"GALVANIC" ENGRAVING AND RETOUCHING

by

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(Translated from the German).

I. *"GALVANIC" ENGRAVING.*

In the *Reichsamt für Landesaufnahme* the term "galvanic" engraving is used to designate the process whereby a drawing which has been photographically transferred to a malleable and rolled copper plate is electrolytically engraved. The application of this process, which is an inversion of the usual electrolytic metal-plating process, was first proposed by the then Tech. Inspector, Oberkartograph MANGELSDORFF in 1928. After long experimentation it was found in October 1930 that the isinglass copy provided a working layer which would offer sufficient resistance to the galvanic current, and this has been employed since that time.

The details will be described later.

There was thus developed, entirely independently, a process which had been known in principle for over fifty years but which had found relatively little practical application in Germany. (1) The process was known variously as "electrolytic etching", (2) "electrolytic engraving", (3) "galvanic etching" (4) and "galvanic corrosion" (5). The idea of producing metal printing blocks by electrolyse by means of anode connections, derives from Sir Thomas SPENCER (6). Repeated references to this process are to be found in German publications (7) and numerous German patents have been granted in this field, such as D.R.P. 158, 757 (8) and 217, 771 (9). In North America and in England so-called electrolytic etching machines (10) have been developed consisting in principle of galvanic baths with equipment and transformer. One well-known English machine which is in use in Germany is the *Tintex* machine (11). In 1916 A. H. HOLT (12) called attention to the suitability of copying directly from the glass dia-positive to the metal in electrolytic etching as in the enamelling process, because, about the year 1885, the transfer to copper could only be accomplished by means of chrome-gelatine paper.

(*) See also : *Hydrographic Review*, Vol. XIV N° 2, November 1937, p. 25 et seq.

(1) The first allusion to the subject in German treatises seems to be the *Electro-Metallurgy* of NAPIER, 1851.

(2) K. ALBERT : *Lexikon der graphischen Techniken.* Halle a.d. S., 1927, publisher : Wilhelm KNAPP, p. 55.

(3) W. PFANHAUSER : *Die elektrolytischen Metallniedershläge*, Berlin, 1922, 6th Edition, Publisher : J. SPRINGER, p. 583.

(4) WEISS-SCHEER : *Die Galvanoplastik*, Hartleben Edition, Vienna, 2nd Edition, p. 237.

(5) O. VOLKMER : *Die Verwertung der Elektrolyse in den graphischen Künsten. Mitt. des Militärgeographischen Instituts*, Vienna, 1884, Vol. 4, p. 79. On the contrary, no reference to the procedure is found in the article of HÜBL : *Studiën über die Erzeugung galvanoplastischer Druckplatten* (*Mitt.* des *Militärgeographischen Instituts*, Vienna, 1886, Vol 6, pp. 51-96).

(6) *Die Elektrizität als Altzmittel.* Photogr. Chronik, 1899, N° 69, pp. 449-450.
Das elektrische Atzverfahren. Photogr. Chronik, 1899, N° 74, pp. 481-482.
Report on the two articles in the *Jahrbuch für Photographie und Reproduktionstechnik.* HALLE, 1901, p. 715.

(7) O. PRESLINGER : *Die Elektrizität im Dienste der Photographie und der graphischen Künste.* Photographische Korrespondenz, 1903, p. 68.
J. HAUBOLD : *Die Elektrizität im Dienste der Reproduktionstechnik*, Zeitschr. f. Reproduktionstechnik, 1910, p. 187.
J. BEKK : *Die Autotypieätzung in systematischer Darstellung.* Der graphische Betrieb, 1930, 5th year : October number. Edition of the Bildungsverband d. deutschen Buchdrucker, Berlin.
William GAMBLE : *Die electrolytische Atzung.* Zeitschrift Reproduktion, 1931, Part 5, p. 9 .

(8) Patent applied for the 28-10-1903, received 24-2-1905. Cl. 15b, Dr. H. STRECKER, Mayence, and Dr. O. C. STRECKER, Darmstatt. Procedure for electrolytic etching of printed characters on zinc. British patent N° 6071, 1900.
Report in the *Jahrbuch für Photographie u. Reproduktionstechnik*, 1905, pp. 468-469, and in the *Process Photogramm*, 1905, p. 101.

(9) Patent applied for 9-10-1906, received 13-1-1910, Cl. 57b, Dr. H. STRECKER. Procedure for obtaining metal printed characters by means of electrolytic etching. Report in the *Jahrbuch für Photographie und Reproduktionstechnik*, 1910, p. 585, and in the *Zeitschr. f. Reproduktionstechnik*, 1910, p. 196 ; also in *Process Photogram*, 1909, p. 186.

(10) *The Graphic Arts Monthly*, Chicago, 1930, May number.

(11) *Der graphische Betrieb* 1930, 5th year, October number, p. 304. Edition of the Bildungsverband d. deutschen Buchdrucker, Berlin.

(12) A. H. HOLT, in the *Process Year-book*, 1916, p. 71. Report in the *Photogr. Korrespondenz* 1920, p. 188.

Since the photographically transferred drawing is to show the bare metal while the covered portions of the photographic layer on the other hand are to act as insulating protective layers, one must start with the dia-positive. However, the dispositive is not prepared on the glass plate with the chloride-bromium silver emulsion with the aid of the adaptor, but by contact copy. The dry emulsion of SILLIB and BRUCKMANN in its uncoloured state has proved very suitable for this purpose. The much-used exposure chamber with the pneumatic printing frame on its upper side has given good results in this work. (Fig. 1). To evacuate the air one can make use of an electric air pump with an automatic switch for starting and stopping. (Fig. 2). The period of exposure is determined exactly to within a fraction of a second by a clock which automatically switches on or off the electric current to the source of light. The light source consists of a number of frosted globes which are grouped on an adjustable board. A red lamp on this board provides sufficient light for adjusting the dia-positive in place.

The widely-known procedure of isinglass copy (1) with LE PAGES Special Photo Engraving Glue or with the isinglass of J. C. HASS, the copying glue of the AGFA, or the British isinglass of the ISINGLASS Company Ltd. will be described later.

The copper plate is first cleansed of grease with benzol, then polished off with whitening (chalk) and a solution of 10 % chromate (10 gr. chromate dissolved in 300 cc water), and is thus cleansed and roughened at the same time. The plate is then washed off under a stream of water with the aid of a wad of cotton and then once again held at an angle of 35° to 40° while under a stream of sulphuric chromate solution (10 gr. chromate with 300 cc. water and 1 % sulphuric acid added), and then rinsed with clear water. The plate is then poured with fishglue and whirled. It is thereupon cooled off, then gradually warmed and exposed in the pneumatic printing frame under the dia-positive. After the exposure the plate is cooled off and then developed in cold water, as a result of which only the places acted upon by the light remain, that is, the covered areas, while the drawing shows clear copper. The layer is coloured by pouring methylviolet over it (with the plate held at an angle of 35° to 40°). The copy is then cleansed with clear water and the places which in the copy have not come out clear or which are covered with methylviolet, are gone over by hand as necessary with a cotton wad. The plate is whirled until dry and then laid for about three minutes in a hardening bath of the following composition :—

1000 cc. of water
100 gr. of amonium bi-chromate
15 gr. chrome alum
2 gr. chromate.

Finally the enamelled layer is annealed. In view of the large surface area of the plate annealing apparatus of at least half the size of the plate is required. Under this process the blue colour disappears and the copy becomes light yellow, then darker and darker. As soon as a light brown colour has been obtained the plate is cooled off.

Before proceeding with the galvanic engraving, any surface damage is repaired with asphalt or bicycle enamel ; the bottom side of the plate is closed up after two copper bands have been soldered on. The cupric oxide which results from the annealing is then cleaned off from the image side by means of a 3 % sulphuric acid solution, an iron chloride solution of 30° Bé or a 5 % cyanide solution. The places covered with a very thin layer of glue cannot be removed after the annealing process.

The etching in the galvanic bath is accomplished by the transfer of metallic particles from the anode to the cathode. If the plate is suspended in the bath as the anode, with the photographic layer turned towards the cathode, the electric current will attack the blank parts, or in other words the drawing — while the covered portions of the plate remain insulated by the photographic layer. For securing the plate in the bath as the anode, use may be made of the principle of the so-called "middle (neutral) conductor" (2) which is employed in the metallurgical industry for the conversion of crude copper into electrolytic copper. If the plate is suspended between the anode and cathode about 5 cm. from each and turned with its photographic layer towards the cathode, the layer side will act as the anode while the rear side of the plate will

(1) F. UMBREIT: *Uber das Arbeiten mit Emaillelösung.* Zeitschr. für Reproduktionstechnik, 1910, p. 146.
E. GOLDBERG : *Die Grundlagen der Reproduktionstechnik.* HALLE, 1923, 2nd Edition, Publ. W. KNAPP, p. 75.
R. RUSS : *Handbuch der modernen Reproduktionstechnik.* Frankfurt a. M., 1927, Publ. KLIMSCH & Co., Vol. II, pp. 16-18 ; 4th Edition, 1934, Vol. II, pp. 20-22.
O. KRUGER : *Die Illustrationsverfahren,* Leipzig, 1929, 2nd Edition, F. A. BROCKHAUS, p. 106.
(2) V. TAFEL : *Lehrbuch der Metallhüttenkunde.* Leipzig, 1927. Ed. S. HIRZEL, Vol. I, pp. 376-377.
Cf. also : D.R.P. 217771.

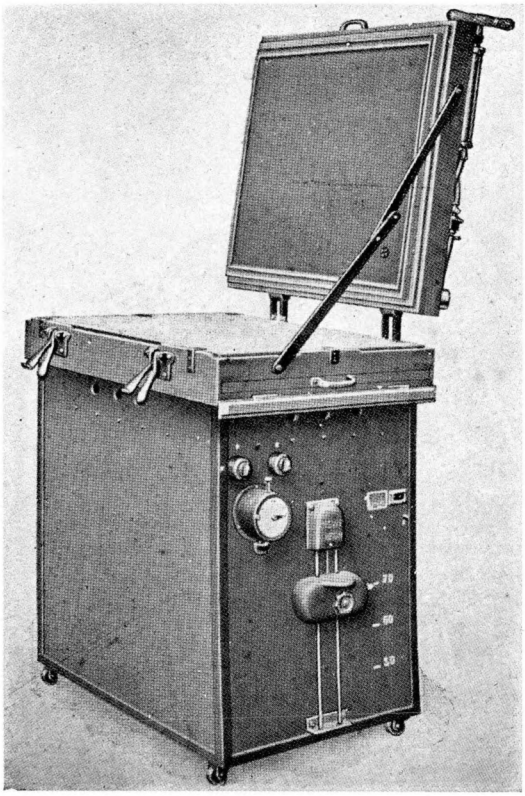

FIG. 1

Châssis pneumatique
Pneumatic Printing Frame.

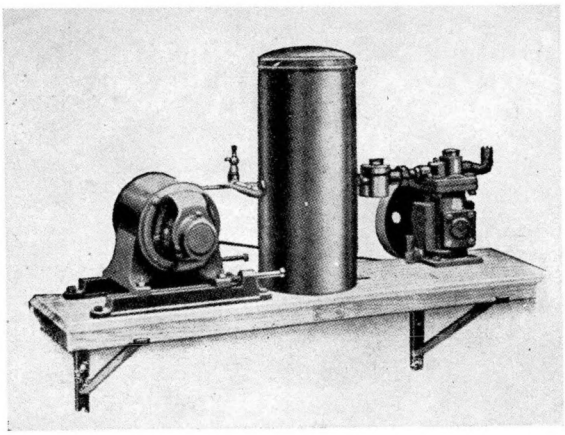

FIG. 2

Pompe à vide électrique
Electric Vacuum pump.

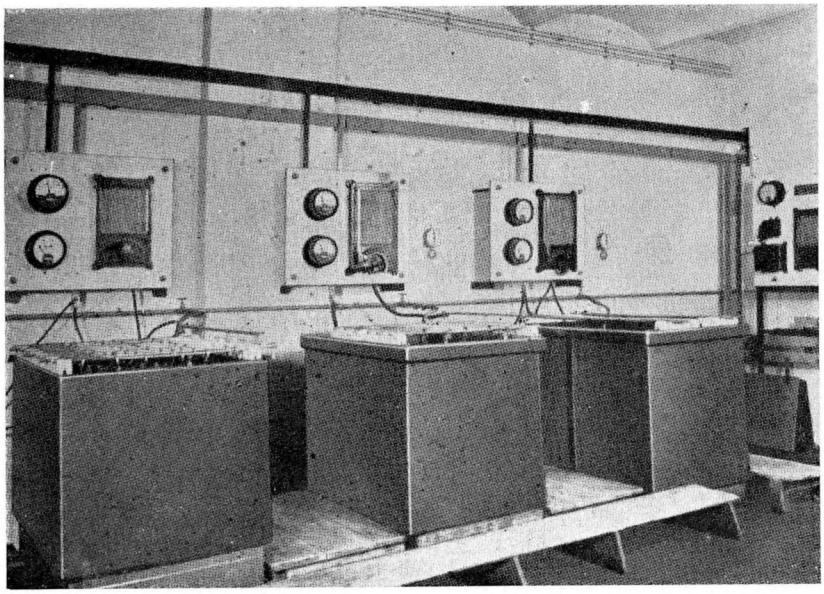

FIG. 3

Dispositif du bain galvanoplastique
Galvanic Bath with Equipment.

then have the properties of a cathode. There is then no direct connection with the source of current and the plate must not be connected with the conducting armature. Insulators such as glass, porcelain and wood can be used in the suspension of the plate. This procedure can be used to advantage as well for etching fine, regular lines.

As the cathode in the bath a grid of copper with 5 mm. meshes of 1 mm. wire may be used to advantage. The *Tintex* machine uses for this purpose a perforated metal plate, which in this case is of steel. Iron also may be used as the cathode. In Sweden, however, further progress has been made of late. According to reports of Director Henrik ORTENBAD, a new process was developed in the Statens Reproduktions in collaboration with the Kungl. Sjökarteverket, both in Stockholm, in which the cathode is provided with a reverse (mirror) image of the copy. All of these types of cathode are advantageous in etching the cartographic image where different thicknesses and depth of line are required. These favour the division of the galvanic current which distributes itself proportionately to the exposed areas; the fine lines taking less current than the broad areas.

One of the concomitant phenomena of the electrolysis is the so-called anode sediment. This is formed by the electrolytic decomposition of the anode and the kind and amount of this sediment depend upon the properties of the metal. While electrolytic copper gives rise to considerable anode sediment and causes the bath to fill with slime, rolled and hammered copper plates on the other hand do not give rise to the anode sediment in the bath. It clings rather to the anode as a sort of gray-green mass and acts as an insulator when present in thick layers. Finally the anodes cease to function altogether, and begin to heat. Depending upon the load in the bath such anodes have to be cleaned once or twice each day. In the case of galvanic etching use is made of rolled and hammered copper plates. The anode film forms, however, in the course of the procedure and is best avoided by strong agitation of the electrolyte.

For the purpose of galvanic engraving the present available installations of machinery and galvanic troughs may be employed, in so far as they are equipped for the vertical suspension of the plates. In the Reichsamt für Landesaufnahme, the following equipment is used :— (1)

For generating the current, two electromotors driving low voltage dynamos, which deliver a current of 800 amperes at 5 volts, are used. The galvanic troughs are made of acid-resisting earthenware of the dimensions $80 \times 73 \times 100$ cm. The right and left upper edges are fitted with porcelain shelves which have depressions every 5 cm.; these depressions are to receive the round copper bars of 1.5 cm. diameter, which are laid across the top of the bath. The agitation of the electrolyte is accomplished by compressed air which is fed in from below, and which is supplied by an electric air-compressor. The baths are connected in parallel. The switchboards each contain one voltmeter and one ammeter, as well as a current density regulator which automatically controls the voltage corresponding to the loading of the bath and the current. For each electrode rod there is a clock mechanism mounted on the wall set for periods of 60 or 10 minutes, which gives the alarm after a set interval of time. (Fig. 3).

The current voltage and the timing of the electrolytic process depend upon the total surface area of the chart; the values in question are on the average 2 1/2 to 4 1/2 volts and 4 to 7 minutes respectively. The composition of the bath is as follows :— to 1 litre of water 30 grammes of English sulphuric acid, specific gravity 1.84; specific gravity of the bath 2 Beaumé. The copper which is deposited at the grid cathode is burnt metal of dirty ashy quality, and has no close adherence to the cathode; it must be removed from time to time as this layer acts as an insulator.

After a certain definite time has elapsed, the plate is rinsed under a stream of water to cleanse it of the anode sediment, after which the protective coating of wax on the back and edges of the plate is burnt off with the aid of a bunsen burner. Thereupon the asphalt varnish is rubbed off with a cotton wad soaked in a mixture of benzine or benzol. The photographic layer, which has not been affected by the foregoing processes, is then removed in a bath of hot caustic lye (1 litre of water to 300 gr. caustic lye). Then the plate is bathed in hot water and to finish the process it is cleaned off with a mixture of 10 % cyanide of potassium and ground chalk.

The deeply etched image of the chart is a remarkably sharp reproduction of the original, since the current eats out the very smallest pieces of metal. If one examines an electrolytically deeply-etched line under the microscope, the edges are seen to be very smooth. This investigation can easily be carried out by means of a small pocket microscope of 40 to 60 magnifying

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(1) A more detailed description is given in LAMPRECHT : *Die Vervielfältigungstechnik bei der Herstellung topographischer Karten.* Special Part N° 2 of the Mitt. des Reichsamts für Landesaufnahme, Berlin, 1926, p. 43.

power, with measuring plate attached, made by the firm of KUNSTMANN in Berlin and which is placed on the plate to be examined. Often a small device called a "line counter" will suffice for the purpose The sharp reproduction obtained in the electrolytic process also holds for the auto-type; for instance, the coloured plates on which a sharply drawn hatching line is obtained (1) without staging or under-etching.

II. *RETOUCHING.*

The extent of the retouching of the electrolytically engraved copper plates depends primarily upon the appearance of the original before the proof impression, i.e. of the chalk impression for the original stone. The condition of the lithographic stone and the skill of the printer, as well as the quality of the photographic plate, play an important rôle. The sharpness of line in a print from the lithographic stone does not attain the sharpness of a well-executed drawing or that of a hand-engraved copper plate. If the lines are examined under a microscope, then it will be seen that the lines on the proof impression show jagged.

A certain retouch is necessitated in separating the outlines from the ground by scraping the dia-positive. In spite of the most careful workmanship, however, it is not always possible to avoid injury to the part of the chart which remains; for instance, when the contour lines pass through a patch of cross-hatching or through the symbol for a tree. The more skilfully the scraping process is carried out, the less the retouching required. Where there is a lack of good photographic transmission to the enamel copy, it is advisable to remake the impression in order to avoid a time-consuming retouching.

The retouch of the black plate is confined as a rule to the few thick lines that must be deepened. Thus for instance the border lines must be gone over with the line graving tool, and the houses re-engraved. The injuries to the plate occasioned by the scraping must be eliminated.

On the land plate the contour lines are labelled in accordance with the gradient and the damage occasioned by the scraping out must be restored. For this purpose a copy or a slip-proof of the finished black plate on the brown plate is necessary. In some cases it is advisable to obtain the brown plate, not by colour separation but from a new engraving.

On the water plate, which is engraved again from a copy executed photographically on the copper, there is naturally no retouch necessary.

(1) *Der graphische Betrieb*, 1930. October number, p. 304. Ed. of Bildungsverband d. deutschen Buchdrucker, Berlin.