CHART — PLATES.

ENGRAVING, CORRECTION AND REPAIR.

On 20th December 1922 the Bureau issued a Circular-Letter (N° 49 of 1922) inviting the Members to supply any information available on the following subjects : —

(a) the perfection of a satisfactory mechanical method for the execution of copper-plate engraving,
(b) the effective repair of a cracked copper-plate, and
(c) the permanent retention of copper inserted into a copper-plate where a hole may have become formed owing to excessive correction in one place.

Replies have been received from more than half of the total number of Members and the following gives a summary thereof : —

Chile.

The Director of the Office of Hydrography and Navigation informs the Bureau by letter dated 27th January 1923 that : —

(Translation from the Spanish text).

(a) For engraving a copper-plate an engraving tool and steel points are used, and for transfers the celluloid process.

For engraving soundings, frames, shading of scales and land-tints a set of machines is used.

(b) For corrections on plates the followind method is used : —

The condemned portions are marked out on the back of the plate by means of lamp-black, then by beating with a light hammer, the plate being on an anvil, the face is brought up even with the engraved face.

(c) With respect to this matter we have no experience for, so far, in no case has it happened that any pierced plate has had to be repaired.

Denmark.

The Hydrographer of Denmark, writing on 30th November 1923, informs the Bureau that his Office : —

(a) does not use any mechanical method for the execution of copper-plate engraving;

(b) and (c) has no experience in the repair of a cracked copper-plate or in the permanent retention of copper inserted into a copper-plate, when a hole may have become formed owing to excessive correction in one place.

DESCRIPTION OF A GALVANIC APPARATUS AND A CUTTER-FILE USED BY THE DANISH HYDROGRAPHIC OFFICE.

Fig. 1. Shows the motor and dynamo, supplying the current, and the precipitation apparatus.
a. Copper plate.
b. Glass cylinder filled with sulphate of copper (Cu S O4) dissolved in water to 20 or 22 Beaumé (i.e. specific gravity 1.1738).
c. Anode. The distance of this from the copper plate is about 10 cm.
d. Motor.
e. Dynamo.
f. Resistance.
g. Starter.
h. Plate with safety plugs, switch, ammeter and voltmeter.
The glass cylinder is made tight on to the copper plate by means of wax.
For 1 square decimetre of plate a current of 2 ampères is used, by which 2 grms. are precipitated per hour.
Any part of the copper plate, inside the glass cylinder, on which no precipitation should take place, is coated with acidulous asphalt dissolved in turpentine.

Fig. 2. Shows the cutter with its guide-block and base as well as the motor.
a. Cutter.
b. Adjusting screw for raising and lowering the cutter.
c. Guide-block.
d. The handles of the guide-block.
e. The base on which the guide-block is moved backwards and forwards, so that the cutter is passed over the precipitated copper and grinds this off. As the copper is ground off, the cutter is screwed down gradually little by little by means of the adjusting screw b.
f. The copper plate.
g. Motor (3000 revs. per minute at least).

Fig. 3. Shows the cutter with its guide-block as well as the base on a large scale. The base is raised on its side with the underside forward. The three dark squares are pieces of leather, on which the base rests on the copper plate and the friction thereof is sufficient to cause the base to remain fast on the copper plate while the guide-block, with the cutter, is moved backwards and forwards on the base.

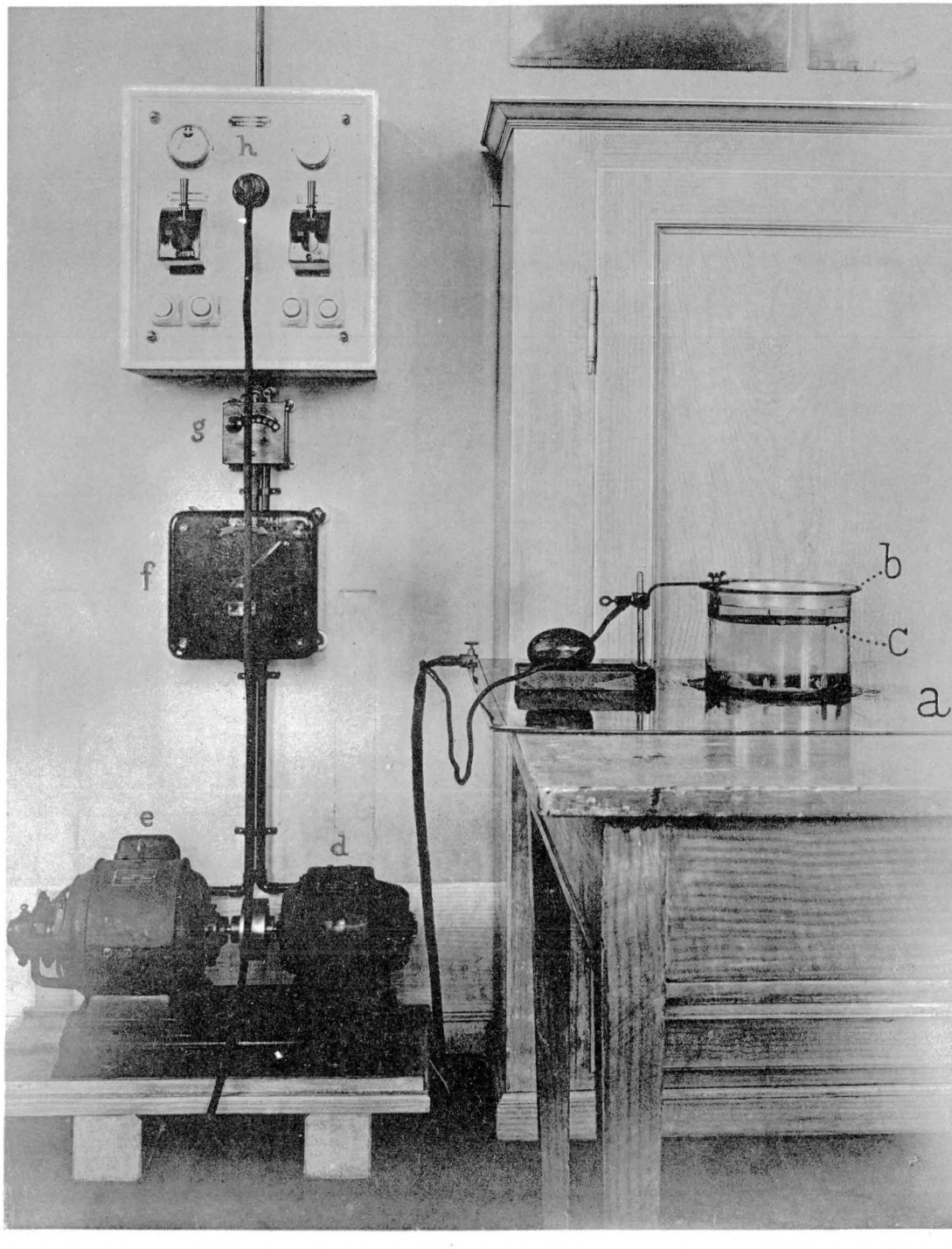

Fig. 1.

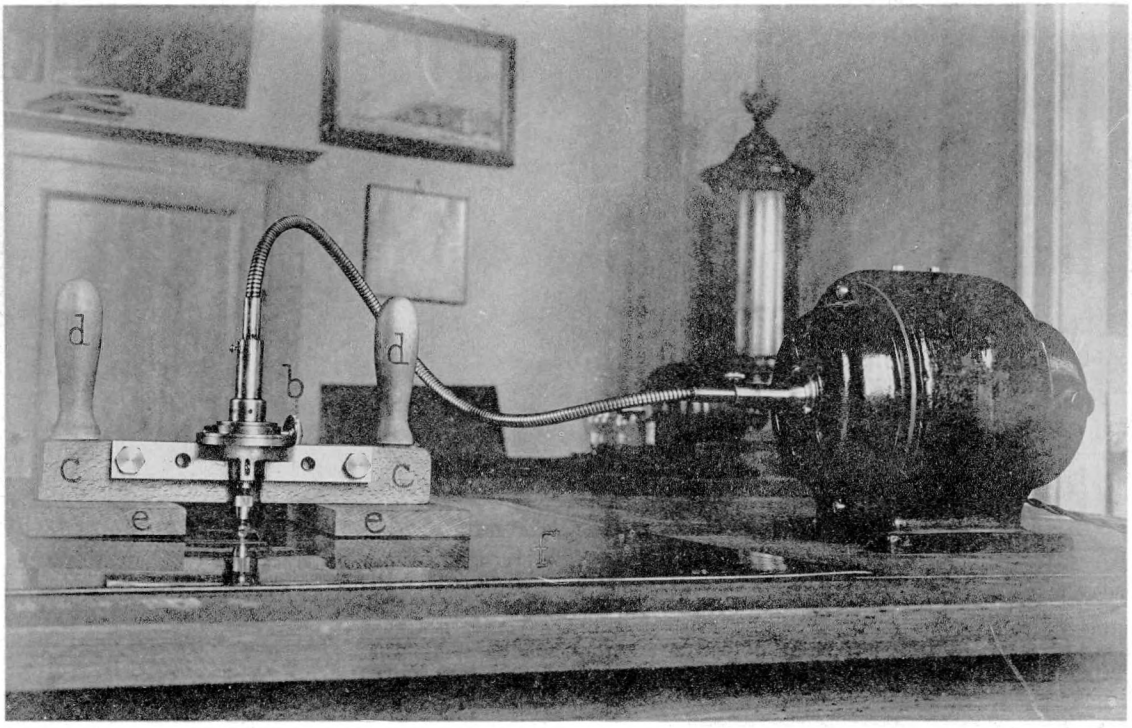

Fig. 2.

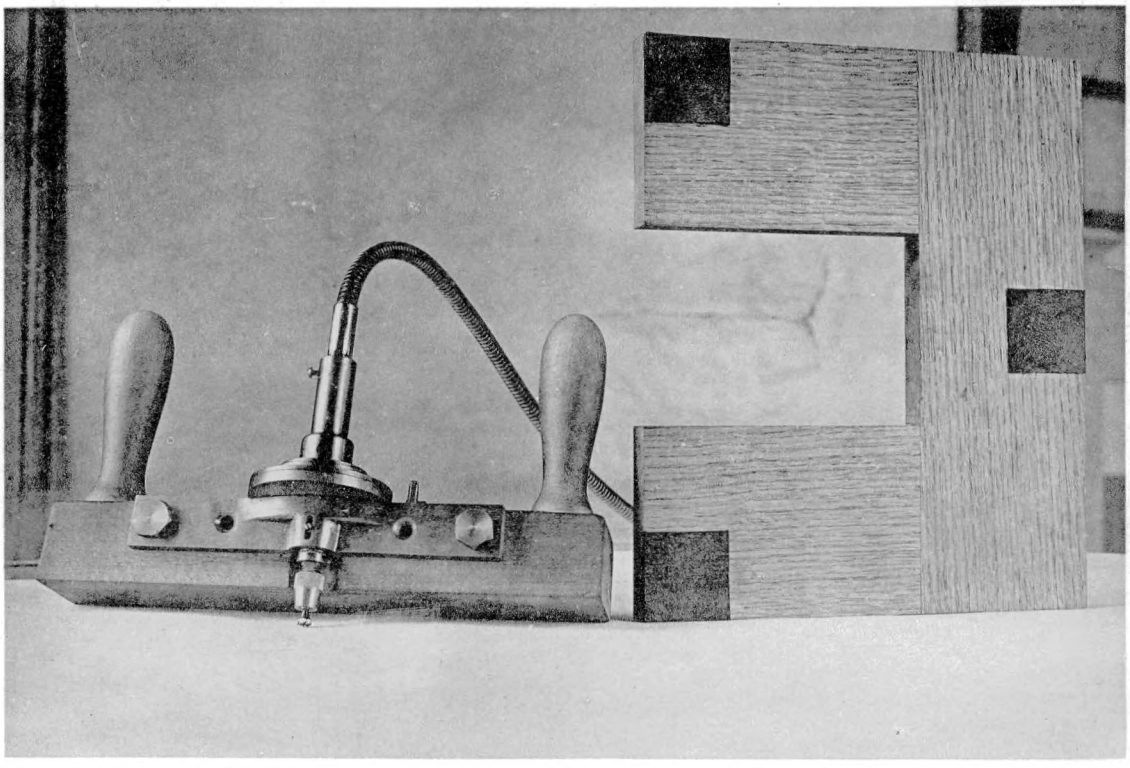

Fig. 3.

France.

The Director of the Hydrographic Service, under date 12th January 1923, informs the Bureau of the following : —

(Translation from the French text).

(a) Our Service is now perfecting a method of engraving copper-plates, up to Double Elephant size, by means of chemical solvents, from a tracing in black. This method entails three operations : —

1st. — A sheet of commercial gelatine is sensitized and then exposed in a printing frame to light passing through the tracing.

2nd. — The sheet is then stuck onto the copper-plate (gelatine to copper), which operation requires some knack, and the whole is plunged into hot water. The tracing floats off and the gelatine remains on the plate. The hot water, by dissolving the non-exposed parts in the layer of gelatine, developes therein the lines of the tracing.

3rd. — Perchloride of iron of suitable strength is then caused to act on the gelatine. It attacks first the thicker lines then the finer lines and finally, by working slowly through the exposed gelatine, it would attack the plate but its action must be arrested before this point is reached.

The results may be judged by examining the copies of charts N^{os} 2641, 3037, 5010, 5421, 5602 & 5606 which were engraved by this method.

(b) & (c) Copper-plates which have split or been holed are repaired by what is known as the galvanoplastic process.

Great Britain.

The Hydrographer has informed the Bureau by letter dated 15th February 1923 that : —

(a) The only mechanical engraving used on British Admiralty Charts is for ruling, tinting and sand dotting by means of the ordinary tinting machine.

(b) The following method for the repair of cracked Admiralty Chart Plates has been devised by Messrs. Malby & Sons, one of the British Admiralty Contractors, which firm has used this method for the last four or five years with very satisfactory results, viz : —

METHOD OF REPAIRING CRACKED PLATES.

1. Cut out an oval round the crack and, from the back of the plate, gradually shelve off from say one inch round the opening to as thin as possible at the edges ; solder a thin piece of sheet copper on the front of the plate and grind off on the inside, i. e., from back of the plate, until a perfectly smooth joint is made.

2. Solder on the connections for suspending the plate in the baths.

3. Boil out the plate in a potash bath, wash off, further clean with whiting, and flush with nitric acid solution — 1 part to 6 ; wash this off quickly.

4. Coat the engraved surface of the plate with a thin coating of cyanide of silver and then render the silver "spongy" by rubbing over with a pad moistened with iodine.

5. The surface (engraved) of the plate is then coated over with beeswax applied hot, leaving open those parts on which a deposit is to be made.

6. These parts are again cleaned with whiting and flushed quickly with nitric acid, and the plate is then plunged quickly into —

Bath nº 1 (consisting of a cyanide of copper solution) for a few minutes (say 2 or 3) when the coating should be perfect. Voltage 5 or 6.

7. The plate is washed once more, flushed over with nitric acid, and plunged into —

Bath nº 2 (consisting of a sulphate of copper solution) and allowed to remain until the desired thickness is obtained. Voltage 1 or 2.

N. B. — It is desirable to keep the current on continuously day and night, until the plate is finished.

8. The plate is then washed off and dried, and the wax removed. The piece of thin sheet copper soldered on to the front of the plate is then ground off until the new deposited metal is reached, then the plate knocked up in the usual way from the back.

9. The edging of the deposited metal is rough and irregular, and is ground off : —

(1) by a rotary cutter to remove the roughest parts ;
(2) by a carborundum wheel running on a flexible shaft at say 2000 — 3000 r.p.m. ;
(3) by a finer emery wheel ;
(4) by the ordinary polishing mop.

10. A suction plant is necessary to carry off the fine copper dust caused by the grinding wheels.

11. The plate is then tested by running it through press several times at dry proof pressure.

SOLUTIONS.

Cyanide of silver — purchased in the open market already made up.
Bath nº 1.
Cyanide of copper solution — Solution as made by Messrs. W. Canning & Cº.
Bath nº 2.
Sulphate of copper solution : —
2 lb. 2 oz. to 1 gallon of water, add 4 to 5 ozs. Sulphuric acid to each gallon.
Potash Bath — Saturated solution of American Potash and water.
Temperature of Bath nº 1 (cyanide of copper bath) 80 to 85 degrees (F.).
Temperature of Bath nº 2 (sulphate of copper bath) 65 degrees (F.).
The temperatures of the baths should be kept constant.
Some form of agitation is necessary for Bath nº 2 (sulphate of copper bath) but Bath nº 1 (cyanide of copper bath) is not agitated.

It should be observed that this information has hitherto been kept secret by Messrs. Malby & Sons, and that in the event of others using this process it may be necessary to consider whether some remuneration, to be arranged, should be made to this firm for the work and expense involved in working out the process.

(c) Trial has been made of the method of inserting copper into a copper plate hole formed owing to excessive correction in one place, but the results so far have not been satisfactory.

A method of depositing copper in the engraved cuts, instead of erasing the work from the copper plate, has however been tried recently and appears to be a success.

Italy.

The Director of the Royal Hydrographic Institute wrote on 2nd January 1923 : —

(Translation from the Italian text).

(a) Engraving of plates, when not done *by hand*, is carried out either *by galvanoplastic photogravure* or by *chemical photogravure*.

Both of these methods give satisfactory results.

The more accurate results are obtained by galvanoplastic photogravure but on the other hand chemical photogravure can be done much more quickly.

(b) If a crack appears in an engraved plate this accident has nearly always been met by taking a galvanoplastic cast of the plate and from this, after scraping and cleaning off the raised ridges due to the cracks, a new and perfect female cast is made.

Plates have been repaired, but only rarely, by galvanoplastic precipitation of new metal over the crack and retouching the area affected.

(c) So far it has never happened that a hole has been formed in a plate on account of much correction in one spot. However, frequently a deep cavity has formed for this reason on the back of plates.

This also has been remedied by galvanoplastic precipitation of new metal in the cavity.

Japan.

In a letter dated 17th February 1923 the Hydrographer informs the Bureau that : —

(a) This Department is very anxious to perfect, or to have information about, some satisfactory mechanical method for the execution of copper-plate printing.

Machines now in the practical use of this Department are as follows :

1. A "machine à griser" (dotted line engraving machine) which has been used since 1878, when it was bought from Holland.

2. A machine for engraving and lettering compass roses made by Queen and Company, U. S. A.

3. A border ruling and tinting machine.

Besides the above, this Department has a machine for engraving soundings. But this one is of little practical use and more study, it is considered, is necessary to improve this work.

(b) This Department has had very few opportunities of having copper-plates cracked.

(c) In case a hole has been formed on a copper-plate by excessive correction in one place, it is the practice of this Department that either some pieces of paper of suitable dimensions are pasted, or moderate knockings are given, on the back of the plate, at the portion where the hole exists, so as to keep the whole printing surface of the plate even.

This Department has no experience of having copper inserted into such a hole in a copper-plate.

The following has been extracted from the publication entitled. "The Japanese Hydrographic Department". (*see* page 185).

1. Copper-Plate Printing.

Formerly only the Dutch etching process on copper was in use at this Office for chart preparation, whereas copper-plate engraving came into use in 1907 for the first time. These two processes were solely used together until 1915, when the development and extensive use of an etching process with photographic application had relegated these processes to some special charts and small amendments only. In this etching process with photographic application, a print was, prior to etching, to be made on the sensitized surface of copper-plate by exposure to the sun together with a positive plate obtained by photography from an original chart. Since 1918, a more developed process has been in use in which a print on the sensitized surface of copper can be obtained, without requiring any positives, by exposing it to the sun together with a semi-transparent paper original chart.

On the other hand, electro-type printing and copper-plate printing by transfer from lithographic stone were also used on a small scale; and, to cut such figures as compasses, scales in border lines, or shading of land, some instruments have been used.

2. Lithographic and Zinc-Plate Printings.

In this Office, lithography was in use for chart publication for years, from 1879 to 1915, and was regarded as essential for quick preparation, although it was not able to supplant copper-plate printing which had superiority in clearness of print. The lithography in the use of this Office was that of the transferring method, except for a short period in the early days when actually drawing process was used.

On the other hand, zinc-plate printing was investigated from 1894, and aluminium-plate printing from 1905, and, while the latter proved to be of no practical use, the former made so great a progress in 1914 that lithography was entirely replaced by this in a single year. But the development was still remarkable after that; in 1915 it became possible for the figure of chart to be produced on zinc-plate from the negative plate which we obtained by photography from copyfaired original chart, and since 1919 the work has been produced on zinc-plate directly from the copyfaired semi-transparent original chart. The latter process, producing positive figure from positive work, affords excellent clearness to charts and is most chiefly used at present.

3. In a word, both copper-plate and zinc-plate are now prepared in this Department, that is, charts are first produced by zinc-plate, and afterwards engraving on copper is, if necessary, commenced. To state more fully, it is a custom of the Department to preserve zinc-plate as the fundamental, and not to prepare copper-plate unless it is either of very complicated topography or of perfectly detailed survey.

As to presses, copper-plate printing presses were used from the early days, while lithographic ones were introduced later on. At present, prints are generally obtained by zinc-plate printing or zinc-plate printing by transfer from engraved copper.*

As chart paper requires moderate tenacity and less liability to contraction and distortion, offset printing is preferable to direct printing; this Department, therefore, has used it since 1912.

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* Note by I.H.B. — The meaning of this phrase does not seem very clear.

Netherlands.

The Hydrographer informs the Bureau that his Office was studying, in December 1922, a method of filling up engraving on copper plates by means of electro-deposit of metal instead of the system of scraping down the face and hammering up the back.

The work was being carried out by some German firms but, up to the date of the report, only one plate had been completed. The Hydrographer adds : —

"In our short experience it gives satisfaction".

Sweden.

The Hydrographer writes, under date 5th January 1923 : —

(a) that no satisfactory mechanical method of engraving copper-plates is known in this Office,

(b) that no method of repairing cracked copper-plates is practised here,

(c) that, for extensive corrections in the copper-plates, this Office, for several years, has made use of electrolytical deposits, executed in accordance with the method described below.

It may be mentioned also that, for corrections, extending over the whole area of a copper-plate, an electrolytic replica (negative) of the plate is made by a galvanic plant. In this replica the lines and figures are in elevation and can be erased easily, whereupon a replica is made of the negative just mentioned. On the second replica, which is a positive, the erased areas are now free from engraving and the corrections can be inserted by engraving.

It is believed that for filling holes produced by over-correction also, galvanic deposit would give good results.

AN ELECTROLYTIC METHOD OF DEPOSITING COPPER ON ENGRAVED COPPER-PLATES.

First, that part of the copper-plate to be corrected is cleaned by means of a solution of 7 per cent potassium-hydrate, which must lie on the plate about 45 minutes in order to remove all grease. The plate is then carefully cleaned with a soft brush and whiting.

After this is done, the area which does not require to be corrected is covered with asphalt varnish and the borders of this covered area are coated with wax and walled with plastic clay.

In order to get the area containing the intended erasure absolutely clean a solution of 100 grammes of 92 % sulphuric acid in 1000 grammes of water may be poured over it and then carefully washed away ; the cleaning-process is finished by pouring on a solution of 200 grammes of 65 % nitric acid, 100 grammes of 92 % sulphuric acid, and 2 grammes of common salt, which is washed off after a little while.

Alternative process. — Cover the copper-plate with a thin film of asphalt varnish. This being well dried, the parts of the engraving to be corrected are erased with a graver. It is necessary that the graver be absolutely free from oil or grease. The borders of the area to be corrected are covered with wax and walled with plastic clay.

One of these alternatives being completed, proceed as follows : —

Into the walled area pour a solution of sulphate of copper and sulphuric acid, which is prepared in the following manner : — a bag containing sulphate of copper is immersed in a glass pot filled with water. In 2 or 3 days the solution has reached a sufficient concentration (specific gravity 1.185). This solution is mixed with another consisting of 1 part of 92 % sulphuric acid in 8 parts of water in such a way that 3 parts of the copper sulphate solution are taken with 1 part of the sulphuric acid solution. The mixture thus obtained (specific gravity 1.165) must be filtered carefully and is then ready for use.

The electric current can of course be taken from a generator but in this Office galvanic batteries are used for correction-deposits. Small unglazed pottery pots — the number dependent on the size of the area of precipitation — are placed in the copper sulphate solution on the plate. Into these pots is poured a solution of 20 drops of sulphuric acid in 1 litre of water with a zinc rod as electrode. The battery circuits are closed by copper wires connecting the dry ends of the zinc rods and the copper plate. It is of importance that the contact areas be well cleaned.

For taking galvanic replicas of copper-plates the current may be a transformed lighting-current.

As the method of making corrections described above has not always proved entirely satisfactory, experiments are being made at the present time with current taken from an accumulator battery, and if desired, further information regarding the results of these experiments can be given later.

United States of America.

The Director of the Coast and Geodetic Survey states by letter dated 15th March 1923 that : —

(a) The Coast and Geodetic Survey has not perfected any mechanical methods for the execution of all details of copper-plate engraving. We do, however, use a number of mechanical means and devices, of which the following may be noted :

Ourdan Sounding Engraving Machine (which engraves soundings and bottoms), Grays subdividing device for border scales, roulettes for engraving the edge of sand stipple, roulettes for bluffs, sand dunes, etc. ; roulettes for fathom curves ; punches for marsh tufting and for marking buoys, etc., railroad tie marker, ruling machines for marsh symbols, tinting, etc.

We also use a photographic process for transferring the work from the drawing (or compilation sheet) to the copper-plate.

We have recently been experimenting with an electrolytic process for filling in engraved work, or making erasures rapidly on copper, where corrections are to be made. This process was invented by Mr. W. E. Bailey, of the U. S. Bureau of Standards, Washington, D. C. and the results so far have been very encouraging.

Mr. Bailey, in his experiments, had the cooperation of the engraving and electrotype sections of this bureau.

These experiments led to the adoption of an interesting, and it is believed novel, adaptation of the galvanoplastic method of electrotyping, by means of which it is possible to remove quickly small or large areas from the surface of the plate to the depth of the engraved work.

An electrode is inserted in the nozzle of a hose through which a solution of copper sulphate is thrown under pressure against the plate on the area where the

correction is to be made. An electric circuit from a generating source is formed between the plate and the electrode in the nozzle, through the stream of solution impinging on the plate. A current pressure of from 12 to 15 volts has been found satisfactory. This voltage is far in excess of pressure ordinarily used in depositing copper, and the action is very rapid. By making the plate the positive electrode, copper is removed from it to any desired depth. The cut portions of the plate are not affected since they are filled with ink or any non-conducting substance.

By this erasing method a depression as deep as the engraved lines is made. By the use of a hammer on the back of the plate the depressed area may be leveled with the surface and, after polishing, the plate is ready for the application of new work.

Although the solution after striking the plate flows over it, the only point affected is that against which the stream is directed. Small areas of the surface are quickly removed as the engraved lines are not cut deeply.

The removal of about one twenty-fifth of the thickness of the plate usually erases all work likely to need correction. After this depression is transferred to the back of the plate by bumping up, it may, if desired, be filled in on the back by using the same process with the direction of the current reversed.

As indicated above, the electrolytic action is rapid. An area about 2 inches square can be removed from a plate to the depth of the engraving in six minutes.

The Ourdan Sounding Engraving Machine.

This machine may be generally described as follows : —

A bar runs on tracks. Attached to the bar is an engraving head and near this are devices for moving the engraving point to any position over the plate to be engraved. The engraving point has a weight attached to it which presses this point into the copper. The shape of the sounding is controlled by a stylus, guided by the hand of the operator along the lines cut into a pattern disk.

The bar is hollow and contains the rack which moves the engraving head laterally along the bar. Attached to the bar are quick motion and slow motion gears. Gears move the bar along the tracks. Other gears move the engraving head along the bar by means of the rack. The slow motion of the gear just mentioned is used principally for spacing between soundings. By means of the vertical motion along the tracks, and the horizontal motion along the bar the engraving point is brought into its proper position.

Engraving is executed as follows : —

The Copper-plate (with soundings and bottoms transferred to it from the compilation sheet) is made parallel with the bar by placing the engraving point in a perpendicular position approximately above the lower corner of the projection on the plate and then adjusting the plate until the point when lowered to the plate and moved horizontally will make a line coinciding with the lower "neat" line drawn on the plate. This "sets" the plate.

The nearest sounding is then selected and the engraving point is brought to a position above the sounding by means of the position finder, which moves with the engraving point, but runs along the surface of the plate.

The engraving point is then lowered to the plate by the left hand of the operator and pressed into the copper by the weight of the cylinder attached to the point. (When it is lowered to the plate, the engraving point passes through an opening in the position finder).

When the engraving point is lowered to the plate (by the left hand of operator) a stylus (in the right hand) is placed in the pattern on the disk and moved in the groove of the numeral engraved deeply on the disk. The engraving point moves with the stylus and cuts into the copper a small reproduction of the numeral on the disk.

As soundings usually consist of more than one numeral they must be "spaced". After the first numeral is engraved the engraving point is raised and the slow motion ratchet is used to move the engraving point the required space for the second numeral; the pattern disk is turned, so that the proper numeral is under the stylus when the engraving point is perpendicular; the engraving point is again lowered and the second numeral is cut.

The bottoms are engraved on the pattern disk as they appear on the chart, viz, rky, hrd, etc.; the only spacing done is between bottoms.

There is considerable "burr" thrown up in engraving. This must be removed by scraping and polishing the plate, before it is ready for printing. Some hand engraving is also necessary for finishing the bottoms.

As originally designed this machine was a pantograph which engraved on the plate a reversed copy of the original drawing. The drawing and plate were placed side by side upon the table and adjusted by the "neat" lines or projections. One operator handled the position finder over the drawing and another operator, the engraving head over the copper-plate. As drawings are affected by atmospheric conditions and practically copper is not, the required accuracy was not possible, even with constant adjusting to the projection intersections. The number of soundings engraved was no greater than if cut by hand by two engravers. The machine was then changed, so that one man could operate it, if the soundings were transferred to the plate. By use of photo matrices for transferring and with one operator, about three times as many soundings are engraved by this machine as can be engraved by hand in the same time.

Transferring by photo matrices is a great time saver. If the work on the original is open, a wet plate negative flowed with a solution of gum arabic is used as a matrix. If the work on the original is closely drawn, a positive is made from the wet plate negative and from this positive a matrix is made by coating a dry plate with a bichromate of potash sensitizer and, after development, swelling the gelatine of the dry plate in hot water.

The lines on the matrix are transferred to the copper plate by the well known wax transfer method. Wax is rolled over the matrix; then a piece of sheet gelatine (or celluloid) is placed on the wax-coated matrix and rubbed with a flat burnisher. This makes the wax on the *surface* of the matrix adhere to the sheet gelatine. As the lines are depressed in the matrix there is no wax on the sheet gelatine where there are lines on the matrix. The wax coated sheet gelatine is then placed, coated side down, on the copper plate, adjusted to the projection on the plate, and again rubbed with the burnisher. This transfers the wax to the copper-plate. The transfer then consists of a wax coating on the

copper plate where the paper is blank on the drawing. Where there are lines on the drawing there is exposed copper on the transfer. This exposed copper is stained by the fumes of ammonium sulphide. The wax coating is washed away with benzine or alcohol; and the transfer, consisting of lines, stained by ammonium sulphide, on a copper plate, is ready for engraving. The purpose of the wax coating is simply to resist the action of the fumes of ammonium sulphide, while it is staining the exposed copper, just as an etching ground resists the action of acid while it is "biting" the exposed copper where the ground has been removed by the etching needle.

Unless it is very roughly used the stained transfer will remain on the plate until the engraving is finished.

In regard to items (b) and (c), we have no trouble as we made electrotype "altos" from our plates as soon as they are engraved. If a plate cracks, a new one can soon be made from its "alto". When charts are very extensively corrected we make the erasures on the alto (erasing is comparatively simple, as the engraved work is raised on the alto) and then make a new plate from this alto. The corrections are then applied to the blank places on the new plate and a new alto is made from this plate.

I trust that the foregoing suggestions may prove of service to the Hydrographic Offices of the Associated States, and shall await with interest the receipt of suggestions from other sources which may indicate the possibility of further improvements in our own methods.

Greece, Portugal & Siam.

The Bureau is informed that the Hydrographic Services of these States do not use copper plates for charts.