THE MECHANICAL PRODUCTION OF PLATES FOR PRINTING CHARTS

In an article "Die Mechanische Herstellung von Kartendruckplatten und ihre Bedeutung" published in *Dr. A. Petermanns Mitteilungen*, December 1928, page 323, on the occasion of the 70th anniversary of Albert PENCK, Dr. Hans H. F. MEYER, cartographer of the *Institut für Meereskunde* in Berlin reviews the various modern means and methods for the mechanical production of plates for printing charts.

This very well documented article to a great extent supplements the descriptive articles on this subject which have appeared in various volumes of the *Hydrographic Review*. In particular a number of bibliographic references are given on this question and it appears that a review thereof would be opportune. The reader is referred to Dr. MEYER'S original article for more detailed information.

The materials employed for chart plates may be metal (copper, steel or zinc) or lithographic stone of calcareous schist. For engraving on stone direct use is made of steel points variously ground. For metal engraving, and primarily for engraving on copper, use is made either of graving tools (burins) of various shapes (blunt for thick lines, narrow for fine lines, rounded for curved lines, double for double lines, etc.), or sharpened steel punches (for topographic symbols and numerals), the outlines of which are cut into the copper by light taps of a hammer. For the production of dotted lines use is made of spur-wheels.

When the fair sheet has been completed by the cartographer it is the task of the engraver to give the work an artistic appearance. This is easily accomplished on stone which is softer than metal and where a single passage of the engraving tool generally suffices; but the procedure is more complicated in engraving on copper because the metal is fairly tough and it is necessary to cut the lines in both directions in order to obtain the desired depth.

The photomechanical methods (heliogravure, photolithography, photoalgraphy, photozincography, etching on copper and zinc plates with acid) permits the plates to be produced with great rapidity without requiring the professional skill of the engraver, but on the other hand such processes necessitate very careful work on the part of the draughtsman.

A disadvantage in the use of photomechanical methods is that the plates thus produced do not easily lend themselves to corrections of the charts. But this remark does not apply to the heliogravure process, though it has the fault that the plates being of very soft electrolytic copper will not stand much pressure.

The fact that it is possible to make an almost infinite number of corrections on directly engraved plates, and particularly on copper plates by means of galvanoplastic deposit, has resulted in their adoption by the larger Hydrographic Offices and the cartographic Institutes of the various States in spite of the onerous and laborious work involved in their preparation. The Offices publishing charts, in particular, make almost exclusive use of copper engraving owing to the corrections which must be made almost daily to keep these documents up to date.

The drawing of letters and conventional signs is so frequent on charts that the question of producing them automatically by means of machine was early considered with a view to ensuring the necessary uniformity in appearance. In fact, a glance will reveal differences in the heights of the letters of 0.1 $^{m}/_{m}$ and slight modifications in the design of the symbols drawn by hand. Above all the engraving of letters absolutely necessitates the use of machines.

Thus the German Admiralty has six machines for engraving charts: one machine for engraving straight lines of any width, one machine for dividing scales of charts, one machine for shading the scales, one machine for engraving the soundings, and the nature of the bottom, one machine for engraving the compass roses and another for the ground tints.

Among other Hydrographic Offices which use engraving machines may be mentioned: the United States of America, Great Britain, Japan, the Netherlands and the Topographical Services of Norway and Denmark.

These machines may be divided into two groups :—

A) Stamping machines, which can only be employed on copper plates;

B) Engraving machines fitted with a pantograph, which may be employed equally for copper, stone or glass.

A. *THE K. PETERSEN STAMPING MACHINE.*

This is the Autoengraver, of which a description and explanation of the method of operation were given in *Hydrographic Review* Vol. V, N° 1, page 41.

The type and dimensions of the characters have no influence on the efficiency of production. In a period of eight hours of steady and regular work a production of about 1,800 numerals and characters may be expected; that is, for small characters the production is about six times that of hand work and for large characters about ten to fifteen times. The burrings (*i.e.* metal thrown up) have to be eliminated.

With the machine in use till now in the Norges Geografiske Opmaling, charts N° 229 and N° 325, on which are 1,300 and 440 names and 14,200 and 130 numerals respectively, have been made. The appearance of the letters is equal in every respect to those of a copper engraving. It is evident that the machine may also be employed in the case of names with letters on a curve, since the platform of the machine is movable about a vertical axis. Incidentally the machine may also be used for photolithographic reproduction, by fitting an inking device to the disk and printing on the drawing the figures, names and signs desired. During an efficiency test this machine was able to engrave 30 names, comprising 239 letters, and 31 numbers, comprising 64 figures, in 80 minutes.

B. *PANTOGRAPH MACHINES.*

Pantograph machines give a reduction from a model or uniform pattern which is outlined by a control point. Every kind of symbol or of continuous lines or of letters may be easily drawn up as a pattern; the pantograph guarantees absolute uniformity and conformity with the pattern, over the entire cartographic documents.

On lithographic stone these machines produce the finished work, for, owing to the softness of the material, the diamond point of the machine leaves a cut as deep as that of the graver in the hand of the lithographer. On the more resistant copper-plate either a mark is made by the machine which is subsequently gone over by less experienced engravers to obtain the desired depth for printing, or the copper plate is covered with a protective coating which is cut through when engraving. After this a solution of perchloride of iron ($Fe\,Cl^2$) (See *Hydrographic Review* Vol. I, N° 2, page 27; Vol. IV, N° 1, page 33) is spread over the plate which eats into the parts which are bared, thus the lines on the plate are deepened. The lines thus obtained, when viewed under the microscope, resemble more nearly those obtained by heliogravure, the edges being more or less roughened.

Perhaps it might be possible to engrave directly on copper by replacing the engraving tool by a very fine electrically driven milling cutter. In order to avoid vibration in the machine the motor might be suspended as are those of dentists' drills.

Among these machines the following may be mentioned :—

1. *The Ourdan Machines for Engraving Soundings:* invented in 1893 by V. L. OURDAN of the Hydrographic Office in Washington. A description of this machine is given in *Hydrographic Review*, Vol. I, N° 2, page 35 and Vol. II, N° 2, page 43.

An improved model of this machine was constructed in 1924 in the shops of the Naval Gun Factory at Washington. A description of the machine is given on page 11 of the Annual Report of the Hydrographic Office of Washington for the year 1924. The spacing of the letters is done automatically; the machine is capable of engraving negatives on glass and may be operated either by one or two operators.

2. *The Axelholm Engraving Machine.* — This machine, for engraving letters, was invented in 1903 and is constructed by the Axelholm Aktiebolaget of Copenhagen.

A description and the method of use are given in a pamphlet entitled: *Anleitung zum Pantogravieren mit der Axelholmschen Graviermaschinen,* Copenhagen 1923.

This machine is composed of a table to which is attached an ordinary pantograph. A block is situated on this table; it may be moved horizontally and vertically by means of endless screws, and the plate or stone to be engraved is attached to it. The machine is capable of handling stones up to 100×100 ‰ and 9 ‰ thick, or copper plates of 110×110 ‰. In this machine the block is movable about its own axis. The control point is moved by the engraver over the metal patterns which are about ten times as large as the letters desired, thus even an inexperienced operator can obtain perfectly uniform results.

The reducing point of the pantograph is a threaded shaft into which a small bit with a diamond point is screwed. When not in use the diamond is held about 1 ‰ above the plate to be engraved. During the work the diamond is loaded with fairly light weights.

The machine is in use at the Topographical Institute at the Hague and at the *Danske Topografiske Afdeling* at Copenhagen. In the Netherlands it is used to engrave lithographic stones and in Denmark it is employed for engraving copper plates, as well as stone.

3. *The Ross E. Gray machine for engraving letters* (1923 *model*). — *Hydrographic Review*, Vol. II, N° 2, pages 44 to 49 gives details of this machine.

4. *The Pantograver (Lamp-Larrabee) of the United States Hydrographic Office, Washington* 1923. — The articles contained in *Hydrographic Review*, Vol. II, N° 2, p. 50 to 55 and Vol. IV, N° 1, p. 34 to 37, give information pertaining to this machine.

The results obtained on stone with the machines constructed on the principle of the pantograph are comparable in all respects with hand engraving. When stamping machines are used on copper, the results are also identical with those given by engraving on this metal. The same is true with the pantograph apparatus *after subsequent graving to deepen the cuts*; in this case, however, part of the time gained is lost.

When the deepening of the lines of the engraving is accomplished by etching with acid, the fineness and sharpness of hand engraving is not obtained (the result is more like heliogravure); the superiority of direct engraving is not evident except with deep incised engraving.

The direct use of copper or lithographic master plates for printing, requires fairly laborious preparation. A hand press is required and the number of impressions per hour is reduced to about ten copies, which involves an increase in the sale-price.

In Germany the practice of making direct impressions from engraved copper cartographic plates has nearly ceased, and generally transfers are used by which the cost price of a large number of prints is reduced by 86 %. The Marineleitung itself has commenced to publish German Admiralty charts made by transfer; however, in view of the limited number printed they are only about 20 % cheaper than impressions pulled direct from copper plates. There is little probability, therefore, that these will replace on a large scale the editions printed directly from copper plates which are clearer and more durable.

The Hydrographic Office of the United States of America, on the contrary, having a very large distribution of its charts, is employing transfers more and more. The Annual Report of this Office for the year 1927 states that only 263 charts were printed directly from copper plates.

Apart from the financial economy obtained by the use of engraving machines, Dr. Hans Meyer asserts also that mechanical processes go far to remedy the lack of expert engravers possessing the high artistic attainments required for hand engraving. The Hydrographic Offices have suffered from this lack of skilled engravers, for nowadays especially it is difficult to recruit competent young cartographic engravers and certain Offices, such as the Japanese Hydrographic Office and the German Topographic Service, have been compelled to establish special schools for cartographers and chart engravers.

By employing machines for engraving new charts, and thus avoiding having recourse to expert engravers, the latter are freed to do work which the machine is incapable of executing, such as the art of engraving the hachuring and the making of corrections. These latter, on account of the rapid changes which occur in civilized countries, are daily becoming more frequent As early as 1918 the Military Geographic Institute of Vienna employed copper engravers exclusi-

vely for making corrections. Revision becomes necessary every ten years for topographical maps and for many years past marine charts have had to be kept up-to-date permanently to meet the requirements of safe navigation.

Several years are required to engrave a chart by hand, so that unless constantly kept up to date, the data given by the chart are out of date by the time the sheet is published. For this reason, in the case of much used charts the Marineleitung, for instance, has found it necessary to issue a provisional photolithographic edition in advance of the edition printed from the copper plate. However, this method, which requires very careful preparation of the fair-sheet from the point of view of drawing, is onerous and involves unnecessary loss of time.

Production is greatly accelerated by the use of machines and it is no exaggeration to state that it may be doubled without increase in personnel. (See Annual Report of the U. S. Hydrographic Office for the year 1927). The practical efficiency of the machines themselves may even be further improved in detail, as has been proven by the fruitful experiments made by the Hydrographic Office of the United States.

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