REPRODUCTIVE PROCESSES

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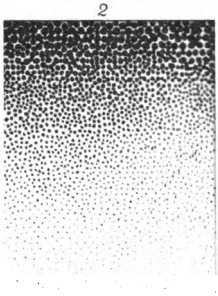

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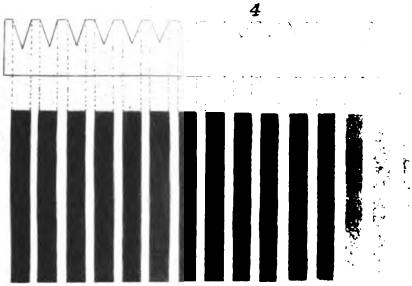

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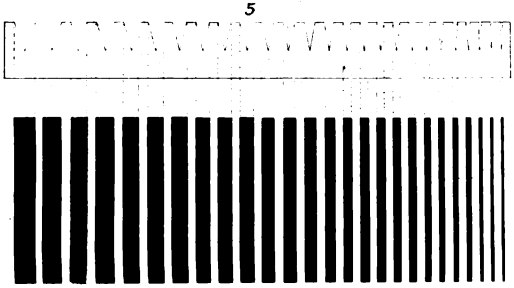

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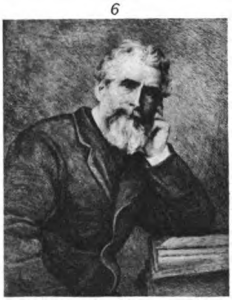

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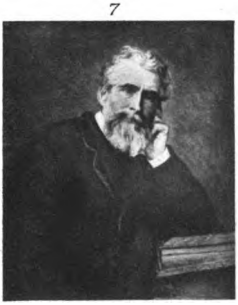


TYPOGRAPHIC TECHNICAL SERIES FOR APPRENTICES—PART IV NO. 29

REPRODUCTIVE PROCESSES OF THE GRAPHIC ARTS

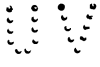
A BRIEF DESCRIPTION OF RELIEF, INTAGLIO, AND PLANOGRAPHIC PRINTING PROCESSES

BY

A. W. ELSON

TO WHICH IS ADDED CHAPTERS ON OFFSET PRINTING AND ON COPPER-PLATE AND STEEL-DIE ENGRAVING AND PRINTING BY OTHER AUTHORS

PUBLISHED BY THE COMMITTEE ON EDUCATION
UNITED TYPOTHETAE OF AMERICA
1920



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PREFATORY NOTE

THE contents of this book (excepting the articles on Offset Printing and Copper-plate and Steel-plate Engraving) are taken from a series of lectures upon Reproductive Processes of the Graphic Arts, by Mr. A. W. Elson, of Belmont, Mass. These lectures were given before the classes in Printing and Publishing at Harvard University and are reproduced here by special permission of Mr. Elson and the publishing department of Harvard University.

The chapters on Offset Printing and Copper-plate and Steel-plate Engraving were compiled for this publication by other authors.

The photo-mechanical processes of Halftone and Line Relief Engraving, including the modern developments in two-color, three-color, and four-color processes, are omitted in this volume, as they are described in text-book No. 14 of this series.

CONTENTS

THE REPRODUCTIVE PROCESSES OF THE GRAPHIC ARTS

CHAPTER I

Introduction

THE purpose of the reproductive process in the graphic arts is to produce designs upon plates from which impressions may readily be made by means of the printing press.

Usually a print from a plate is intended to be a facsimile of some existing design or drawing—or as close an interpretation as the process is capable of producing. In other words, the aim is that the plate shall reproduce forms, and values in light and shade as they exist in the original.

Sometimes the design upon the plate is made directly from nature or is the direct expression of an imaginative design. The plates of the painter-etchers are notable examples of such work.

All designs, drawings, or pictures are made in lines, in dots, or in flat and graded tints; and all forms, and values of light and shade are expressed in the arrangement and gradations of these three elements.

In the reproductive processes the same three elements, lines, dots, and tints, are used, and Figures 1, 2, 3, Plate I, represent the manner in which they may be arranged to express gradations from deep shadows to light tones. Figure 1 illustrates shading by lines; figure 2 by dots; figure 3 by tones.

The lines may vary in size and form, they may be straight or curved, broken or continuous; the dots may be made

in many sizes and shapes, and the tints may vary in depth of tone. We shall presently see how each one of these methods is used to represent forms, and light and shade (*chiaroscuro*).

Hand Processes

The term *hand* process means that the printing plate or block has been produced by hand work,—by the skill of the worker in the use of a few simple tools.

The photo-mechanical processes substitute the action of light and acids for this dexterity.

Perhaps the word "process" is too suggestive of mechanical means to describe the method by which such notable works of art were made as the printing plates of Dürer, Rembrandt, and Raphael-Morghen. A process practiced with much artistic feeling and skill becomes one of the fine arts, and usually should be so designated. It is desirable, however, for the sake of clearness to use terms which are descriptive, and the term *hand* processes is used to distinguish the method dependent on hand work from the *photo-mechanical* processes where the result is attained in a totally different way.

A successful result in the photo-mechanical processes is dependent largely upon skill in photography, knowledge of the action of certain chemicals, and care and intelligence in mechanical manipulation, whereas a successful result in the hand processes is obtained by the artistic sensibility of the worker, coupled with mastery over his tools.

There are three well-defined groups of hand processes:

(1) The relief processes.
(2) The intaglio processes.
(3) The planographic processes.

In describing them the reason for each name will become apparent.

CHAPTER II

Relief Processes

IF one takes a block of wood or metal perfectly flat on its surface and of even thickness throughout, and cuts away the surface in part, so that it has the appearance shown in Fig. 4, the result is a relief printing plate. A roller, charged with ink, passed horizontally over the surface of this plate will rest only on the portions marked A B and on the dot. The roller can not touch the remainder of the plate which is depressed below the surface of the line and dot.

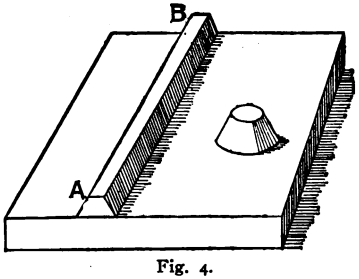


Fig. 4.

After inking, a sheet of paper is laid over the block and pressure is applied to the back of the sheet by pressing with a suitable tool or by the platen or the rotating drum of a printing press. On lifting the sheet the paper bears an impression of the line A B and the dot, or of that portion of the block which is raised or in relief, hence the name, relief plate or block.

The principle here shown is equally applicable to any design in lines or dots, however simple or elaborate. *It is a relief block or plate when it is cut or engraved with the intention that the portion in relief shall take the ink.*

A relief plate must have sufficient depth in the portions that are below the surface so that the inky roller can not touch the depressed parts; and each line or dot must have sufficient space between it and the nearest line or dot to

prevent the shallow intervening engraved space filling up with ink from the roller.

In relief-plate printing the amount of ink that can be applied with best effect depends upon the character of the plate. If the lines or dots are coarse and wide apart, a greater body of ink may be used than if they are fine and close; but whether the block is coarsely cut or finely cut, the quantity of ink used can be but slight, because being on the *surface* it is apparent that if any considerable body of this soft, yielding substance is applied, it will be spread by the great pressure required in printing, and driven from the relief portions which it covers, into the depressed portions, and the result will be an impression lacking in clearness and decision. As the ink is applied to the entire surface of the block it necessarily is of even thickness over the entire printing portion.

One of the characteristics of relief printing is that the body of ink on the impression is very slight and of even thickness and can not give the intense strength attained by some of the other methods of reproduction yet to be described. A second characteristic is that the lines or dots must be spaced sufficiently far apart to prevent the filling of any of the depressed portion which should receive no ink.

It is therefore impossible in relief printing to produce continuous graded tones, as shown in Plate I, Fig. 3. The black which is at one end of the diagram can be represented, but the tones between the black and a pure light must be imitated by means of white spaces between the lines and dots, varying in size according to the strength of the tone desired.

With these limitations of relief printing in mind we are ready to decide what particular form of expression best suits this process.

Relief-block printing was at first used for simple designs of various kinds, usually in heavy black lines on

white ground and from these simple forms of expression it has finally developed until at the present time the most important works in beautifully graded tones, such as the paintings by Rembrandt, are reproduced by this method. There can be no doubt that the process can portray in a most satisfactory manner any design or drawing in lines, subject to the limitation that the lines shall not be so fine as to break down under the pressure of the press or so close together that the ink will spread into the engraved spaces between them. Is it, however, a perfectly satisfactory process for reproducing originals which have effects of light and shade expressed in tones?

All of the tones that are seen in Fig. 3, Plate I, may appear in such a drawing or painting mingled in infinite variety throughout the whole. Relief-plate printing can only imitate the continuous tones by lines as in Fig. 1, Plate I, or by dots as in Fig. 2, Plate I. The subtle shading, which is so frequently present in shadows, must be expressed by little white dots in a black ground or by narrow white spaces between black lines. Neither of these methods will produce the unbroken modulated tones.

Relief printing, therefore, is not adapted to reproduce in an entirely satisfactory manner a drawing or painting in which the toning is an important feature of the original.

Holbein and Bewick were masters of relief-plate work because they used the process effectively, and the series of blocks called "The Dance of Death," by Holbein, are the best examples of relief plates, because the process has been used by the artist to express what it is capable of doing well. These prints have power from the black and white standpoint, because the lines are vigorous, and well defined, and have white spaces so placed as to accentuate the strength of the blacks. The prints have a luminous quality, due to these white spaces between the lines. They even suggest texture, because the lines are formed to

convey a vivid impression of the materials they represent. The raggedness of the peasant's garment, the lumpiness of the furrows, are all strongly brought out in "The Plowman," by Holbein (Fig. 5).

Once a relief-plate engraver departs from this principle and attempts to express unbroken tones, he brings the process in competition with other processes much better adapted to render such effects, mezzotint engraving for example, and while one can not but admire the wonderful skill displayed in the work it must finally be admitted that it is not the most robust form of the relief process.

Fig. 5. The Plowman, from "The Dance of Death," by Holbein.

Relief-block printing probably originated with the goldsmiths. The fact that the earliest blocks were executed in Manière Criblée, or dotted style, seems to lend color to this theory, for the goldsmiths were much given to using punches for dotted designs on metal, and some of the earliest blocks for relief printing were probably executed on metal.

Furthermore, the goldsmiths were the leading craftsmen of their day and were skilled in the use of tools well adapted to producing a printing plate. They were also accustomed to take impressions from their ornamental engraved work. To be sure, these impressions were very

weak, being taken in blackened oil, with much more oil than color, but they still were suggestive of printing.

The earliest dated relief prints are "[illegible]e Virgin" in the Brussels Cabinet, 1418, and "St. Chr[illegible]ier," dated 1423.

Wood Engraving

When wood began to be used as a material for relief plates is not accurately known. In the early stages of xylography, as the art of making printing blocks on wood is called, the principal tool was a knife and the block was cut *with* the grain. These were the days of wood *cuts,* as distinguished from wood *engravings.* The wood was *cut* with a knife, instead of being engraved with a graver. Thus the word "wood-cut," when applied to modern work, is a misleading term. The modern process is wood engraving. The chief concern of the woodcutter was to cut, in relief, the lines of the drawing furnished him by the artist. The woodcutter was a skilful craftsman if he rendered sympathetically the quality of the lines. He had not to consider what sort of lines he would use, the artist decided that for him. He cut the block away in the spaces that were not to take the ink, thinking only of the shape of the printing lines which he formed and left standing.

The art of producing designs to be cut on wood blocks for relief printing was practiced very early in Germany, the Netherlands, and Italy. Dürer (1471-1528) was one of the early masters. Holbein the Younger, now generally considered its mightiest exponent, came next, and his renowned series called "The Dance of Death" was published in Lyons in 1538.

Up to the time of Thomas Bewick (1753-1828), known as "The Father of Modern Wood-Engraving," the blocks were usually cut *with* the grain on cherry and pear wood. The early woodcutter thought of the

uncut block as a white surface, part of which he transformed by his work into black printing lines.

Bewick reversed this method. He thought of the block as solid black, just as it would print if the impression were pulled from it before engraving, and he obtained his results by considering the effect of the white lines cut into this black surface. There were some blocks produced in the fifteenth and sixteenth centuries in *white-line engraving,* as this method is called, but the work was executed in a crude and stilted manner, and to Bewick is given the credit of first using it in a finished and effective way. Furthermore, in Bewick's time the designs were not first drawn on the block in lines, but in continuous tones.

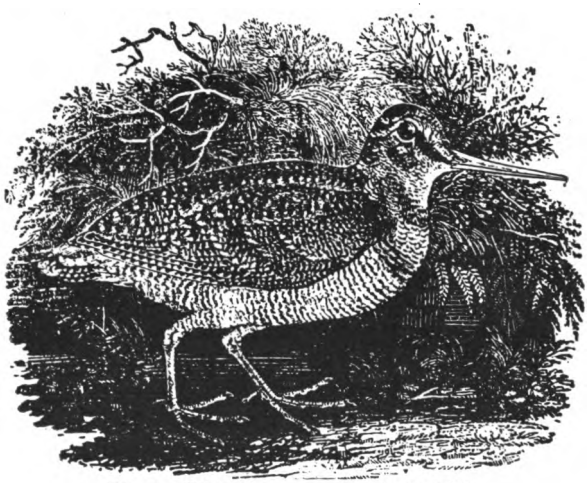


Fig. 6. White-line engraving, by Bewick.

The old method called for skilful craftsmanship in executing the lines faithfully and sympathetically; modern wood engraving as ushered in by Bewick required the translation of the drawing in tones on the block into an

interpretation in lines—quite a different and far more difficult task for the wood engraver.

Bewick also introduced the use of boxwood and cutting *across* the grain. As boxwood rarely comes more than five inches in diameter large blocks must be made by securely fastening small ones together by pinning and finally shrinking an iron hoop around the whole.

The modern engravers use but few tools; gravers of various kinds, tint tools, gouges or scrapers, and flat tools or chisels. The graver is the chief tool. It is sometimes square (Fig. 7-A), and is then the most difficult to use because the slightest variation in pressure will broaden or narrow the line, often unintentionally, but in the hands of a master it is the most effective tool. The lozenge tool or acute-angle graver (B) is also used, and the tint tool (C) for cutting parallel lines of a fixed width. The gouges (D) are for removing the larger spaces of the engraved portion of a block.

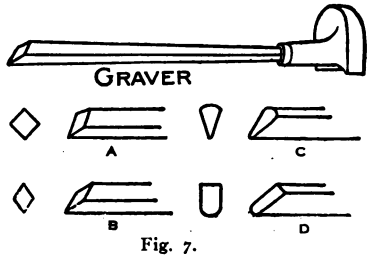


Fig. 7.

Wood engravings are usually electrotyped and the printing of the edition is done from the electrotype, not from the block itself.

The advantage of relief-plate printing over other methods lies in the cheapness with which large editions may be printed on a power press. No other hand process can produce plates that can be printed in the same form with the typographical work and therefore cheaply. Although originals in continuous tones cannot be reproduced by relief printing as well as by other methods, it must be added that the best modern wood engraving, chiefly

producing designs in chiaroscuro, has done a mighty work in educating the public taste in art. The works of many American engravers that could be mentioned are universally recognized as artistic productions of a very high order. In fact, woodcutting and engraving, from their beginning to the present day, have played an important rôle in educating the public. It is not unlikely that they suggested movable types and hastened the invention of typography, for there seems to be good ground to believe that letters were cut in connection with pictures on wood blocks before they were cut as movable types.

In the days when books were rare and reading an uncommon acquirement amongst the masses, relief prints aided the advance of the civilizing work of religion. Holbein's masterful drawing became widely known; Bewick made the birds of the British Isles more familiar to a large number of his countrymen, and the best American magazines have aided in making the greatest paintings familiar to a large public.

CHAPTER III

Intaglio Processes — Copper and Steel Engraving

FIGURE 8 represents a sheet of copper of about one-eighth inch thickness throughout. Into it has been cut with a graver the channel or line A-B. The line throughout is below the surface of the copper and corresponds to the shape of the graver with which it was cut. The surface of the copper is represented by C-D. This is a diagram of a line engraving.

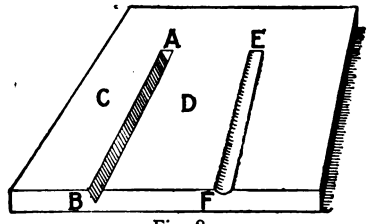


Fig. 8.

The method of printing the plate, the tools and materials used, and the press, are all quite different from what are used for relief-plate printing.

The inking roller (Fig. 9) is made of thin discs of woolen cloth tightly clamped together to make a smooth but yielding mass. In the early stages of the art the ink was applied by a dabber (Fig. 10), made of leather or cloth, and at times this method is now used.

The printing ink is usually mixed by the printer and is not prepared by the ink manufacturer. A mass of dry color and burnt linseed oil is placed on a slab and the printer proceeds to rub it with a muller made of glass or stone. This mulling process must be continued until the ink when rubbed between the thumb and finger feels perfectly smooth. The grinding of the ink is important, for no good work can be done with a badly prepared ink. Ink containing coarse particles of color will give broken lines.

Hard black is used chiefly for printing intaglio line plates. It wipes short and crisp without much tone. Soft black, as its name indicates, is softer and more smeary

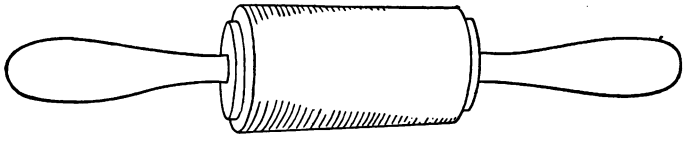


Fig. 9. Plate Printer's Roller.

in character, as is also lampblack, which is only used sparingly to increase the clinging of the ink to the plates. These last two are chiefly used for mezzotint, etching, and photogravure printing, where the production of soft tones rather than crispness is desired.

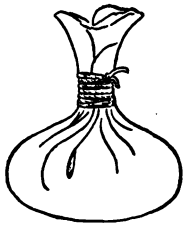


Fig. 10. Dabber.

The roller or dabber, charged with ink, is worked over the entire surface until the plate is covered with a heavy mass of color and the lines well filled with ink. During this manipulation the plate must be warmed over a printing stove, as the ink is stiff and it can not be readily worked when cold.

The plate printer then wipes his plate with rags of open-mesh cloth, such as cheese cloth; the open spaces in the cloth fill up with the ink which he removes from the flat surface of the plate, and this process also packs the ink into the lines of the plate. The skill in wiping consists in cleaning the ink from the surface of the plate without dragging any ink from the engraved lines. With the palm of his inky hand, which he has rubbed on a block of gilders' whiting, the plate printer briskly polishes the surface, removing the scum which still remains from the wiping rag. This scum is not wanted in printing a line engraving,

but in etching printing it often plays an important part in securing a satisfactory result.

The impression is now taken on a sheet of moistened paper by pulling through a copper-plate press. The ink is drawn out of the lines through the adhesion brought about by the heavy pressure and the suction of the wet paper.

What was cut in, or intaglio, in the plate is what has printed, hence the name, intaglio engraving.

The thick, dense body of ink gives richness to the impression, which gains a soft, mellow quality, furthermore, from the shadows cast by the lines which are in perceptible relief on the paper.

The most complicated design in fine line engraving is but an expansion in number and variety of lines and dots on the principle here shown. All degrees of width of lines (with the limitation that no line be so wide that the ink will wipe out of it) and great variety of depth of printing lines can be made on the copper. The finest line that the human hand can engrave is the only limit to the degree of fineness of intaglio line engraving, for if the ink is ground sufficiently it will fill in the merest scratch on the copper. Furthermore, the finest line will stand up under the pressure of the press and a series of such fine lines, however near together, may be printed so that each one is sharp and firm on the impression.

One can see, therefore, that intaglio line engraving is superior as a process to relief-block engraving for obtaining depth of color and delicacy and clearness of line. But that is not all of its superiority. The lines in the shadows may be engraved very close together, sufficiently so almost to touch each other, and yet their separation can be preserved on the impression, thus enabling the engraver to obtain a luminous quality in large masses of shadows, which in relief printing would appear dull and lacking in

"juiciness." And, finally, the engraver has not only the resource of expression to be obtained by the difference in width of his lines and the difference in size of his dots, which is modelling by division, but he also varies the depth of his lines and dots and models by depth.

Plate I, Fig. 5, represents a cross section of a plate engraved with a series of lines modelling from dark to light by means of making one line *narrower* than the other. They are all engraved of equal depth. An impression of each line is shown directly below the point where it is engraved in the plate. That is modelling by division. Above Fig. 5 is a section of another plate in which each line is of equal width and the modelling is obtained by the variation in the *depth* of the line in the plate. That is modelling by depth. A line engraver may use either modelling by depth or by division as he finds it most desirable. Practically he combines the two means. His heavy lines are usually wider and deeper than the lighter ones.

And so, when relief-plate engravers attempt extreme fineness of line, or attempt subtle modelling in the shadows, they bring their work in direct comparison with work by a process which has natural gifts for doing these things better, and the work of the weaker process pales somewhat before the more beautiful modelling of shadows and the more delicate and pure quality of light tones of intaglio line engraving.

The term *line* engraving is used to distinguish those intaglio plates or prints which are executed in lines, either continuous or broken. Dots are often used in connection with lines. The practice of the art probably dates back as far as relief printing, perhaps farther, and here, too, the goldsmiths were probably the first to practice it. They were accustomed to doing Niello work. Niello is described by Luigi Lanzi in his "History of Painting in Italy," in the division on the Origin and Progress of Engraving on Copper

and Wood. He says that "the method was to cut with the chisel upon silver whatever history, portrait, or flower were required, and afterward to fill up the hollow part of the engraving with a mixture of silver and lead, which, from its dark color, was called by the ancients—Nigellum, which our countrymen curtailed into Niello; a substance which, being incorporated with the silver, produced the effect of shadow contrasted with its clearness and gave to the entire work the appearance of chiaroscuro in silver."

According to Vasari, "Maso" Finiguerra, one of the most renowned workers in Niello, was in the habit of never filling the little hollows or cuts prepared in the silver plate until he had first made a proof of his work. Such Niello proofs are still in existence. They may be readily recognized by the fact that the picture is reversed, and also by the weakness of the print, being pulled in lampblack and oil and the pressure applied by a roller held in the hand. This led to the idea of an intaglio printing plate.

The date of the beginning of line engraving was about the year 1440.

As the intent of this lecture is to describe processes rather than to compare the work of those who practiced them, only a few names of workers need be mentioned.

After Finiguerra came Baccio Baldini, whom Ruskin refers to so often in connection with the engraving of Botticelli's work. Botticelli also began to engrave plates in 1474 or thereabout. Then came Andrea Mantegna. Up to this time impressions were pulled by running a roller held in the hand over the paper. Then came the invention of the roller press for printing copper intaglio plates, and also the stiff ink, already described, which gave richness and decision to the impression. Germany is entitled to the credit for this advance in the art. The date is probably about 1470, and the early German work of this period is printed better than the Italian.

Martin Schoengauer, of Colmar (1455-1499), was the first of the German school of line engravers, and then came one of the greatest of the Germans in the reproductive arts, —Albrecht Dürer. Other noted engravers were Lucas Van Leyden, who made aerial perspective an important feature of his work, and the Italian Marc Antonio Raimondi, who engraved Raphael's work under his personal direction.

There were a number of celebrated Flemish engravers at the time of Rubens—some working under his direction. A great school of portrait engravers existed in France about the time of Louis XIV. Edelinck, Nanteuil, and the Drévets were among the important workers. Jacobus Houbraken (1698-1780), in Holland, was renowned for his wonderful texture of flesh and hair. Raphael-Morghen declared him unequalled in this respect.

The art flourished vigorously at the end of the eighteenth century and at the beginning of the nineteenth in Italy, and the work of a group of men of this time from Raphael-Morghen to Toschi must rank with the very best in the history of line engraving.

In England the names of Strange, Sharp, and Woollett are among the greatest. Bartollozzi, who also worked in England, was the originator of the stipple manner of engraving, a separate style and perhaps not a particularly happy one, except for its delicacy of effect. This stipple style consists in modelling in dots of various shapes by means of the graver. In the beginning of the nineteenth century the art of line engraving declined, at least in any virile form.

The opinion which prevails that line engraving faded away under the pressure of the photo-mechanical processes does not seem to be well grounded. When we consider that few, if any, important line engravings have been produced since about 1830, in connection with the fact that the photo-mechanical processes were not then in existence,

we can readily understand that some other cause must be found. Ruskin referring to the line engravers, says that they themselves ruined their own craft by vulgarizing it. "Content in their beautiful mechanism, they ceased to learn and feel as artists."

Steel plates were used for the first time for intaglio engraving in the first half of the nineteenth century. It is, therefore, inaccurate to speak of any intaglio line engraving which was produced earlier than the last century as a steel engraving. They were all copper-plate engravings.

The modern method is to cover the plate with an etching ground on which the main lines of the engraving are drawn and bitten with acid. The ground is removed and the lines sharpened and deepened with the graver—the chief tool for intaglio line work, as it is also for relief engraving.

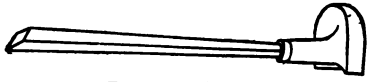


Fig. 11. Graver.

In intaglio line engraving, however, the graver is used to make the printing lines instead of for removing the part of the plate that is not to print, as in relief-plate work. A dry point, or needle, is used for fine lines and a burnisher to diminish the printing strength of any line which is too strong. By pressure with the burnisher on the line the metal can be pressed together, so that the line becomes somewhat shallower and decidedly narrower. The scraper is also used when the burnisher will not reduce the printing strength of a line sufficiently. The burnisher merely pushes the metal into the line and closes it, while the scraper, being sharp, scrapes away the metal and leaves a shallower sharp-edged line. The excessive use of the burnisher tends to injure the sharp and decisive character of the printed line.

Beautiful examples of line engravings are no doubt to be found in many different periods, nevertheless we can

not go far astray when we say that its best expression is found where a master hand has used the qualities in which the art excels; namely, clear, rich, graceful, and delicate lines to represent some subject which eminently calls for this form of expression. Raphael-Morghen's engraving of Guido's "Aurora" is such a plate; a beautiful flowing quality of lines is here found, and the engraving has all that refinement, pureness, delicacy, and silvery effect in which intaglio line engraving is supreme.

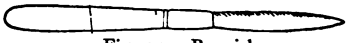


Fig. 12. Burnisher.

Ruskin has said of the natural use of line engraving that, first of all, the object is the decorative arrangement of lines, to cover the plate with lovely lines forming a lace-work and including a variety of spaces, delicious to the eye.

Before leaving the subject, attention should be called to the commercial side of the process. It is used extensively for printing bonds, certificates of stock, paper money and stamps, billheads and letter-heads. The involved geometrical designs in lines often seen on paper money and on borders of bonds and on coupons are made on a machine. Steam-press printing has been applied to intaglio line plates but never yet in an entirely satisfactory manner for art work. A fine line engraving must still be printed with the same tools, ink, and press that have been used since the fifteenth century for this work.

Etching

It is comparatively a simple matter for any one who can draw well to make an etching on copper. The same person could not produce an equally good result in line engraving or mezzotint without much practice and many failures. The reason for this is that the skill with the tools required for making sound and perfect lines in etching is but slight

compared with that necessary to engrave satisfying lines with the burin or graver in line engraving, or beautiful tones with a rocker and scraper in mezzotinting.

A celebrated etcher, Paul Rajon, has said:

"It is so easy, so very easy to make an etching,
And so hard, so very hard to make a good one."

Perhaps the explanation is that etching is so flexible and responsive a medium of artistic expression, capable of conveying artistic ideas so satisfactorily that it was used as a medium of expression by the greatest artistic geniuses; such men as Rembrandt among the old masters, and Méryon and Whistler among the modern—men who were giants in the graphic arts. And these men have made a standard —have shown what the etching process is capable of producing. While the technique of etching is simple and quickly acquired, it must be used in a masterly manner to produce a fine plate by the standards established.

The etcher is not trammelled by such limitations as surround the line engraver and mezzotinter. In pushing the burin through a copper-plate the manner in which it is grasped in the hand and the force required to remove the copper or steel prevents any great freedom of expression in line engraving and the result is apt to be somewhat hard. The scraping of a copper-plate in mezzotinting is a method by which only a variety of tones can be obtained and variety of texture can not be produced.

The etcher may use his needle with almost the freedom with which a painter uses his brush. He may obtain strong effects of light and shadow, transparency in any of the tones, and textures in great variety. This indicates the flexibility of the process.

Ruskin has said of etching that it is an indolent and blundering method at best. It undoubtedly is easy for the skilful etcher to produce an artistic effect by comparatively few well-directed strokes of the etching needle and he does

not have to labor long and hard over his plate, as in line engraving, before anything beautiful results.

If that be Ruskin's reason for his words, then by this test of a work of art the method of painting of Hals—so rapid but vital—might be called indolent. Painstaking and laborious methods do not necessarily produce artistic results. The great power in etching lies in the fact that the essential drawing may be expressed so forcibly and in such a fresh, free, and rapid way by a master that in some cases any finish of effect might only detract from these admirable qualities. Is not this "indolent method," as Ruskin calls it, rather a responsive method, to be ranked amongst the greatest of the graphic reproductive arts?

The fact that the process does not call for a long schooling in the use of the special tools has undoubtedly led many men of originality and ability in art to practice it and has given rise to painter-etching where the original conception is placed directly on the copper.

An etcher starts with a copper-plate of even thickness (about one-eighth inch) and of polished surface. Upon this surface he first places his etching ground, a composition of wax or varnish which is in the form of a ball, surrounded by silk. He heats his plate that the composition may melt and flow through the silk. He works his wax evenly and thinly over the whole surface of the plate. He then smokes the ground with smoke from the flame of a wax taper and when the plate has an even black appearance over all he allows it to cool. It is now ready to work. With the etching needle in his hand, held as a pencil, he scrapes through the ground down to the copper and uses care that in every part of every stroke the copper is laid bare. Different effects of line may be obtained according to whether he merely bares the copper or scratches into it. The line, to etch evenly, however, must either be bare copper throughout, not scratched below the surface in any part, or else

scratched to an even depth into the copper throughout the whole line.

After his drawing on the plate is complete, the etcher proceeds to paint the back of the plate with varnish or asphaltum, that the acid may not bite into it. He is now ready to etch. He places the plate in an india rubber or porcelain tray and pours some nitric acid of about 20 degrees Baumé over the surface of the plate. When the acid, which immediately eats into the copper, has bitten the lines of the etching that are to print lightest to a sufficient depth, the plate is taken out and washed with water and the water removed with blotting paper.

The etcher now paints such portions of the plate as have bitten sufficiently deep with a brush charged with stopping-out varnish, to prevent further biting in these parts, and he again places the plate in the acid. This process is repeated until the plate is finished. The lines that have bitten the least will be the shallowest and print the lightest and those which have bitten the longest will be the deepest and print the darkest. This is modelling by depth, but there is also some modelling by division, because the lines which have been in the acid longest will not only be the deepest but also the widest, as the acid after a while will begin to bite sidewise as well as downward. His lines also vary in the width they are drawn.

The method described is called biting with stopping-out. There is another method, called flat biting, which is not commonly used. By this method the etcher bites his lines but once and all to an equal depth. He relies entirely for his modelling on different widths of his lines in the wax, using a broad needle or several needles for his darkest tones and varying the width of his lines by finer needles as he works toward the lighter tones. Here he models by division only.

There is usually much work to be done on a plate by the etcher after his principal acid biting of the lines is completed. He may re-bite locally on his plate by stopping-out

with transparent varnish, through which may readily be seen the lines he wishes to lay bare with the needle, and etching again with the acid. He may also with a dabber again lay the etching ground on the plate with great care so as to cover only the *surface* of the plate and not enter the lines. He may then re-bite anywhere he pleases on the plate, by putting on the acid locally with a brush. After every effect that he desires to produce with the acid is obtained and the etching ground removed, he may retouch with a graver to sharpen or deepen lines, or with a dry point to add free lines to connect spaces that are too bare.

But even when an etcher has finished his plate he is only half through his labors, for he must either print it himself or supervise the printing of it by an etching printer. There is only one way of printing a line engraving properly, and that is to get the full value of each line and leave no tint or scum on the plate. The printer needs no directions from the line engraver beyond a suggestion as to the strength of the ink. This is not so with etching printing.

There are many different effects that can be obtained from printing the same plate in different ways. First, however, a preliminary impression is pulled of the plate, with what is termed a "clean wipe," which means that the ink is completely removed from the surface of the plate. The plate is printed exactly the same as a steel engraving, but the result is but a mass of lines, usually very wiry in appearance, and the impression has a thin and uninteresting effect. (Plate I, Fig. 6.) This impression is pulled to show the etcher the width and depth of the lines in his plate. At times plates are etched so that the edition may be printed in this manner, but it is rare and the results are not usually the best examples of the etching process.

The next impression may be varied from the first in many different ways, according to the effect desired. First, a tone may be left over parts of the plate to connect the lines and give softness to those portions. Second, by bringing

the wiping rag of fine muslin to a pointed shape and passing this lightly over certain portions of the plate the printer draws the ink out of the lines somewhat above the surface of the plate, and not only broadens the lines he has touched, but fills the spaces between them with a tone, thereby obtaining rich qualities and a great depth of color where the lines have sufficient depth to enable him to draw a quantity of ink out of them. This is called drawing up, or retroussage. (Plate I, Fig. 7.) He may then, with a piece of wood or his finger or a clean rag, wipe the tone off the plate in spots where he desires high lights. He may, if desired, lay a graded tone in the sky with the palm of his hand where no work whatsoever exists on the plate.

We have not named all the resources of the printer nor of the etcher, but one can see that they are many. Etching is supreme among intaglio processes. First, because between the working of the plate by the etcher and the printing any graduation in lines, dots, or tones that is shown in the three diagrams, Plate I, Figs. 1, 2, 3, can be produced. Second, it is supreme because no process interposes so few difficulties of technique between the artistic conception of the etcher and the fixing of that conception on the printing plate.

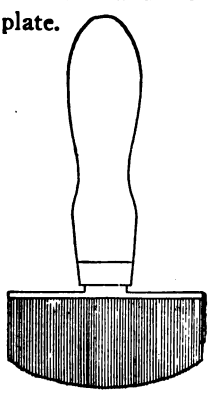


Fig. 13. Mezzotint Rocker.

Mezzotint

The mezzotint process is another form of intaglio engraving. It is called by the French "Manière Noire," while the Germans call it "Schabkunst."

A copper sheet of about the same even thickness as would be used for a copper-plate line engraving, perfectly flat on the surface, is the basis of the plate. The first tool used is a rocker, a hard steel instrument with sharp teeth on a curved surface. (Fig 13.) The plate is lined off

into sections. The worker holds the rocker firmly and nearly perpendicularly in the hand and rocks it to and fro over one section of the plate. He then turns the plate 90° and rocks again over the same surface, proceeding in this manner until he has gone over the entire plate about thirty or forty times in as many different directions, always rocking and pressing the tool firmly into the copper, a difficult and irksome task, but one for which no good substitute has been found.

The result of this labor is a plate filled with innumerable deep holes which when printed will hold the ink in the same manner as a copper-plate engraving; the impression will be a solid, rich, velvety black mass of ink. Hence the French name for the process, "Manière Noire" (black manner).

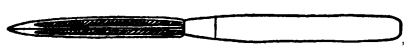


Fig. 14. Scraper.

The mezzotinter next takes a scraper (Fig. 14), usually with three sharp edges, and with one of these edges begins to scrape away the copper in such places as he desires lighter tones, and where he desires a high light he will scrape the copper until the holes in the plate made by the rocker have disappeared and he has secured a smooth surface, finally using a burnisher to polish the copper in these high lights of the picture. Scraping is the manner of working the plate. Hence the German name for the art, "Schabkunst" (scraping art). The English word, "mezzotint," is not so pointedly descriptive, but merely denotes that it is a plate in half tones.

The printing of a mezzotint is a difficult task, calling for great skill on the part of the workman, and today capable mezzotint printers are rare. The printer inks the plate in exactly the same manner and with the same tools and ink that he would use for a copper-plate line engraving, except that the ink is usually of a softer character. After the whole surface of the plate is thoroughly inked in, so

that every engraved portion is filled, at least so far as it can be filled with a roller or dabber, he proceeds to remove the superfluous ink with a wiping rag, but in wiping he takes pains to let his rag get "fat," as it is technically called, that is, well filled with ink, and with the fat rag he presses and wipes the ink into the holes of the plate.

The lightest parts of the print are sunk the deepest below the original surface of the plate. This is one of the characteristics of a mezzotint plate. In Fig. 15 the point "A" is the farthest below the surface of the plate and yet it will not print because the grain made by the rocker has been scraped away and, there being no tooth, it will hold no ink. Mezzotints model by depth and division. The grain or dot in the lightest parts is not only the shallowest, but the white spaces between contiguous grains are the widest.

Fig. 15.

Here we have an intaglio process which can produce smooth tones and can give every variety and shade of tone in the subtlest gradations. Ruskin has called it chiaroscuro drawing on metal. Surely, then, its forte is in producing works where chiaroscuro is the chief end aimed at. The process is not well adapted to reproducing variety of textures, because the mezzotinter can rely only on grain or dots to form his textures, unless he adds lines with a graver or etches them in. But this can only be done successfully in a broad way for outlines, not in a minute way to obtain textures.

The earliest known mezzotint is "Landgravine Amelia of Hesse," and to Ludwig von Siegen belongs the honor of having invented the art. This was in the first half of the seventeenth century. It was developed to its highest expression, however, in England, where it was introduced

by Prince Rupert, and developed there first by Dutch and Flemish artists and then brought to greater perfection by native mezzotinters.

Notable examples of mezzotint are the portraits by MacArdell, after Reynolds; the work of John Raphael Smith, the best productions by Samuel Cousins, and the mezzotint plates of the Liber Studiorum of Turner. In most of the latter plates Turner etched the outlines and mezzotinters afterwards completed the chiaroscuro of the plates.

Mezzotint has its strength in power to give the most delicate gradations and richness of tones, and in representing the delicate shadings of flesh or the gradations of light and shadow in a landscape. It can not, however, give the technique of painting of the highest order; it always has a smoothness, a certain monotony of texture, that makes it rather a translation into beautiful melting tones of the more virile and expressive brush work of the great portraits and paintings that have been reproduced by this method. The "painty" qualities of the original it can not catch, because to work the crisp touches of the painter's brush with so unresponsive a tool as a scraper is beyond human patience and skill, and to suggest these effects in lines is not practicable, as they are difficult to add after the grain is once rocked on the plate. Lines can be put on the plate before rocking, but must be so deep that only heavy outlines are practicable, such as are used in the Liber Studiorum plates. Mezzotinting has declined, as has line engraving. The reason is difficult to find, but possibly the increase in prints from less expensive plates has tended to influence an indiscriminating public to neglect the finer in favor of the cheaper.

Dry Point

Dry pointing is the art of working on copper for intaglio printing with a pointed steel needle. It takes its name from

the fact that it is not followed up by the wet acid for biting, and as the lines are made with a point, the term dry pointing is descriptive of the manner of working.

Dry pointing differs from line engraving because in the latter the line is cut with a sharp edge and the copper is cleanly removed from the plate by the graver, whereas the dry point raises the copper out of the line but leaves it attached as a ragged mass above the level of the plate. (Fig. 8, line E-F.)

The dry pointer may with a scraper remove this copper which his point has plowed up, but he often allows it to remain, as it gives a certain quality which is desirable in some effects. Such a dry-point line with the burr attached catches the ink in large, heavy masses, and gives a rich and velvety effect, for not only does the engraved line itself print, but the ink is gathered against the burr on the opposite side from the intaglio line in the plate from which the burr came.

The edition that can be printed when the burr is not scraped away is but very limited, for this burr is attached to the plate but slightly and is soon torn away by the wiping rag in printing or broken down by the pressure in running through the press.

CHAPTER IV

The Planographic Processes

THE planographic hand processes are confined to lithography, the printing surface being a stone, and to the processes where other material is substituted for stone, but in using these substitutes, chiefly zinc and aluminum, the general underlying principle is the same as printing from stone, although the manipulation is different. Aloys Senefelder invented lithography in 1790.

Lithography

Lithographic stone is of a calcareous nature and the best is found in Germany. It is used in a thickness varying from two to four inches and is prepared as to its surface in different ways according to the character of the work which is to be produced on it.

Crayon, pen work, and engraved work are the three methods used. If the stone is to be engraved, the surface is ground smooth with sand and water and then polished with pumice and water-of-ayr stone. If the pen is to be used, a smooth surface is also required; but if a crayon drawing is to be made on the stone, the surface is ground with a grain the fineness of which varies with the nature of the subject that is to be put on the stone. If a subject which is bold in effects is to be printed, the stone will usually be grained coarsely; but if the subject is to be finely worked, the grain will be correspondingly fine.

Lithographic Crayon Work. In making a crayon drawing the artist works with a lithographic crayon, which is black in color and greasy in nature. The grain given to the stone serves the same purpose as the grain in crayon paper and catches the particles of crayon. The light and shade of a drawing is thus produced on the stone in the

same manner as it is on a sheet of crayon paper. Light or heavy stones may be obtained by the difference of pressure of the hand in manipulating the crayon, or by variation of the crayons used, either soft or hard. The stone is then etched with an acid of about two parts of nitric to forty to sixty parts of dissolved gum arabic; the mixture being lightly sponged over the stone. The greasy lithographic ink on the top of the grain resists the acid, but the bare stone, at the bottom of the grain, absorbs the solution readily, as the action of the acid and the gum arabic gives to the stone the property of absorbing and holding water. Although the parts which have been etched are slightly below the surface of the stone, the depression is very slight and the principle of printing does not rest upon this depression. To all intents and purposes it is a plane surface throughout, hence the name, planographic printing.

The operation of printing consists, first, in damping the stone—with a wet sponge in hand-press printing or with a wet roller in power-press work. The water will be taken up by the etched portions, but will be repelled by the greasy crayon ink of the drawing on the stone. If a lithographic roller charged with ink is then passed over the stone, the parts which have not been touched by the crayon will resist the ink, but the drawing, being greasy, will have affinity for the printing ink and will take it up readily. After a very careful inking-in, the impression is pulled. The process of wetting and inking must be repeated for each impression.

Beautiful results in chiaroscuro may be obtained in lithographic crayon work and many artists of renown have used this process. The tones are not quite continuous to the eye, but sufficiently so to give an agreeable effect. The finer the grain the more nearly continuous will be the tone.

Lithographic Pen Work. A lithographic pen, similar to a fine writing pen, is used for drawing the design on the stone and especially prepared greasy lithographic ink is used on the pen. But little black and white work is done by this method. It is in color work by this process that pen work becomes chiefly valuable. Sometimes a brush is used instead of a pen.

Engraved Work. A smooth stone and a sharp needle in a wooden handle, held in the same manner as a pencil, comprise the material required for lithographic engraved work. The stone has first been prepared by etching with acid and gum arabic, so that if it were wet and inked up it would resist the ink over the whole surface. In working the design by scraping with a needle the preparation on the stone is removed and the slight depressions which are made in the stone hold ink partly because they are below the surface and print in the same manner as an intaglio plate and partly because the ink-resisting preparation has been removed from the stone by the needle point. The edition is not printed from this engraving, but by the transfer process, which plays a most important part in this art.

Transfer Process. Impressions are pulled from the engraving on the stone by rubbing greasy lithographic transfer ink into the lines by means of a wooden block covered with felt. These impressions are pulled on the hand press on prepared transfer paper, usually *Papier de Chine* (china paper), and are carefully laid on another sheet, supported on a board, and are held to it by pricking with a point through the two papers. The sheets are removed from the board and put face down on another stone and run through the lithographic hand press. The paper is soaked off and the stone is etched; it is then ready for printing. Transfers of pen or crayon work are made in a similar manner.

By means of the transfer process hundreds of copies of a single design or many different designs may be put on one

stone. Steel or copper plates in lines may be transferred in the same manner, but if the engraving is very deep it is difficult to prevent the spreading of the great quantity of ink drawn out of the lines of the engraved metal plate and subjected to the heavy pressure of the transfer press. An ink must be especially prepared to overcome this difficulty.

Billheads, business cards, letter-heads, bonds, stock certificates, and similar commercial work are the chief products of lithographic engraving.

Many experiments have been made to substitute another material for lithographic stone. The great weight of the stones, their extreme costliness; the danger of breaking, thereby not only entailing the loss of the stone, but possibly of some valuable drawing; the cost of transportation and storage were factors that, soon after the invention of the process, made it clear that the discovery of a substitute material was imperative. It is only within our own time, however, that the problem has been solved.

Aluminum and zinc are both in general use today as substitutes for lithographic stone. The principle of printing is identical with that of lithography already described. It is planographic printing dependent chiefly on the repulsion of greasy ink and water. The preparation of the plates and the technique throughout is sufficiently varied from the manipulation of stone so that it has taken many decades to bring to a successful solution what seemed at first a simple matter.

Closely following the successful use of zinc and aluminum for planographic printing came an advance in printing machinery, made possible by the fact that the two metals could be used in thin sheets bent around the printing cylinder of a rotary press. This press is far more rapid in printing than the reciprocating lithographic press. The introduction of offset printing is the most important advance in planographic printing in recent years.

CHAPTER V

Photo-Mechanical Processes

THE impulse to develop ways of saving labor, which is constantly active in man, and the spirit of scientific research were probably the underlying motives which led to the discovery and development of the photo-mechanical processes in the graphic arts.

The result of this development has been a great increase in the quantity of the product, and the cost of reproduction has been diminished, but the high degree of artistic expression and of craftsmanship displayed in the best hand process work is usually lacking in photo-mechanical reproductions.

There has been some distinct artistic gain in photo-mechanically retaining the technique of the original and the fine detail of modelling in the reproduction of paintings, which was almost impossible by hand work; but, on the other hand, there is usually a loss in the preservation of values, due partly to the inferior artistic training or instinct of the workers and partly to defects of the processes. In photo-mechanical line work the original may be followed more closely in the exact size and form of each line, but the quality of the line has suffered compared with hand work, particularly where great sharpness or delicacy is required.

It must also be said that the photo-mechanical processes have produced, without hand work, some results in beautiful tones in great variety that are not attainable by any other method, and, furthermore, when the plates by these processes are retouched or finished by an artist, equal in ability to the best that worked by the hand processes, the results have been of considerable artistic merit, and a great amount of hand work has been eliminated.

The first work of importance leading towards the development of making plates by photo-mechanical methods was the experimentation of Thomas Wedgwood and Sir Humphrey Davy in England, and particularly the work of Joseph N. Nièpce of Châlons-sur-Saône in France. These were the first three to experiment with the camera obscura and a lens with a view to making pictures. This was in the early part of the last century. 1813 is usually given as the date Nièpce began his work. He worked in the direction of producing a printing plate, and succeeded finally in accomplishing this by covering a metal plate with bitumen dissolved in oil of lavender, on which he placed an engraved print in lines and exposed it to the light. The bitumen was hardened and rendered impervious to acid by the action of light, except where the lines of the engraving protected the plate; and after dissolving with a mixture of petroleum and oil of lavender the bitumen which had been protected from the light by the lines of the engraving, he etched the lines into the plate. In this manner he obtained an intaglio line plate, which could be printed in the copper-plate press. An impression of one of these plates, made in 1824, a portrait of Cardinal d'Amboise, may be seen in the United States National Museum at Washington.

The next name of importance in this connection is Mungo Ponton, who in 1839 discovered that a sheet of paper dipped in bichromate of potash and dried and exposed to light would turn from yellow, the color given it by the bichromate, to brown, thus establishing the fact that the bichromate when dry and mixed with glue (the sizing in the paper) was sensitive to light.

Next comes W. H. Fox Talbot, who was the father of modern photo-mechanical printing plate processes because the manipulation now used is practically his method of working, with some additions in first obtaining a negative and positive photographically. In 1852 Talbot took out a

patent for a method of producing intaglio plates by means of bichromate of potash mixed with gelatin or glue. He flowed a thin layer of the bichromated gelatin over a sheet of steel and exposed it to light under a line engraving. On removing the engraving and biting the plate with acid, he found the bichromated gelatin, which was hardened by the action of light, resisted the acid, while it penetrated into the steel plate through the portion of the gelatin that remained soft because it was protected from the light by the lines of the engraving. On removing the gelatin film, called *the resist*, he found he had an intaglio line-engraving, and as it was made entirely by the chemical action of the light on the bichromated gelatin, and the chemical action of the acid on the steel, it was produced photo-mechanically. The making of this plate involved the essence of the technique of all the photo-mechanical printing plate processes of the present day with one exception.

[The photo-mechanical relief processes (halftone and line engraving) would naturally be considered at this point; but as these commonly employed processes are described at some length in another volume of this series, explanation of their details is not necessary here.]

Photogravure

In photogravure, which is the chief photo-mechanical intaglio process, the result is attained for which the Duc de Luynes offered a prize in 1856. His announcement read, "It is with a view to hastening the moment so much desired when the process of printing or lithography shall permit the reproduction of the marvels of photography without the intervention of the human hand that M. the Duc de Luynes has established this prize."

Photogravure can accomplish this result when every operation of the process is perfectly successful. Some hand-

retouching of the plate is, however, almost always necessary to produce a satisfactory result.

The method used in photogravure is as follows: A copperplate of about one-eighth inch thickness is carefully polished and then cleaned with potash, whiting, and diluted sulphuric acid, washed with water and quickly dried. A box of suitable height is used for depositing on the plate either powdered asphaltum or powdered resin, which is called the grain. This grain may be either blown into the box with bellows, just before the plate is grained, or it may be in the box, in which case it is agitated by the rotation of the fan inside or by any other suitable means, and when the grain is distributed throughout the box in the form of a very fine powder the agitation is stopped and the grain allowed to settle. The coarser particles, being heaviest, will fall at once to the bottom and these particles are too coarse to be useful for the work. After the subsidence has gone on for some minutes and the finer particles of grain begin to settle, the polished copper-plate is placed on a board and put into the bottom of the box through a slot or door which is then closed tightly. The plate is allowed to remain until a fine powder is deposited over it.

It is removed after a few minutes and the process of graining repeated. Some workers, however, perform the operation but once, and some as many as three times. After the final graining the plate is taken out and placed on a stove heated to a temperature of about 195° Fahrenheit, if resin is used, and a higher temperature for asphaltum. The effect of the heat is to cause the fine grain to arrange itself in the form of round particles or dots, the coarseness varying with the coarseness of the powder. In some cases the grain assumes a vermiform appearance.

The heating must cease after a short period and the plate must be quickly cooled or these dots of grain will continue to expand and finally flow over the plate, rendering it

useless for the purpose. This layer of cooked grain on the plate is sometimes called an aquatint ground.

A warm solution of gelatin from which all impurities have been removed by special manipulation is next taken and a small percentage of bichromate of ammonia or potash is mixed with it; this is flowed over the grained copper, in a dark room, on a whirling machine which throws off by centrifugal force all excess of solution, leaving a very thin, even coating on the plate which is then allowed to dry. This gelatin film is called the "resist." When perfectly dry it is put in a printing frame in close contact with a glass positive, which must be a perfect copy in light and shades of the picture to be reproduced on the copper. The frame is brought out into the light and the exposure is made, that is to say, the light passes through the positive on to the coated copper. This light printing is usually made in the shade. The effect of the light will be to make the gelatin resistant to the acid in proportion to the transparency of the different tones of the positives. In the lights of the picture, which are the transparent parts of the positive, it will make the gelatin resistant to acid to a considerable depth. In the shadows of the picture, the dark parts of the positive, it will be affected to but a slight depth. The positive is finally removed and the plate is ready to etch.

The mordant, as the etching acid is called, is perchloride of iron, about 40° to 42° Baumé. It is poured into a rubber or porcelain tray into which the plate is plunged, proper care having been taken to cover the back of the plate and the margin of the copper on the face and outside of the work with a coating of asphalt to protect these portions from etching. The acid will bite through the thinnest portions of the gelatin resist first, these being the darks of the positive which have obstructed the passing of the light and prevented the hardening of the gelatin film to any

considerable depth, and the acid will attack the copper-plate *between* the particles of grain, as the resin or asphalt of which the grain itself is composed is acid resisting.

As the etching proceeds, the acid will bite deeper and deeper into the blacks and will also begin to bite in the next lighter tone where the gelatin is hardened to a greater depth. As the process continues the worker gradually diminishes the strength of the acid from 40° or 42° to 39°, then to 38° and so downward until in the lightest tones he has weakened his acid to 35° or 34°. The etching may last from ten minutes to half an hour. The darkest tones etch the longest time, the next tones somewhat less, and the lightest tones but very little, and not only has the grading in the time of biting from blacks to lights preserved the modelling, but the etcher has continually weakened his acid, so that all the tones lighter than the extreme black have been bitten in weaker and weaker acid, as they graded from dark to light, and hence are etched shallower and shallower as the acid is weakened.

The etching completed, the plate is removed from the acid, the film and grain are removed, and the plate printed in the same manner as described for other intaglio plates.

The result in photogravure is an impression composed of fine irregular shaped particles of ink of diminishing thickness from shadows to lights, usually closer together in the shadows than in the lights, this giving modelling by depth and division. The particles, however, are so close together throughout over the whole plate that the effect to the eye is that of continuous tones. The print resembles very closely a finely rocked mezzotint.

Photogravure undoubtedly produces the most beautiful results of the photo-mechanical processes. First, because it is an intaglio process and has all the advantages that the hand intaglio processes have over the relief processes, and second, because the plate may be extensively retouched.

The retouching is done with roulettes, scrapers, and burnishers. The object of the retouching is to repair any blemishes and to correct any false values in the plate and to add any loss of modelling.

The photogravure process in general use is identical with what is here described, except the resist; the gelatin film is made in a totally different manner.

Klič Photogravure

The method of photogravure in general use is known as the transfer process and is the discovery of Karl Klič of Vienna.

A thin film of gelatin (known as carbon tissue) of even thickness, slightly colored with pigment and adhering to a paper backing, is sensitized by drawing it through a bath of about 2% to 3% solution of bichromate of potash or ammonia. It is dried by heat or by means of an air current. A piece of this film is exposed to light under a positive—this time the positive is reversed as to right and left. After the necessary light exposure, the film is placed in a pan of cold water with the plate. At first the gelatin film curls up, but as it is softened by the water it gradually flattens, and just before it becomes perfectly flat it is placed upon the grained copperplate and pressed against it firmly with a rubber squeegee. It is removed from the water and dried between blotting paper for about ten minutes, that the gelatin film may adhere to the plate, and then the plate with the attached film is plunged into warm water.

The light printing is not carried so far as to harden the gelatin through to the back of the supporting paper. The gelatin which has not been acted upon by the light and which lies next to the paper will begin to dissolve and presently the paper which supports the film can be stripped from it and the film will remain attached to the copper. The development is continued until all of the gelatin

which has not been acted upon by the light, and thus rendered insoluble is washed away, and we have for our resist a film of gelatin very thin, but yet of varying thickness—thinnest in what are the shadows of the picture, thickest in the lights, and grading in thickness for the tones between these two extremes.

The manipulation of etching is the same as already described under contact Photogravure.

Collotype or Gelatin Printing

A most interesting development in photo-chemical printing is the process called collotype (from the Greek *kolla,* glue), and also known as gelatin printing, and under the names Albertype and heliotype, from special modifications in working.

The three principles upon which it rests are, first, the fact that gelatin mixed with bichromate of ammonia will become hardened by light in different degrees, according to the amount of light printing it has been subjected to; second, that if completely hardened it will not absorb water, but if partially hardened it will take up water in inverse proportion to its hardness; and third, that greasy ink and water have no affinity.

If we take a sheet of glass slightly roughened, flow a thin coating of albumen over it, dry it in a heated box, when dry flow over the albumen a coating of bichromated gelatin, again dry in a box, when this second coating is dry expose the plate in a photographic printing-frame in contact with a reverse negative that has been taken off the glass on which it is made, onto a transparent film and allow the light to strike through the negative onto this gelatin surface, we shall have a gelatin printing plate. When the free bichromate is washed from the plate it is ready to print.

The method of printing is simple. Water is dropped from a wet sponge and is allowed to rest on the plate until the gelatin has taken up all it will absorb. The remainder is sponged off and the plate is slightly dried with a blotting-paper.

The condition of the plate may be described as follows: In the shadows of the design (the light parts of the negative) the gelatin hardened by the action of light has absorbed no water. In the tones grading from the shadows to the lights the plate has absorbed more and more water, and the lighter the tone in the design (which means the darker the tone in the negative) the greater the absorption.

A lithographic roller of leather charged with greasy printing-ink is passed over the plate, and the shadows of the design (the hard gelatin on the plate) having absorbed no water will take the ink freely, the next tones having taken up some water will take the ink less freely, and the lightest tones which have taken up much water will take but little of the greasy ink.

If a gelatin roller charged with softer, more fluid ink is now passed over the plate it will act in the same manner as the first rolling, except by this means the delicate tones in the lighter tints are added.

The plate is printed on a lithographic hand press by first laying on the paper, then placing a sheet of smooth zinc on top of it, and running under pressure. The impression is lifted and we have the most beautiful tones which any process can give. They are soft and continuous, showing no grain to the eye. This operation is repeated for each impression, except that after a limited number of prints the water will have evaporated to some extent and the plate must be wet again. A larger number of impressions with one wetting may be obtained if glycerin is added to the water to prevent rapid evaporation.

The plates may also be printed on a power press by soaking with glycerin and water, the press being similar to the

lithographic steam press, except that it needs no damping roller and has a mask of paper to cut out clean edges to the prints. This mask is also necessary in hand-press printing. Usually the impression of the mask is evident in a slight depression of the paper close to the edge of the print.

The process is well adapted for small editions, as the cost of the plate is trifling. The plate is not kept after printing an edition, as it soon becomes too hard for use, but the negative which is on a flexible film is easily preserved in a book and a new plate is quickly made.

The process has grave defects, however, for fine work. The blacks are apt to be muddy, having no rich standing body of ink separated by fine spaces, as in photogravure. The body of ink is slight and run together as in relief printing of blacks; and, furthermore, no pure lights can be obtained, as however much the gelatin is wet it will usually take some ink from the second roller. The process has another serious defect in the fact that the plate, being very sensitive to moisture, will print with quite a different effect in a moist atmosphere than in a dry one. Again, a certain amount of moisture is taken up out of the plate by each sheet of paper printed, so that the plate is never twice in exactly the same state of dampness, and therefore will never twice take up the ink in exactly the same amount. An even-color edition by this process is almost impossible, yet the results as a whole, when skilfully worked, are of value, especially when the subject is such that it does not call for rich blacks or pure high lights. The middle tones of the process are more perfect technically than those produced by any other method, either hand or photo-mechanical.

[This concludes Mr. Elson's papers on the Reproductive Processes. The chapters following were written by other authors.]

CHAPTER VI

The Offset Printing Press

THE offset press is different from any other kind of press used in the printing or lithographing business in that the printed work is offset onto the paper from a rubber blanket.

All offset presses have their cylinders positioned one above the other, but not in a straight line from top to bottom; the middle cylinder is set a few inches to the front, or almost at right angles with the top and bottom cylinders.

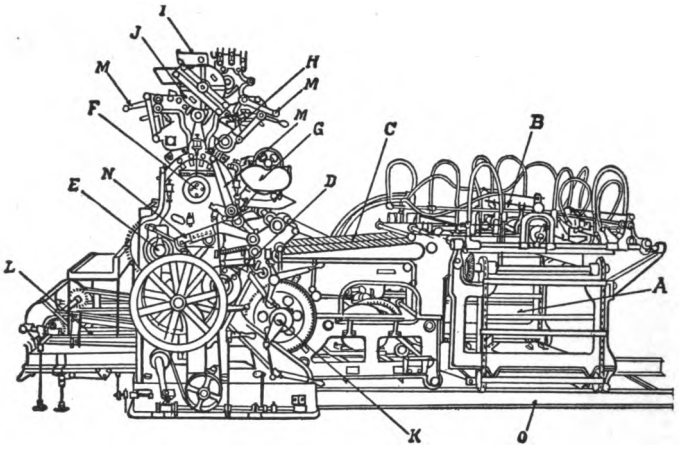
Cylinder No. 1, or the top cylinder, is the one on which the zinc plate is strapped and is known as the plate cylinder. Cylinder No. 2, or the middle cylinder, is the one on which the rubber blanket is carried and is known as the rubber blanket cylinder. Cylinder No. 3 is a plain steel cylinder with finely ground and polished surface and is known as the impression cylinder. All cylinders are the same size at bearers, but the blanket cylinder is usually ground smaller between bearers. This is done to give the operator a chance to take out or build up at will, so as to get the proper pressure for good printing. To secure the best printing the plate and blanket cylinders should be the same size between bearers. The lower cylinder is movable for adjusting when running heavier or lighter stocks. The cylinders are geared at the ends so as to work in time with each other. The plate cylinder and the rubber-blanket cylinder are so ground as to leave raised bearers at each end.

Unlike most presses the offset inking apparatus is built at the extreme top of the press; and immediately under and just over the press end of the automatic feeder is the water fountain and water rolls. It is well known that in

lithographic zinc or surface printing it is necessary to use water, which acts as a repellant to the kind of ink used, so only that portion of the plate where the printed lines are will take ink, the other portion taking a film of water. Lithographic inks of all kinds are greasy and when the plate is first made the work is rolled up with greasy ink and all the surface of the plate on which there is no work is washed and remains a clean grained surface. The water rollers pass over the plate first and the grained surface on which no work appears takes a slight film of water from the water rolls and the other part of the surface refuses to take water because of the greasy ink.

The plate on cylinder No. 1, as referred to above, is a full sheet of zinc covering the entire surface of the cylinder. To prepare this plate for the press it is first necessary to grain the surface of the zinc by placing in a grainer box with fine sand and water added; then the surface is covered with marbles or steel balls and the machine is geared to rotate in a circular motion from side to side, the marbles and the sand roughing the plate and giving it a uniform grain. Graining plates is not technical work, and different grains, which are often necessary for different classes of work, can be secured by running, working the apparatus a longer or shorter time. Only a few minutes are necessary to grain any plate.

The plate is now washed and is then ready to receive the design or transfer. This is done by taking a proof of any desired type form, electrotype, line etching, wood or steel engraving on transfer paper. This is a paper coated with a solution made as follows: Half a pound of flour, half a pound of starch, and two ounces of dextrin, dissolved in cold water to a consistency of a syrup; mix this into a half gallon of water after it has been heated to a boiling point; pour in slowly and stir constantly. Then take from the fire and add one pound of glycerin. Give the paper one or two coats of this, as desired.



The Harris Offset Press, Automatic Sheet Feed

DESCRIPTION OF OPERATION.—The pile of sheets is placed at A, on a platform which is automatically raised the thickness of the sheet as the feeder at B separates the top sheet from the pile and carries it forward to the roller table C, which places the sheet against fingers at the front and one side, for feeding register. The sheet is then moved forward by means of feed rolls to the gripper fingers of the impression cylinder D, which is a bare steel cylinder with a highly polished surface.

The impression cylinder D brings the sheet into contact with the surface of cylinder E, which contains the rubber cover holding the inked design or impression which it has received direct from the prepared zinc or aluminum plate placed around the cylinder F.

The aluminum plate containing the design to be printed is about .012 of an inch thick. It has been prepared like a lithographic surface, by the transfer process, and is drawn tightly around the cylinder. Next to this cylinder F is an apparatus at G which dampens the surface of the plate by means of cloth rollers while the cylinder rotates. The ink fountain I supplies ink to a set of distributers and rollers at J and H. The plate passing under the inking rollers receives ink only on the lines of the design, as in the lithographic process described in these pages.

After the sheet of paper is printed it is taken by the delivery cylinder K and is passed on to the receiving table at L.

The levers M are for raising or lowering the inking rollers. The mechanism N is connected to an automatic trip in such a manner as to throw the printing cylinders apart in case of interruption in the feeding of the sheet. The sheet feeder B and the roller table C may be moved back from the rest of the machine in order to give better access to this part of the machine.

These proofs are taken by inking the forms or designs with transfer ink with a hand roller and pulling a good impression, the same as in ordinary printing.

These impressions are laid, face upward, on a sheet of paper the size of the printing plate, in exactly the position that they are to appear in the finished work. These proof sheets are made to stay on the larger sheet by pricking with a sharp point through both papers. Then the large sheet holding the small forms or proofs is laid face downward on the zinc plate and pulled through a hand press, which presses the work onto the face of the zinc. When this is done soak off the transfer paper with water, and after washing and drying the plate gum it up lightly with a solution of gum arabic and fan the plate dry. Then rub it up again by using a sponge with thin gum in the left hand and a rag charged with thin ink in the right hand and go over the plate with these alternately several times, using more gum if the plate has a tendency to tint. Dry again and gum up the plate, spreading the gum evenly with a damp rag; fan dry; wash out the plate with a rag (free from moisture) with asphaltum; fan dry; wash again with water and take all surplus water off with a damp rag and roll up with hand roller. After the transfer is well charged with ink, dry and dust the plate with powdered resin, remove all spots, and then etch and gum up plate.

An etch for this purpose can be made as follows:

Solution No. 1—1 oz. phosphoric acid syrup, 85%; 1 oz. water.

Solution No. 2—1 oz. chromic acid (chemically pure); 1 oz. water.

Take one ounce of No. 1 and one ounce of No. 2 and sixteen ounces of thin gum. Mix the gum and No. 1 together first, and then add No. 2.

The plate is now ready for the press and the front or gripper edge of the plate is inserted into a row of clamps

at the front of the cylinder. After clamping the zinc, which is flexible (.010 to .012 thick), it is pulled around the cylinder and the back end inserted in the clamps, which automatically draws the zinc tight to the cylinder. The printing plate goes on the top cylinder.

The rubber blanket is a specially made blanket for offset work, and is drawn around the second or middle cylinder much as the plate was put on the cylinder above. Until the last few years rubber blankets have been imported from England, but they are now being manufactured successfully in the United States.

We are now ready to print, so far as the plate is concerned; but there are several press adjustments that have to be made, and should be made before the plate is on the press, if possible.

The automatic feeder must be set to run in time with the printing cylinders, and this is done by fitting the gears to mesh at a certain point when pushing the feeder up to the press. The register guide will have to be set, too; and most important, after plate is on, is to see that the printing pressure is correct.

A peculiar thing about one make of offset press, and the one that has by far the most presses in successful operation, is that the front guide for register is on the cylinder and there is no tumbler gripper used. Higher speed can be secured because of this. All offset presses, except the one first mentioned above, use automatic feeders of the same kinds as those used on ordinary printing presses, but the first concern manufactures its own feeder and it is an integral part of their press. It is worked by suction and has four suckers which pick up the paper, advance it to what is known as take-in rolls; the paper then goes onto a roller table (a series of wooden rollers all turned from small gears) which advances the sheet to the stop guides; then it is picked up by over-feed rolls and after being

registered sidewise is carried into the guides from the over-feed rolls at a little greater speed than the face speed of the cylinder, and the grippers only open slightly to allow sheet to be registered and then close at proper time. There is no chance for jar or kicking the sheet out of register.

The paper stock is piled on a truck and run into the automatic feeder; one truck can be loaded while the other is being piled. Then as the paper is taken off of the pile in the feeder the mechanism of the feeder automatically raises the truck top and when nearly to the top a new truck load can be shoved in under and be in readiness, changing with only a momentary stop of the machine.

Most of the large presses have also what is known as a "pile delivery," from which the truck top is started at the top of the lift and recedes or goes down automatically as the paper is delivered from the press.

There is practically no make-ready to an offset press other than simply building up the entire rubber blanket to have the proper pressure to both the plate cylinder and the printing cylinder. Therefore one zinc plate can be taken off the press and another put on and the job started to run within from 20 to 30 minutes in most cases.

The ink used in all cases is so-called offset, being an ink that is mixed short and not stringy like the ordinary printing inks. The offset process is more economical in the cost of ink than other methods of printing, because of the relatively inexpensive cost of manufacture and the smaller waste due to the method of handling.

Almost all kinds of paper can be used for offset printing, but the paper manufacturers have met the demand by making a varied line of soft papers which are less expensive, more bulky yet lighter in weight, on which beautiful half tones can be printed with little or no make-ready.

Although the transfer method of putting the design on offset zinc plates has been the universally accepted one up

to a short time ago, there is another method which is taking precedence over it and has more elasticity than any other known method; that is, the photolitho method. The best plates have been made by this photographic method; there are many different processes being experimented with. The old photolitho idea has been most successful up to the present time. However, we may look to see great improvements made through some of the processes that are now being tried out; in fact, there are several that have been perfected which simplify the plate-making method, especially whereby large plates can be made quickly by the photolitho method, often in one or two hours' time.

Photolithography as applied to offset printing has progressed much faster than process work for the relief-printing presses at the inception. It was in 1878 when Frederick Ives made the first printing plate by photography, but it was not until 1881 that he made the first commercial half-tone plate; and it was a number of years after this before the half-tone was perfected with any material degree of success.

One class of work that is rapidly being claimed for the offset press is all kinds of ruled and blank forms. This is so from an economical standpoint, as no brass ruling is necessary, but the most complicated ruled jobs can be drawn by a sharp point directly on to the zinc plate. Color work of all kinds has also become a specialty for the offset printing method.

CHAPTER VII

Rotary Photogravure

RECENTLY the photogravure process has found a new application in the form of the engraving and printing method known as rotary photogravure. In this process an intaglio photo-engraving, instead of being produced on a flat plate to be printed from by the slow method of the copperplate or steel-plate press, is engraved by the cross-line method on a copper cylinder and printed from by the far more rapid means of the rotary press. For such printing the ordinary method of inking intaglio plates, which consists of forcing thick printer's ink into the hollows of the engraving and wiping off the surface before each impression, is impracticable. Instead of that, the inking is done by the method used in the printing of textile fabrics and wall paper from copper rolls. This is effected by covering the surface of the engraved cylinder with a thin liquid ink of any desired color, which flows into the hollows of the engraving and is cleared from the surface by means of a scraper, known in the trade as a "doctor," leaving the ink in the hollows from which it is taken up by the paper as it passes over the rotating cylinder under pressure from above.

The main features of the rotary photogravure process are the production of the engraving on the cylinder as an intaglio etching with graduated depths and producing this intaglio with a network of thin cross lines. These are provided for the purpose of holding the scraper or "doctor" on the surface of the intaglio, the liquid ink left by the scraper being held in the interstices between the crossings in quantity varying with the depth of the etching. The result is produced by exposing a washout gelatin film under

a transparent positive of the picture, then exposing it again under a line screen, but using one of transparent cross lines instead of the normal half-tone screen of opaque cross lines. The exposed film is then placed on the copper cylinder and there developed by washing out, or it may be developed on paper like a carbon print and transferred from that to the surface of the copper. The metal is then etched with iron perchloride which penetrates the dry film more or less, according to the varying thickness of the undissolved gelatin, and bites into the surface to correspondingly varying depths. The cross lines of undissolved gelatin, resulting from the exposure through the transparent screen, shield the metal surface uniformly, leaving a corresponding network of thin cross lines in the etching.

Like all intaglio engraving and printing processes, the rotary photogravure method is capable of producing very fine effects; but as the engraving must be cylindrical and requires a special method of printing the process can not be economically applied except where large editions are to be printed off, and it is consequently available mainly for use in the pages of illustrated periodicals of large circulation and for pictorial supplements to daily newspapers. The impression cylinder carries the sheet, and the presses in use today are usually of the web type, printing a continuous roll and running at a speed of 2500 to 3000 impressions an hour. The process must be worked with great skill and knowledge of minor details.

CHAPTER VIII

Copper-plate and Steel-Die Printing

TWO classes of intaglio printing which have grown to a very considerable extent, and which are closely associated in a distinct branch of the industry, are those known as copper-plate printing and steel-die stamping. These methods of printing are particularly specialized in connection with the stationery trade, although in recent years work of this kind has been used to some extent for general business purposes.

The classes of work for which copper-plate printing is employed are personal and social cards, wedding and party invitations, greeting cards, holiday and business announcements, letter paper, envelopes, etc. Printing of this kind is usually done in limited quantities, for personal distribution or to be sent through the mail, and therefore the relatively slow and expensive method of duplicating copies suffices to meet the requirements.

Copper-plate Engraving

The engraving is usually done on a plate of copper about one-sixteenth of an inch thick, the size of the plate being a little larger than the card or sheet to be printed from it. The face of the plate is highly polished and the letters, lines, or other designs are carefully planned on its surface in the desired position, special care being taken in the placing of the lines and letters before the engraving is commenced.

The engraver first makes guide lines with a soft pencil or marking tool. Horizontal lines indicating the size and position of the word-lines are made first, beginning with the base lines for the small letters, then the line for the

top of the tall letters, and next the height of the small or lower-case letters. If the lettering is to be script (which is a common style employed), light vertical lines are made at regular distances apart across the length of the whole line. These vertical lines are ruled at an angle to correspond with the slant of the main straight lines of the letters to be engraved. When these guide lines are made the letters and words of the copy are lightly sketched and spaced in the desired position across the card. This sketching is done carefully, as the general result depends upon the skill with which this preliminary lay-out is executed.

Fig. 16. Method of Engraving the Plate.

When the plate surface is thus prepared the actual engraving is done with a cutting tool or graver held in the hand. The heavy lines are cut first, usually all the heavy slanting lines, then the light slanting lines and the curved lines, after which the position of the plate is changed slightly and the cross lines connecting the up-and-down strokes are put in. Next there are the finishing points, such as the ends of the capital strokes, and lastly the engraver goes over the whole plate to correct any defective or unfinished lines.

This engraving is done under a strong magnifying glass held in a position to allow free movement of the hands of

the workman. The plate is supported on a small leather-covered cushion upon which it can be held firmly and be turned readily to the desired angle for ease in cutting the various lines.

Engraved copper and steel plates will reproduce fine lines with a delicacy and precision superior to any other method. Copper plates will give clear impressions up to several hundred copies, often thousands of copies, depending upon the character of the work, the stock upon which the printing is done, the manner in which the engraving is executed, and the skill with which the plate is used in printing. Engraved copper plates may be steel-faced or nickel-faced to make them more durable for long runs. A steel plate is more difficult to engrave and consequently more expensive as well as more durable. Where many copies are required, or the printing is to be on tough stock, or the engraved plate is subjected to severe usage, steel plates are used instead of copper.

Printing the Copper Plate

After the plate is engraved and proved for correctness it is attached to the bed of the press for the printing process. A wax-like preparation or cement on the back of the plate is used to hold it in place. This secures it firmly and yet allows it to be removed easily after the required number of impressions are taken and the plate and bed to be cleaned off readily.

The inking is done by means of a small, soft roller, filling up the lines of the engraving. The surplus ink is then wiped off the surface of the plate, as already described for other intaglio printing. Care is taken to fill all the lines and to avoid taking the ink out of the shallow lines when the surface is wiped off. This part of the work requires considerable skill. The polished top of the plate must be perfectly clean in order to produce a clean printed

sheet. The wiping is done first with a soft cheese cloth or similar material, and then with a little fine bolted whiting on the ball of the printer's hand. The final cleaning is done with the hand—a convenient and effective method, as well as one causing the least amount of wear on the plate. It is not a cleanly method for the printer, as the work produces a grimy condition of the hands. No other method, however, has been found to equal the human hand for this particularly important detail of the work.

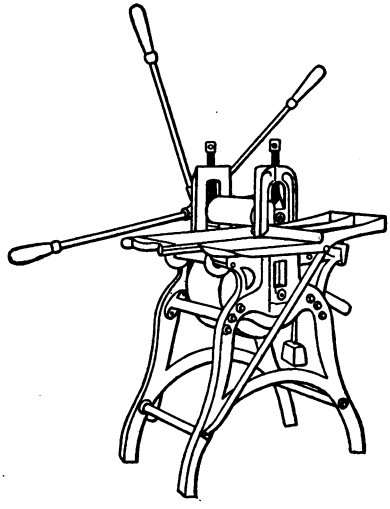


Fig. 17. Plate Printing Press.

The depth of the engraving on an intaglio plate is not very great, in many places not more than the slightest scratch. Consequently a very little wear of the surface will quickly affect the depth of these lines. The wear of a plate is due chiefly to the operation of wiping off the ink from the surface, and the wear due to the actual printing pressure or other causes is relatively slight. For this reason the cleaning of the plate after each impression has a great deal to do with the durability of the plate. A careless, unskilful plate printer will quickly wear a good plate, while a careful workman will get better impressions and more of them.

The press used is entirely unlike that employed for relief printing. It consists of a bed and a curved impression surface, like part of a cylinder, called a D-roller (Fig. 17). Printing surfaces for work of this kind are relatively small

as compared with other printing machines, because only small pieces of work are done. The pressure required, however, is many times more than is needed for typographic or relief-plate work of the same size sheet, as the sheet to be printed, when laid on the plate, must be forced down into the engraved lines containing the ink. The impression roll and the bed are geared to operate together. The bed is supported underneath by a large heavy roller directly in vertical line with the impression roller above. These two rotating parts are held firmly in the side frames of the press, and the impression on the plate as it lies on the bed is given between these two stout surfaces turning together in journal boxes. The amount of impression is regulated by screw bolts in the journal boxes of the impression roll in the upper part of the side frames.

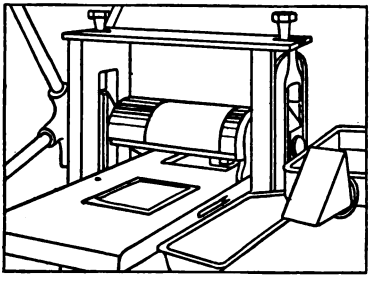


Fig. 18. Detail of Press Showing Method of Printing.

The press is operated by means of the long spokes shown in the illustration. Sometimes these long spokes are banded by an iron hoop, making a large wheel which allows the operator to grasp it with greater facility when ready to make the impression.

When the plate has been inked in and wiped, the card or sheet is laid in position for printing. One or more sheets of smooth cardboard are interposed between the sheet and the impression roll to protect the back of the printed sheet while the impression is being made. This extra cardboard is usually suspended against the impression roll in position to meet the sheet on the plate when the press is turned for the impression.

The card or sheet to be printed is laid to gages (usually slips of paper pasted on two margins of the plate) so that the printing may be properly placed. When the card is in place a turn of the press makes the impression and the bed comes back again into position for the next impression.

Plate printing requires a deftness of touch and skill of motion that are acquired only after experience and close attention to little things. Many operations are necessary to produce each print, and these must be performed with thoroughness to secure that nicety which is desired in work of this kind. Girls are often employed to assist the printer by taking off the cards and interleaving them with tissue sheets.

Although plate printing for small quantities is done chiefly by hand work on presses of the kind just described, there are other presses using mechanical power to perform the important operations. Inking and wiping the plate are done automatically, though the cards are fed and taken off by hand.

Correcting the Copper Plate

A slight amount of correcting may be done on a copperplate if an error is made in engraving or a change is desired in the wording. When the change is to be made where the lines are shallow and the correction can be inserted without disturbing the rest of the lettering, the plate is tapped on the back so as to raise that particular spot on the face a little higher than the surrounding surface. The wrong lines are then rubbed down and obliterated by burnishing the surface until it is smooth enough to allow a re-engraving of the new lines. Corrections and changes within a line already cut in the plate are limited to substitutions of letters or words which occupy the same space as the original matter to be removed. A letter or word at the beginning or end of a line, or a whole line, may be added if there is room on the plate, or they may be erased completely. Changes made on engraved

plates are expensive, however, and great care is usually taken to prepare the copy properly before the engraving is done. A plate which has become worn by many wipings and impressions may be re-engraved and repaired in the same lines to make it in good condition again.

Engraving by Machine

A great deal of copper-plate engraving of certain letter styles is now done by machine. The machine employed is constructed on the pantagraph principle. In this apparatus the plate to be engraved is fixed on a table in the upper part and a set of large master-letters, engraved in a brass plate, are held in position on a lower table. A fine pointed tool on the end of a suspended frame is moved over the master-letters by the operator and all the motions of this point are duplicated in a much reduced scale by another fine glass point held over the copper-plate on the table above.

The engraving is not done in the metal itself, but in a ground or "resist" surface spread upon the plate. The actual engraving of the metal is done by acid etching, somewhat similar to the common etching process. The acid etching does not, however, produce a plate ready for printing; it makes only the outlines and the fine detail, but this detail is done in a manner which saves a great deal of hand work. After the etching is completed the ground is removed from the plate and hand-tool cutting is necessary to engrave the wider and deeper lines and to finish up any ragged places left by the etching acid.

Steel-Plate Engraving

Steel plates engraved in intaglio are largely used for bank notes, certificates, bonds, business stationery, and other work in which it is desired to get the quality of copper-plate printing with a more durable metal to withstand the

wear of many impressions. The steel is soft enough to allow cutting the lines with a hand tool, but is harder than copper, and after the engraving is completed the steel may be made still harder, thus making the most durable of printing surfaces. For firm, sharp lines nothing equals steel skilfully engraved. For this reason steel is also used for finely printed portraits to be used as inserts in special editions of books, annual reports, and publications of a permanent nature.

A steel plate for engraving is commonly about one-eighth of an inch thick, with a polished face slightly beveled at the edges. The general method of engraving is similar to that of copper-plate work, by hand tools and by acid etching, though with minor variations due to the harder nature of the surface and the character of the subject to be engraved.

Steel is usually cut or etched a little deeper than copper-plates, this little distinction often being noticeable, in a comparison of the impressions from each, by a slightly greater quantity of ink on the surface of the steel-plate impression. Etching is employed to a large extent, the detail of the design being first outlined by this means and the subsequent work of finishing the plate done by re-etching and hand-tool cutting. This latter is necessary in the larger lines especially. The greater part of the lettering and deep-line work is engraved by hand tools. The shading, tints, cloud effects, and light details are usually done mechanically on a ruling machine.

When the etching process is used a ground is first spread on the plate and the photographing, drawing, ruling, or transferring of the design is done on this surface, as explained in previous pages of this book. In portrait and pictorial subjects a great deal of the work is done by means of a ruling machine. This is a mechanism by which a fine marking point is made to trace a series of parallel, wavy, or crossed lines in varying widths and distances apart, to

produce the different gradations of color necessary for the picture. Half-tone screens in cross-line and Ben Day patterns are also transferred to the ground to prepare it for the etching. An examination of any fine engraving of this character under a strong magnifying glass will prove an instructive study.

The copy is put on the plate in various ways. In all cases the design must be carefully planned in detail before the engraving of the metal is begun. The necessity for this is even greater than in copper-plate work, on account of the impracticability of making changes in the metal after it is once cut. Some kinds of plain copy may be drawn directly on the metal and the engraver's skill may be depended upon for satisfactory results. Copy may also be placed by photography, by tracing, or by offsetting. Work that is to be cut by hand should be in line, but half-tone negatives may be used to reproduce work that is to be etched.

Elaborate borders such as seen on bank notes, bonds, certificates, etc., are made mechanically. The designs are first made intaglio and are afterwards transferred in relief to small steel cylinders or "rolls." These rolls are then hardened and are placed on a special machine where they stamp the design in a continuous line in the portions of the plate to be used for printing. By this means duplicate plates can be made quite readily. These rolls are, of course, very expensive and are made only for important work where the outlay will warrant the expense. Large firms have certain stock patterns which they can use in various ways. The purpose of the roll is one of accuracy, as it would be quite an impossible task to engrave by hand a continuous border and make it exactly uniform throughout. By means of the "roll" the pattern can be forced into the plate and the pattern repeated in uniform design on all sides of a border.

The manner of printing a steel plate is similar to that of a copper-plate, except that in the case of larger plates more powerful presses are used.

Steel-Die Stamping

The difference between a steel plate and a steel die is chiefly in the size. The difference in size is due to the special character of the work for which they are used. The die is a small block, about one-half inch thick, and from one inch square to sizes as large as is practicable to make a suitable impression. For use in stamping stationery, in which it is largely employed, the size does not average larger than two inches by six inches. The smaller sizes are more common, for stamping small groups of lettering, like an address line, for initials, monograms, crests, trade-marks, and similar small devices.

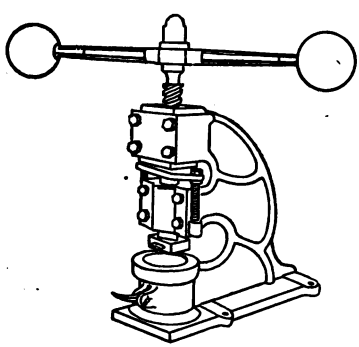


Fig. 19. Hand-Stamping Press.

The engraving of dies is almost entirely by mechanical or hand-tool work and the cutting is much deeper than in the larger steel plates. The printing is done with the die and a counter-die, which is a reversed counterpart of the design registered in the press to strike the back of the sheet and press it into the engraved die. The deep cutting and the counter-die thus produce the design on paper in bas-relief—in color when the die is inked, which is the common practice, but sometimes in blank without ink. This embossed or raised surface of the impression is the distinctive feature of die stamping.

For envelopes, cards, letter paper, and small work the stamping is done on a special kind of press, a relatively small apparatus resting on a bench or strong table. In the ordinary style of this machine the die is held face downward in an impression-head operated by a powerful screw. The die is fitted into a slot from which it is removed readily, as it must be taken out after each impression for inking and wiping for each copy.

The counter-die is made in the press, after the die is fitted into place, by forcing an impression into a piece of hard rubber, or some substance which will take an impression when soft and then will harden to withstand the repeated striking of the impression. The inking is done by simply brushing the engraved part with a wad or soft brush with the color, and the wiping of the surface is done by deftly rubbing it once or twice on a sheet of soft paper.

Paper and Card Adapted for Intaglio Printing

The kinds of paper and card adapted for copper-plate and steel-plate printing are limited to relatively few varieties. Cheap stock is never appropriate. The better grades of writing paper are much used. Soft and spongy papers will not give clean, sharp impressions. Coated papers, such as are used for half-tone relief plates, are quite unsuited on account of their brittleness and because the coating is injurious to the plates. Hard-finished bond papers are used for bank-note and certificate work, but these are slightly dampened for printing. Papers of good fiber with some absorbent quality and of smooth but not polished surface, like vellum, or of slightly rough or dull finish, are the kinds well adapted for intaglio printing. Pasted bristol card and the stock known as "wedding" are largely used.

Imitation Intaglio Printing

One feature which distinguishes an impression made with an intaglio plate from one made with a relief plate is that the ink impressed on the paper by the former process is slightly above the surface of the paper itself, whereas with a relief plate the ink is pressed into the paper and does not usually appear above the surface when dry. This embossed effect of the intaglio plate is commonly considered desirable in certain kinds of work and it can be imitated in a manner with the cheaper relief plate or typographic process. The imitation is made by printing the sheets with a special ink or size and immediately dusting the sheets with a fine powder of a resinous character, and then passing them over a heated surface or through a hot compartment where the heat melts the powder sufficient to cause it to adhere to the ink. The addition of the powder to the ink produces a slightly raised surface on the printed parts of the sheet.

The operation of the method depends upon the ink or size and the powder used, as well as upon an apparatus by which the heating and dusting of the sheet is accomplished. Otherwise the manner of printing is similar to that of typographic work on a job press and impressions can be made much faster than upon the ordinary intaglio-plate press. There are several patented substances and machines for work of this kind, and inks or powders may be obtained in a variety of colors, both in high gloss and in dull finish effects, to imitate the colors used by plate printers.

Supplementary Reading

THE ART OF LITHOGRAPHY—By Henry J. Rhodes, Published by Scott, Greenwood & Son, London, England, 1914. A manual of planographic printing. 327 pages, illustrated.

HANDBOOK OF LITHOGRAPHY—By David Cumming. Published by Adam & Charles Black, London, England. 243 pages, illustrated, with questions and index.

OFFSET LITHOGRAPHY—By Warren C. Browne. Published by the National Lithographer, New York. 200 pages. A recent publication treating of photolithography, offset, and tin-plate printing.

COLOR PRINTING AND COLOR PRINTERS—By R. M. Burch. Chapter on Modern Processes by William Gamble. Published by Baker & Taylor Co., New York. 274 pages, large 8vo.

PENROSE ANNUAL—Published by Lund, Humphries & Co., Ltd., London, England. An illustrated review of all photo-mechanical processes edited by Wm. Gamble. Each volume contains articles on the latest developments in illustrative and reproductive processes.

THE GRAPHIC ARTS AND CRAFTS YEAR BOOK—The American annual review of the printing and allied industries. Published by the Republican Publishing Co., Hamilton, Ohio. Contains a section on Plate-making and Engraving.

HANDBOOK OF PHOTOENGRAVING—By N. S. Amstutz, Inland Printer Co., Chicago. A revision of Jenkins' Manual of Photoengraving.

HALFTONE AND PHOTO-MECHANICAL PROCESSES—By Stephen H. Horgan. Published by the Inland Printer Company, Chicago. 234 pages illustrated. One of the best books on the subject.

ETCHING AND OTHER GRAPHIC ARTS—By George T. Plowman. Published by John Lane Co., New York, 1914. 154 pages, illustrated.

ETCHING—By Earl H. Reed. Published by G. P. Putnam's Sons, New York. 1914. 148 pages, illustrated.

WOOD ENGRAVING—Three essays by A. V. S. Anthony, Timothy Cole, and Elbridge Kingsley. Published by the Grolier Club, New York. 1916.

SUGGESTIONS TO STUDENTS AND INSTRUCTORS

The following questions, based on the contents of this pamphlet, are intended to serve (1) as a guide to the study of the text, (2) as an aid to the student in putting the information contained into definite statements without actually memorizing the text, (3) as a means of securing from the student a reproduction of the information in his own words.

A careful following of the questions by the reader will insure full acquaintance with every part of the text, avoiding the accidental omission of what might be of value. These primers are so condensed that nothing should be omitted.

In teaching from these books it is very important that these questions and such others as may occur to the teacher should be made the basis of frequent written work, and of final examinations.

The importance of written work cannot be overstated. It not only assures knowledge of material but the power to express that knowledge correctly and in good form.

If this written work can be submitted to the teacher in printed form it will be doubly useful.

QUESTIONS

1. What is the purpose of the reproductive processes in the graphic arts?
2. From what is the design upon the plate made?
3. What is a print from a plate intended to be?
4. What are the elements of all pictures?
5. What elements are used in the reproductive processes; what do they express, and how?
6. What is a hand process?
7. What is a photo-mechanical process?
8. Upon what do photo-mechanical processes depend for successful results?
9. Describe a relief printing plate.
10. What is necessary for a good relief plate?
11. On what does the amount of ink to be used on a relief plate depend, and why?
12. Give two special characteristics of relief printing.
13. Can continuous graded tones be produced by a relief plate?
14. For what was relief printing originally used, and how has it developed?

15. What are some of the capabilities and some of the limitations of relief printing?
16. Name two masters of this art and indicate some of the excellencies of one of them.
17. Who originated relief printing?
18. What are the earliest relief prints known?
19. What is a wood cut, and how made?
20. When did wood cuts begin to be used?
21. Who was Thomas Bewick, and what change did he introduce in wood engraving?
22. What is the difference between the old and the new art of printing from wood?
23. Describe the wood engravers' tools and tell for what purpose each is used.
24. How are wood engravings used for printing?
25. What are the advantages of relief-plate printing over other kinds of printing?
26. What has been the educational value of this process?
27. What is the characteristic of the intaglio processes?
28. How is the ink applied in these processes?
29. How is the ink prepared?
30. What sort of ink is used in these processes?
31. Describe the process of inking the plate and taking the impression.
32. What effects are produced by the quality of the ink?
33. What can be done by this process?
34. State the excellencies of this process.
35. What is modelling by division? by depth?
36. What is intaglio line engraving?
37. How is line engraving supplemented?
38. Describe the origin of line engraving, and state when it was first practiced.
39. Name some early engravers.
40. What changes were made in the process of making the prints?
41. Name some famous line engravers in different countries and tell what you can about them.
42. When did the art flourish; when did it decline, and why?

43. When were copper plates used and when steel?
44. What is the modern method?
45. Name the tools used and describe the use of each.
46. What is the commercial use of this process?
47. How does etching compare in difficulty with engraving? Make this comparison quite full.
48. How does the etcher prepare his plate?
49. How does the etcher make his drawing on the plate?
50. What is "biting and stopping-out" and what is "flat biting"?
51. How does the etcher finish his plate?
52. How is the plate printed?
53. Why is etching supreme among the intaglio processes?
54. What is the mezzotint process?
55. Describe the rocker and its use.
56. How does the mezzotinter proceed after he has finished rocking his plate?
57. How is the mezzotint printed?
58. What are the excellencies of the mezzotint?
59. When was the mezzotint invented?
60. What are the limitations of the mezzotint?
61. Describe dry pointing.
62. What are the planographic processes?
63. Tell about lithographic stone.
64. What three methods are used in lithography, and how is the stone prepared for each?
65. Describe the production of a lithograph by each of the three methods.
66. Describe the transfer process.
67. What advantage has it?
68. Describe briefly a photo-mechanical process of engraving.
69. What are its advantages over other processes?
70. What are some of its limitations for artistic work?
71. How long has photo-mechanical engraving been practiced?
72. What can you say about its invention and development?

73. To whom is credit due for first producing practical results with the process, and what was his achievement?
74. What can you say about the use of the process today?
75. What is the result produced in photogravure?
76. Describe fully the method used in photogravure, including the preparation of the plate, the photographing, the etching, and the final retouching.
77. Name and describe the process invented by Klič.
78. Describe briefly the principle of collotype printing, stating its peculiar advantages and some of its disadvantages.
79. Describe the offset printing press, including the ink and water rollers.
80. How is the plate on the No. 1 cylinder prepared?
81. How is the design put on the plate?
82. Describe briefly the fastening of the plate and preparation of the press for printing.
83. Describe methods of feeding the offset press.
84. What can you say of "make-ready," ink, and paper in offset printing?
85. What is taking the place of the transfer method in putting the design on the plate?
86. What special kind of work is done very successfully on the offset press?
87. Describe briefly rotary photogravure.
88. What is the distinctive feature of rotary photogravure?
89. What are the peculiarities and capabilities of rotary photogravure?
90. What is copper-plate printing now largely used for?
91. Describe the engraving of a copper plate.
92. What is the special thing which copper and steel intaglio plates will do better than any other printing process?
93. What can you say of the durability of copper and steel plates?
94. Describe fully the process of printing from a copper or steel plate.
95. How can a copper-plate engraving be corrected?
96. Tell what you can about engraving by machine.

97. What is steel-plate engraving used for, and why?
98. How are steel plates made?
99. How is the copy put on a steel plate?
100. What mechanical process is used in engraving steel plates? Describe its use.
101. How are steel plates printed?
102. What is the difference between a steel plate and a die?
103. How are steel dies engraved?
104. How are steel dies printed?
105. Describe the use of the counter-die.
106. What kinds of paper are used for intaglio printing?
107. Describe a method of imitating the embossed impression of an intaglio plate.
108. What materials are used to produce this imitation work?

ACID BLAST—A method of etching halftone and line plates by forcing sprays of acid on the face of the plate, instead of simply immersing in the liquid. Greater depth of etching and sharper lines are obtained in this manner.

ALBERTYPE—A picture printed in ink from a photographic plate of gelatin and albumen sensitized with potassium bichromate. Also the process of printing such a picture. Named after Joseph Albert, the inventor.

ALUMINOGRAPHY—The process of making and using aluminum plates for lithographic and offset printing. Also termed Algraphy.

ANASTATIC PRINTING—A process of printing from slightly raised metallic surfaces, reproducing from an old print a series of new impressions. The print to be reproduced is treated with a weak acid and submitted to pressure against a metal plate, transferring and fixing the design, which is then etched as a relief plate.

AQUATINT—A method of etching on copper in which the tinted parts are bitten in the plate by acid.

ARTIST'S PROOF—One of the first impressions of an engraving, lithograph, etc., especially one with the artist's signature.

ARTOTYPE—See Albertype.

BATH—A pan or other vessel containing a liquid or solution for toning, developing, etching, or plating.

BITE—To cut into or corrode a metal surface with acid, as in etching; to etch.

BURIN—An engraver's tool with a lozenge-shaped point; a graver.

CALLIGRAPHIC ETCHING—A process of etching in which the design is made with pen and ink on a clean copper plate. When dry the plate is covered with a thin varnish or etching ground, smoked and soaked in water to soften the ink, which can then be removed with the varnish by a gentle rubbing, leaving the design to be etched in the usual manner.

CAMEO—In a general sense, any small carving or engraving in relief; reverse of intaglio.

CEROTYPY—See Wax Engraving.

CHALK PLATE PROCESS—A method of producing a printing plate by stereotyping from a drawing made by a needle on a metal plate that has been thickly coated with a chalk preparation.

CHIAROSCURO—The distribution or the blending of the lights and shades in a picture.

CROSS-HATCHING—A method of shading, in drawing and engraving, by a series of crossed parallel lines.

CLEAN WIPE—When every particle of ink is removed from the surface of an intaglio plate, as when printing a line engraving.

COLLOTYPE—See Albertype.

CUT—A term improperly used to mean an engraved plate or a print made from an engraved plate of any kind. See page 13.

DRY POINT—A method of engraving in which a sharp needle is used to scratch the surface of the plate.

ETCH—To engrave by means of an acid or corrosive fluid.

ETCHING INK—An ink having exceptional acid-resisting quality.

GELATIN PRINTING—A method of printing in which a film of glue or gelatin sensitized with bichromate of potash or ammonia and light-printed is spread on a plate and used as a printing surface. See Albertype.

GRAIN—A granulated effect given to a plate or print, produced in various ways.

GRAPHIC ART—A comprehensive term meaning painting, drawing, engraving, printing, lettering, writing, and other arts in which lines or other marks are made on a surface.

GROUND—A coating laid on the surface of a plate before engraving or etching to protect the metal, or upon which to outline details of an engraving.

HALF TONE—A middle or gray tone; that is, an intermediate tone between white and black. This term, as applied to printing plates or impressions therefrom, is made in one word, without the hyphen, like halftone plate, halftone picture, etc.

HELIOTYPE—A process of making a plate by photographing on a gelatin film usually supported on copper.

HIGH LIGHT—The lightest or whitest parts in a picture, represented in an engraved plate by the finest dots or by the absence of all dots and lines.

INTAGLIO PLATE—A plate so engraved that the portion cut into it prints; opposite from *relievo*, or relief plate.

IVES PROCESS—The process of making three-color printing plates and the method of using them, invented by Frederick Ives of Philadelphia. Nearly all three-color processes are adaptations of this invention.

LINE ENGRAVING—That style of engraving in which the design is presented by lines of varying widths and spaces apart, as distinguished from engraving in which half tones and tints are produced. See page 20.

MANIÈRE CRIBLÉE—An old-time dotted style of engraving.

METZOGRAPH—A variation of the halftone method of engraving, in which a grained screen is used instead of a cross-lined screen.

MEZZOTINT PLATE—A plate engraved by indenting with a rocker and modelling by scraping indentations to varying depths.

MIDDLE TONE—A gray tone; properly a neutral tone half way between the lightest and darkest tones of a picture or of a color. See Half Tone.

MORDANT—An acid by which the biting is done in etching; an adhesive substance for fixing a color or wash on another substance.

NIELLO—The art of decorating silver by incising designs and then filling in the incised designs with silver and lead. Called by the ancients Nigellum and by the Italians Niello.

PENCIL DRAWING—A drawing made by a lead-pencil, a rough paper usually being employed, best reproduced by the metzograph or halftone process.

PHOTOGRAVURE PLATE—An intaglio printing plate etched on copper through a resist prepared photo-mechanically.

PLANOGRAPHIC PRINTING—The method of printing from plane surfaces, as distinguished from raised or relief plates and from intaglio or sunken surfaces.

PROCESS ENGRAVING—A general term used to describe an engraving made by photographic, chemical or mechanical methods, such as the halftone, zinc etching, etc.

RE-ETCH—To subject a plate in whole or in part to a second or further etching; to go over particular spots with a small brush dipped in etching acid for the purpose of making them deeper.

RELIEF ENGRAVING—Describing that kind of a printing plate in which the printing lines are raised above the surrounding parts.

RESIST—A coating of any kind applied to the surface of a plate to prevent or retard the corrosive action of an acid or the fixing of a color.

RETOUCH—To go over a drawing, photograph, or other copy, with a brush, pen, or pencil for the purpose of changing or improving details of a picture, emphasizing some parts and subduing or washing out other parts.

ROLL UP—To apply ink to a surface by means of a roller, particularly a hand roller.

SEPIA—A brown pigment prepared by treating the ink of the cuttle-fish with caustic alkalis, used in water-colors, in drawings, and in printing; an ink of this color.

SOFT-GROUND ETCHING—That in which the ground commonly used is softened by mixing with tallow, the design being made with a pencil on a piece of fine-grained paper stretched over the ground. This, when etched with acid, gives the effect of pencil or chalk lines in the printed impression.

SQUFEGEE, OR SQUILGEE—A tool having a straight edge, sometimes with a strip of soft rubber, used for smoothing out a surface, squeezing water from a sheet of paper, rubbing down a pasted sheet, etc. It is often in the form of a small roller.

STOPPING-OUT—To cover a part or spot in a plate with a resist coating to prevent the action of acid on that particular place.

WASH DRAWING—A drawing or picture made in sepia, india ink, or water-color brushed lightly and evenly over the surface, particularly in the larger spaces of the picture.

WAX ENGRAVING—A process of making printing plates for maps, charts, diagrams, and similar classes of work. It is less expensive than other kinds of reproductive processes and it may be done quickly. A polished plate of copper or brass is covered with a coating of specially prepared wax, and upon this the design is made, either by photography, by hand-drawing, or by some transfer method. The engraving of the wax surface is done by sharp-pointed tools, by ruling machine, or by pressing types into the wax while warm, the markings in all cases being deep enough to reach the metal surface. By this proceeding the wax plate becomes an intaglio and is used as a mold. The large blank spaces are built up as in preparing an electrotype mold, and the engraved surface is then put into an electrotype bath and a copper deposit made on it. A printing plate is made by the same procedure as for an ordinary electrotype. The wax process is sometimes called cerotypy.

WHITE-LINE ENGRAVING—An engraving in which the design is expressed by the form of the white lines.

WOOD CUT, WOOD ENGRAVING—For an explanation of the correct use of these terms see page 13.

ZINCOGRAPHY—The process of etching an engraving on a zinc plate.

TYPOGRAPHIC TECHNICAL SERIES FOR APPRENTICES

THE following list of publications, comprising the TYPOGRAPHIC TECHNICAL SERIES FOR APPRENTICES, has been prepared under the supervision of the Committee on Education of the United Typothetae of America for use in trade classes, in course of printing instruction, and by individuals.

Each publication has been compiled by a competent author or group of authors, and carefully edited, the purpose being to provide the printers of the United States—employers, journeymen, and apprentices—with a comprehensive series of handy and inexpensive compendiums of reliable, up-to-date information upon the various branches and specialties of the printing craft, all arranged in orderly fashion for progressive study.

The publications of the series are of uniform size, 5 x 8 inches. Their general make-up, in typography, illustrations, etc., has been, as far as practicable, kept in harmony throughout. A brief synopsis of the particular contents and other chief features of each volume will be found under each title in the following list.

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In order that the pamphlets may be of the greatest possible help for use in trade-school classes and for self-instruction, each title is accompanied by a list of Review Questions covering essential items of the subject matter. A short Glossary of technical terms belonging to the subject or department treated is also added to many of the books.

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7. **Cylinder Printing Presses** . . . By Herbert L. Baker
   Being a study of the mechanism and operation of the principal types of cylinder printing machines. 64 pp.; illustrated; 47 review questions; glossary.

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