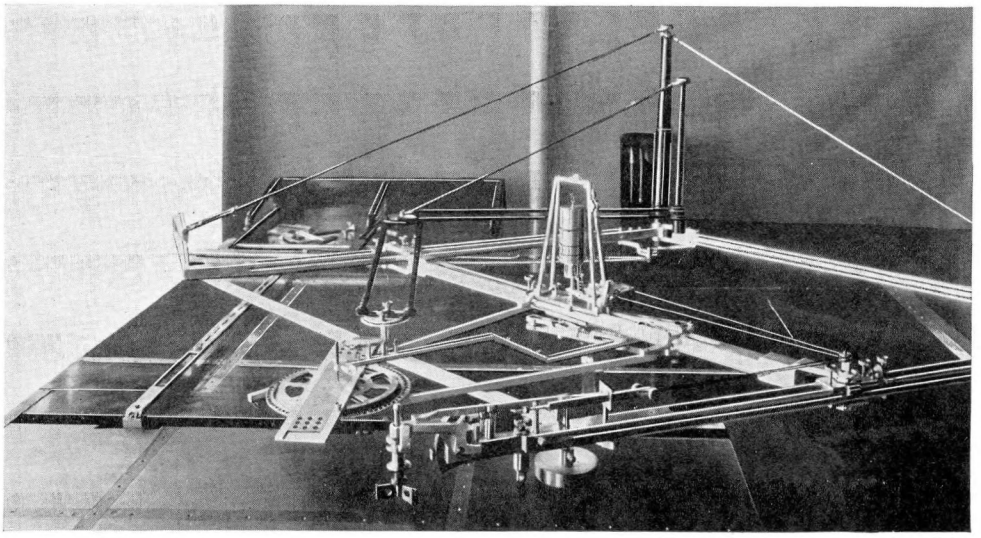

MECHANICAL ENGRAVING OF COPPER CHART PLATES

INTRODUCTORY REMARKS

BY

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In the " *Hydrographic Review* ", Vol. II, N° 2, of May, 1925, (N° 4 of the series) the question of the mechanical engraving of copper chart plates was outlined at some length, and this present discussion is in the nature of a continuation of the subject to bring it up-to-date. The Bureau's Circular Letter N° 49 of 1922 asked three questions of its States Members as to copper plates, the first being whether they had any data as to (*a*) " the perfection of a satisfactory mechanical method for the execution of copper plate engraving ". The "pantograver" used in the United States Hydrographic Office, Navy Department, Washington, was fully described, together with a machine for engraving soundings and another for engraving letters, and also with mechanical devices for border sub-dividing and lettering on curved lines. A new and improved pantograver has just been produced with an attachment by which soundings and lettering may also be engraved, and these instruments shown in Vol. II, N° 2, are already a thing of the past, as the improved pantograver now does the work of all three of the machines, both at reduced cost and increased speed. With all three of the former machines the number of new engraved charts produced annually was 20, and the greatest number in one year was 28. During the past two years, while the new machines were being developed and perfected, the number of newly engraved charts has been increased to 56 for 1925 and 60 for 1926. This has been accomplished by approximately the same force of employées, which formerly produced one-third of that number at about the same cost of labour.

The interesting feature of this is that the inventors of the machines are themselves professional hand engravers whose original occupation is done away with by the use of the machines, but the United States Government bears the expense of experiments, pays a bonus to employées who invent successful labour saving devices, and itself takes over patent rights with equitable compensation to the inventors, so this is not an exceptional instance.

The engraving of soundings by hand was formerly done at the rate of 300 figures a day. The lettering instrument, shown in Vol. II, could cut 2,000 figures a day. The attachment to the pantograver can cut as many as 4,200

figures in a day. The pantograver permits of the finish of a copper plate anywhere from 70 % to 90 %, the remaining work being necessarily done by other machines or by hand, such as the sandy beaches, contours, reefs, bluffs and conventional signs and symbols. As stated in Vol. II, the pantograver was designed by Mr. P. T. LAMPE, embodying the compensating device of Mr. J. H. LARRABEE. It now embodies the letter engraving machine of Mr. ROSS E. GRAY. Its basic principle is the adaptation of the pantograph. In its present form data from other surveys, maps or charts of various scales can be transferred directly to the copper plate and compiled into a finished map or chart of any standard scale desired. It is through improvements made by Mr. LAMPE that the sounding figures and lettering are now practicable with the same machine.

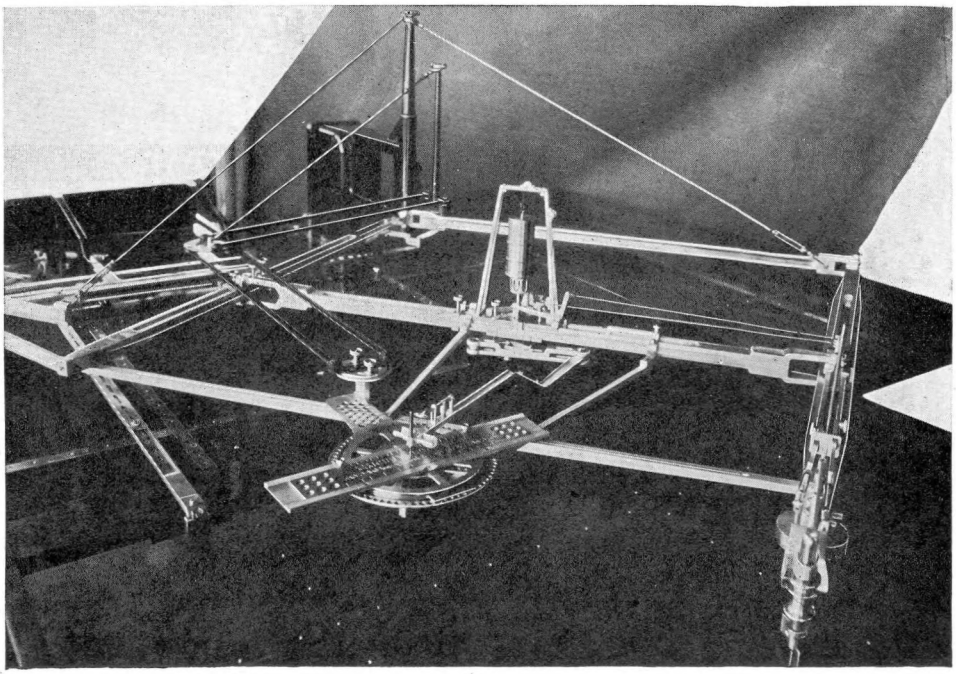
It is the intention of the Bureau later to publish such data as it can obtain as to the different methods of lithographing charts, *viz*, by stone, zinc or aluminium. In this connection it is interesting to note that in the United States Hydrographic Office, where zinc is used, for economical reasons, for lithographing charts, in the newer charts the land area is covered with a flat buff tint, and the water area, where depths are less than 3 fathoms (5^m 5) is covered with a flat blue tint. The dry-at-low-water areas which fall between the high and low water marks are covered with a flat green produced by the overlay of the blue on the buff without additional printing. The improved methods employed in the photo-lithographic production of nautical charts based on engraved copper plates, have resulted in greatly increased efficiency in chart production, both in the quantity and quality of the products. Expensive engraved copper plates are no a longer worn by constant printing. Features which must be periodically changed, such as compass roses, variation curves, light sectors, and range lines, are not engraved on the copper plates, but are supplied in the photo-lithographic process, thereby obviating the expense and damage through the alteration of engraved plates.

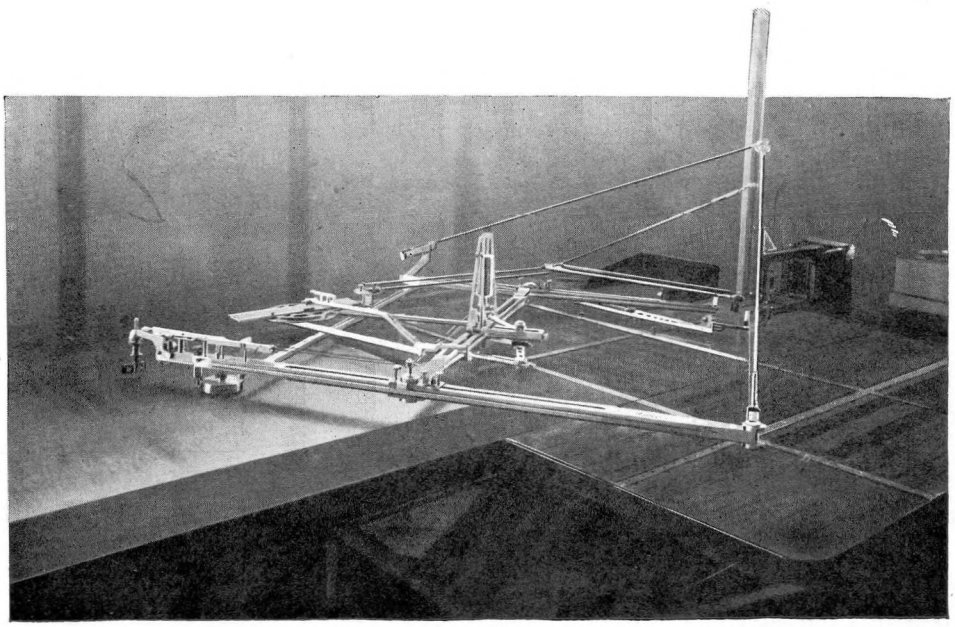
The following notes, and plates giving different views of the pantograver, have been kindly forwarded by the U. S. Hydrographic Office for publication.

THE PANTOGRAVER.

The " Pantograver ", in its present form, has four major parts instead of three as described in the previous article. They are the table, the pantograph, the compensating device, and the letter and sounding engraving attachment. The essential part of the instrument consists of four rigid arms jointed in the form of a parallelogram on a principle similar to that of the reducing pantograph. Three of the arms have graduated scales which permit setting for the various ratios of reduction required.

The compensating device is controlled by two auxiliary pantograph arms, which are so proportioned and placed on the main pantograph as to form a secondary pantograph with a fixed reducing ratio. This secondary pantograph is connected with the copy-board by means of a graduated compensating bar and a connecting rod. This compensating device can be set to automatically restore the correct dimensions of a distorted map or chart. The amount of movement which the compensating bar transmits to the copy-board, through the





connecting rod, is controlled by an adjustable pivot-point fastened to the compensating bar. The pivot point is free to move longitudinally between rails which are rigidly held in place so as to prevent any lateral movement of the pivot-point to the right or left. The copy-board is mounted on ball bearing rollers so as to permit any right or left movement transmitted to it through the compensating device.

Were it not for the compensating device, the Pantograver would only be a strongly built, neatly finished, and accurately adjusted pantograph which would produce a perfect square from a perfect square. The experience of the past two years has proved the value of the compensating device as a means of producing accurate maps and charts. Of the hundreds of original maps and charts that were submitted to the pantogravers for production on copper, it is remarkable how few of them were free from distortions.

The four arms of the Pantograver are connected with ball-bearing joints. The joints, and the diamond reproducing point, are centered on the arms so as to prevent torsion strains and deflections. The diamond reproducing point is set in a shaft, and raised or lowered by mechanism controlled at the tracing point. Suspended over the diamond reproducing point, there is a series of five weights of different sizes which can be made to rest accumulatively on the reproducing point so as to produce lines of any desired width. Once the desired width of a line has been determined, the number of weights that produced it will always produce a like width line whenever desired. By increasing or decreasing the weights upon the reproducing point, at proper intervals, the various widths to indicate properly a river or stream are easily produced. Where a constant width of line is required, such as in contours, the series of weights is an absolute assurance that the line can always be produced at the width desired. The control of the series of weights is also at the tracing point. The tracing point is used to trace the hydrographic, topographic, and culture features of a map or chart, such as coast lines, rivers, contours, railroads and buildings.

For letters, soundings, and symbols, the letter and sounding engraving attachment is used. One part of the attachment is a small reducing type of pantograph with a diamond reproducing point. It is adjustable to five different ratios of reductions that produce eight, nine, ten, twelve and fifteen gauge letters from letter patterns that are seventy-five hundredths of a centimetre in height. The other part of the attachment is a bracket with a holder that has a revolvable disc on which is placed the sounding or letter patterns. Fastened to the anchor head of the pantograver and attached to the disc, there is a mechanism which keeps the center line of the patterns at the desired angle, regardless of the movements of the main pantograver. The entire letter and sounding engraving attachment is so secured to the main pantograver that its diamond reproducing point is directly under the reproducing point of the main pantograver, when the tracing point of the attachment pantograph is on the center of the disc. The relativity of the center of the disc and the reproducing point of the main pantograver is always the same.

The location of the work to be produced by the attachment is determined by positioning the tracing point of the main pantograver at the desired sound-

ing, symbol, or lettering on the copy. The main tracing point is held in place by a lever controlled weight while the attachment pantograph is used to cut in the soundings, symbol or lettering. With the letter patterns in place upon the disc, the center of the sounding, or symbol, or the beginning of a name, is at the center of the disc. As the tracing point of the attachment pantograph is moved away from the center of the disc when following the groove of letter patterns, so does the reproducing point of the attachment pantograph move away from the reproducing point of the main pantograver. When the attachment pantograph is in position, the reproducing point of the main pantograver is lifted to a higher elevation and housed so as to permit clearance space for the attachment pantograph.

Such hydrographic or topographic features that can not be produced by the pantograver or the attachment are engraved by hand. They are sanded beach, coral reef, bluffs, and all lines that are indicated by a dot or dash system such as fathom curves. Where such features are to be hand engraved, their positions, or outlines, are lightly pointed in on the copper plate by the pantograver. A copper chart plate is from seventy to ninety per cent finished when it leaves the pantograver. Pilot chart data is from ninety-five to one hundred per cent finished.

The yearly average of hand engraved new copper chart plates for the nine fiscal years previous to the advent of the Pantograver was twenty. The most in any one of those years was twenty-eight. For the fiscal year 1923, with one experimental pantograver, the total for hand engraved and pantographed charts was thirty-four new copper chart plates. For this past fiscal year, 1926, with two improved pantogravers and a personnel of three to operate them, the total for hand engraved and pantographed charts was sixty. With the increased production of copper chart plates, there is increased accuracy, increased neatness, and an absolute standard of gauges and styles for letters, figures and symbols.

The tracing of hydrographic and topographic features, and the following of the grooves of soundings, symbols, or letter patterns, does not require the artistic ability of a highly skilled draftsman, but it does require the knowledge and experience gained in elementary drafting work. A cartographic engineer, who has had field surveying experience, is the best possible person for operating the Pantograver. It does require a man with such technical education and training to properly supervise the work of it.

The map or chart to be reproduced on copper by the pantograver method need not be the finished original prepared by a cartographic engineer and drawn by a draftsman. Survey sheets, maps, and charts of various scales, can be compiled directly on the copper plate by the pantograver method and produced as a finished map or chart, with the exception of such hand engraving as may be necessary. As an illustration of what can be accomplished with the Pantograver, during the past July there was produced, eighty per cent finished, an engraved chart plate from twelve maps or charts of five different scales. The largest scale was $\frac{1}{5{,}000}$, the smallest $\frac{1}{40{,}000.}$ The scale of the chart

produced was $\frac{1}{20,000}$. Another example was a topographic map that was produced by the pantograver method directly from twenty-three plane table survey sheets. The triangulation control of the area was plotted upon the copper plate and the different plane table sheets were accurately adjusted to that control. Without the aid of the compensating device, perfect adjustment could not have been made.

As an example of how expeditiously a new chart can be published by the aid of the Pantograver the following facts are set forth. On 10 September, 1926, the field sheet of the hydrographic survey of Port Matanzas, Cuba, was received from the survey ship, U.S.S. NOKOMISS. On 24 September, 1926, the pantograver part of the work was finished and the chart was published before 1 November, 1926.

The data for the map, or chart, to be produced on copper are photographed to about two and a quarter times the scale on which the finished map or chart is to be. The glass negatives become the copies from which the map or chart is traced. The copper plate is prepared by having the computed projection lines lightly pointed in. After the plate has been thoroughly cleaned, it is covered with an acid proof ground and placed in position under the diamond reproducing point of the main pantograver. The intersections of the pointed-in projection lines are visible through the ground, and they are used to position the glass negatives, after the pantograver has been set for the proper ratio of reduction and compensation.

In order to produce a map or chart with the same degree of accuracy as that with which the survey was made; the plane table maps of a topographical survey, or the field sheets of a hydrographic survey, are more desirable to work from than the office compiled original. If the plane table, or field sheets have become distorted due to weather conditions, their dimensions are automatically restored by the compensating device. If the names and notes on them are of sufficient legibility to be read, the lettering can be produced on the copper plate in the gauge and style desired.

The work of etching the copper plate does not require skill or special qualifications. A wax bank is placed upon the edges of the plate so that the acid can be flowed upon the work that has been produced. With diluted acid, three parts water and two parts perchloride of iron, it requires fifteen minutes to etch. The work that has been etched is finished and does not require touching up or trimming.