TYPE MATRICES

GUSTAV BOHADTI

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TYPE MATRICES

Being Chapter IV of *Die Buchdruckletter*, translated, with a biographical note, the original illustrations, and a bibliography.

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GUSTAV BOHADTI

Born in Austria, July 15, 1883, he joined the printing department of the Gursch Type Foundry, Berlin, in 1914, which joined the H. Berthold AG Type Foundry in 1918. Starting as a typographer, Mr. Bohadti became head of the domestic order department before his retirement in 1961. Among other offices, he is the honorary president of the Deutsche Faktorenbund which he personally reactivated after World War II. *Die Buchdruckletter* remains the only authoritative contemporary manual of typefounding theory and practice. The present printer acknowledges his gratitude for the author's gracious consent to this translation and publication, as well as to Mr. Karl Graumann, Director of H. Berthold AG, for his kind coöperation.

CONCERNING THE CREATION OF PRINTING TYPES

Type lends body and voice to mute thoughts and carries the written page through the stream of centuries.

— FRIEDRICH SCHILLER

Thoughtful words of the great prince of poets, who knew printing's great significance from his early youth; for first and foremost in importance for the production of a printed work is type. However tastefully a book may be bound and, its literary values aside, printed upon the best of papers, it will be the letterforms in good typographic arrangement which will determine whether the whole will be judged as a cohesive work of artistic merit as well as an expression of contemporary art. The fact that printing is a graphic art, obligates the type-founder in a special way to create meritorius typefaces which must be exemplary in both their technical and artistic aspects.

THE PREPARATION OF MATRICES FOR TYPECASTING

The Technique of Drawing Type Designs

Every letter and point of a new type font, be it a book type, title letter, visiting card type, or advertising face, was designed by a type designer. In every type design, be it ever so well worked over, there are certain letters which the trained eyes of experts deem ugly, suspicious or unusable on technical grounds. These letters must be agreeably reformed by the type designer or entirely newly designed. That these changes are not always placed in effect without battles—until the artist and the technician finally meet at a line of agreement—may be incidentally mentioned. Not infrequently are the artist and technician one and the same person—and strongly individualistic. Exactly these same type creations outlast their times far better than the strongly artistic but highly personal scripts, which often disappear after a very short popularity.

When the type designer develops the idea for a typeface, it is the ability and sensitivity of the typecutter which assure the success of the new letterform. The first type size which is cut, usually 24 point or 28 point, is the norm size. Upon it is lavished all possible care, for upon it depends the appearance of the entire range of sizes. The weight and size proportions of the single letters must optically belong together, for the total impression must allow no foreign element to intrude. In order to forestall visual disappointment, heavier strokes are chosen for the capitals than for the lowercase. Moreover, the rounded letters are made somewhat higher and wider than the straight letters. This is done to create the appearance to the eye that all of the characters are uniform. Exaggerations toward one extreme or the other must be carefully avoided.

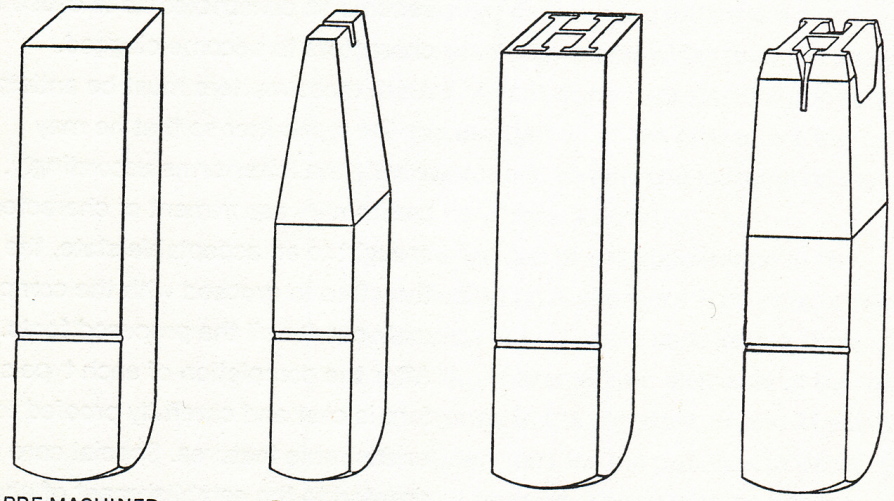
To get an idea of the appearance of the developing type, the word *Hamburg* or *Hamburgeron* is next cut. These letters show almost all of the characteristic elements of the various letterforms in the alphabet. *H* and *M* establish the dimensions for the punches in deciding the width dimension. Forms with one or two rounded sides, as well as the proportions of ascenders and descenders to the x-height, give the so-called nucleus of the type and which, of course, takes into consideration the type alignment as well. Other characters then follow, little by little. In order to proceed with care, as letters are completed, they are cast and proofed to check their appearance in trial words. Only after the norm size has been found perfect by both the type designer and typecutter, which is usually the case only after many trials,[1] are the other sizes of the proposed range attacked.

1. See Karl Klingspor: *Über Schönheit von Schrift und Druck*. In this book the process of cutting the Wilhelm-Klingspor-Schrift is carefully detailed.

The various sizes of a typeface are established by means of a pantograph or by photography, by which the optical particulars are maintained. In the case of a roman type, the letters *H m o g* (and for a Fraktur, *A n e g*) are first cut in all the proposed sizes and rough proofs are pulled. From this panorama (called the Scale) one may distinguish any irregularities which are still present in the range of sizes, for the sources of optical disappointment are manifold. Larger sizes will perhaps appear too wide and bold, and the opposite will appear in the smaller sizes, in addition to which the punches for the smaller sizes will sometimes become so constricted as to cause the inked characters to become clogged.

All of these matters must be anticipated by the typecutter so that he may modify the letterforms accordingly. When this preliminary assortment of characters is brought to an acceptable state, the way is then free to proceed with the completion of matrices for all the proposed fonts.

After the completion of each type size, the font is cast and carefully proofed to eliminate undesirable features. Special care must be devoted to the establishment of character widths. To this end, each of the lowercase letters is placed between a lowercase *m* and *o* and proofed to determine the effect of the side-bearing of each character with the greatest possible accuracy. The capitals are ranged between the letters *H* and *O*. Short trial paragraphs show the total effect of the face. In this manner the side-bearing of the letters, as well as the alignment and thick-and-thin-stroke proportions, may be carefully analyzed. Figures which disturb the collective harmony of the font, as well as those which do not agree with the norm size, must then be recut. Only when the proof shows the attempt to be free of every anomaly, will the artist and technician be satisfied and success be assured.



PRE-MACHINED BLANK

PATRIX OR COUNTERPUNCH

LETTER OUTLINED

FINISHED PUNCH

PUNCHCUTTING IN STEEL AND THE PUNCHED MATRIX

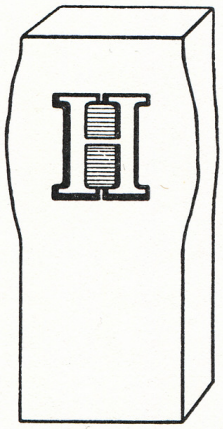
The oldest procedure for producing the "patrix," the steel punch, is steel-cutting. It is less and less practised these days and now enters the question in isolated cases for the text sizes of a typeface, although it is exactly in this circumstance that the sophisticated hand of the steel engraver can exercise the greatest flexibility in avoiding optical anomalies by the most subtle changes in character width and stroke thickness. Rectangular bars of Houndsmans Steel are cut into pieces about 2 inches to 2⅜ inches long. In order to make the steel workable, it is placed in an iron box with powdered charcoal, sealed airtight and heated some 20 hours in a gas or electric furnace, which causes it to lose its hardness and internal tension. Thereafter the pieces are filed square on two of their long sides, and the surface to bear the letter-punch is polished on a fine stone. The polished surface is then covered with clear varnish so that, by tracing or printing down a photo-image of the letter in reverse-reading direction, the image may be lightly scratched with an engraving needle. The engraving of the punch now follows by means of a variety of burins and gravers. Under certain circumstances, a counterpunch may be used, which considerably lightens the work. Forming the blank into a rectangle produces a more certain means of filing and holding the character. Many specially formed files serve to work the outside edges of the letter. Cutting the exact outline of the letter and its hairlines, polishing the face and all outer surfaces complete the punch. Now held in a flame, the face of the punch acquires a fine coating of

carbon and a small apparatus allows proofing the punch so exactly that all of its characteristics may be observed. From this smoke proof it is decided whether the punch follows all the details of the original design.

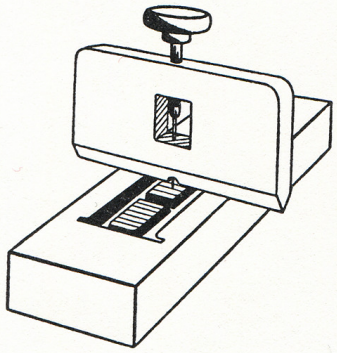
Corrections are only possible if they involve further cutting away of the face. Very small errors on the face can sometimes be corrected. Also one may be able to help oneself by stoning down the face on a fine stone, although this then means recutting the entire face. Major changes, of course, indicate starting over again completely.

Hardening of the steel punch follows in a charcoal, gas or electric furnace; here it is brought to glowing red heat and then plunged into cold water. In order to relieve the brittleness, which is produced by the tempering process, the blackened punch is first cleaned and polished and then placed upon an iron plate where it is heated to a straw-yellow color.

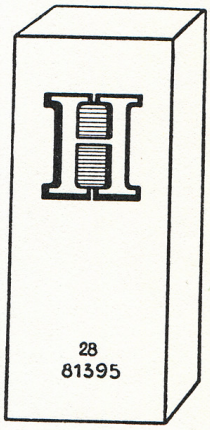
The finished steel punch is placed into a screw press and pressed into the polished surface of a rectangular copper bar. A special apparatus assures the precise positioning of the steel punch, as well as exact control of the depth of drive. The screw press drives the punch into the bar which becomes the matrix for the type. In earlier times the punch was simply beaten into the copper bar—a practice no longer followed today. The job of the justifier is then to grind away the distended sides of the matrix caused by the metal displaced when the punch was driven. The alignment, depth of drive and so forth, are regulated through extensive machining. After the completion of this work, the matrix is ready for casting. Because of the heightened demands of durability in present times, for which the copper matrix is unsuited, other means have had to be found.



PUNCHED
COPPER
MATRIX



CHECKING
DEPTH
DRIVE



JUSTIFIED
COPPER
MATRIX

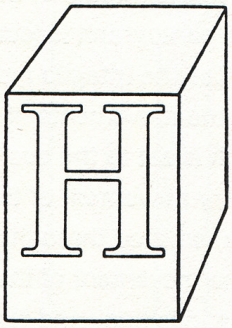
TYPECUTTING BY HAND AND WITH THE AID OF THE ENGRAVING MACHINE

On the polished surface of a piece of type metal, in the form of a rectangular solid of approximate type height, but of an alloy somewhat softer, the letter is transferred in mirror-reversed form through the means of either printing a reduced photo-negative or tracing through a gelatin foil. In the latter method, the lines are scratched into the gelatin and graphite or rouge is used to color it, and

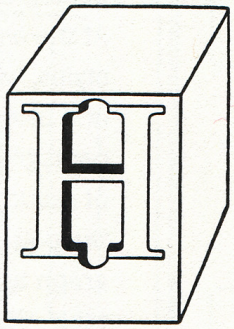
it is then turned over on the surface of the type blank and rubbed. In order to prevent smudging, the image is covered over with a clear fixative. Now the outlines are scratched, hair-fine, with the engraver's scriber. A type character in relief is now produced by grinding away all superfluous metal around the letter. Next the type's face with its steeply inclined sides—the beard—is worked away with variously formed gravers. The typecutter—exactly like the punchcutter—continuously observes the progress of his work through a good jeweler's loup.

A sure hand and a trained feeling for form are necessary to successfully translate the character's form into metal. Progressive proofs serve to indicate the degree of agreement of all particulars between the type character and the designer's drawings. The finished typecut is then joined to the plating bar (see below) and given to the electroplaters.

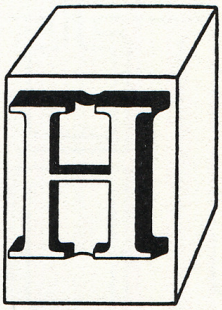
Now days the typecutting done by hand, especially in sizes above Double Middle (28 point) has been replaced by the pantograph. For preparing a typecut with the pantograph, a negative (i.e. reverse-reading) pattern is required. When the trial size is ready, each letter is enlarged to about 20 times the twelve point size with the aid of a pantograph, or projected photographically, and the result of this process, in an exact and pre-determined size, is placed, wrong-reading, on a brass plate approximately two millimeters in thickness. The outline of the face is traced by the stylus, guided by straightedge and curves, and repeated by the engraving cutter and then is deepened with the burin. The result of this is to produce a replica in high relief of the outline of the original pattern, with the surrounding material removed, and which represents the limits of the face where the beard meets the shoulder



OUTLINES
TRACED



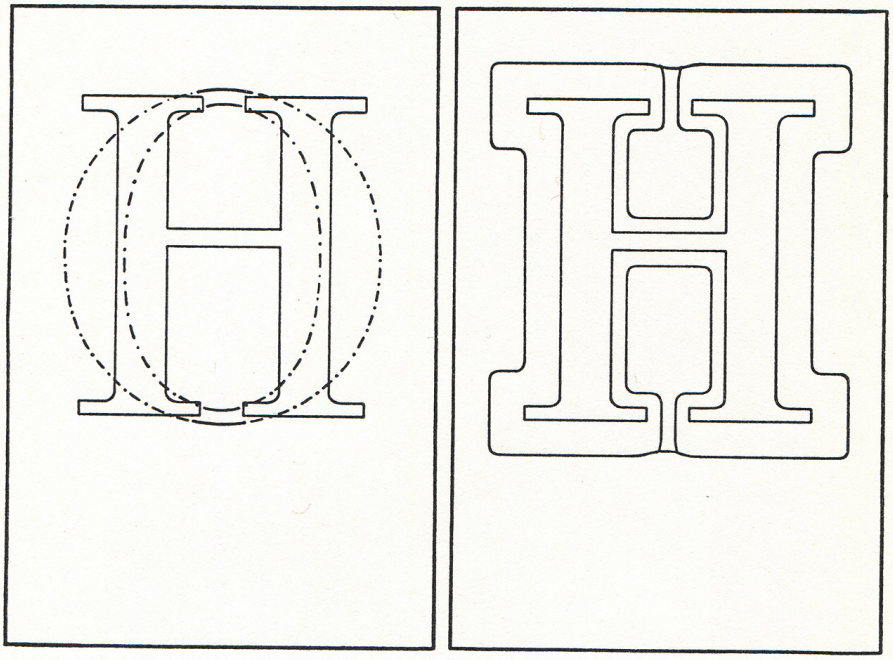
COUNTERS
ROUTED



FINISHED
TYPE-CUT

of the type. Inside, the guidelines approach the face dimensions, since the interstices of the letter (or punch depth) are only half the total depth of the face. The finished pattern is fastened to the pattern table at the right of the pantograph and the trued-up, polished type block is made fast to the engraving table at the left. The spindle with the cutting head and cutter are located above the engraving table. The cutting head is adjustable for the depth of cut desired. The engraving table is affixed to a cross-support and linked to the pantograph axis in the middle of the machine. At the end of the pantograph is located the stylus, which traces the intaglio type pattern and thus guides the movements of the pantograph which is set to the desired ratio of reduction. Every movement of the stylus in the pattern is transmitted through the pantograph arms to the movement of the engraving table. The table glides back and forth under the cutting head which revolves at 3000 rpm and engraves the type face out of the block. A very light milling of the entire face of the type block is followed by a very fine outlining or profiling of the type face. Then the surrounding metal is engraved away to shoulder depth on the outside and about half depth in the interstices. The original type block must, however, be worked over by the type-cutter for details such as sharp interior corners, the face contours and making the upper surface flat. After proofing and approval, each character is made ready for the electroplating bath, exactly as in the case of the hand-cut characters.

Typecutting came to life shortly after the invention of electroplating by Moritz Hermann Jacobi in 1838. The engraving machine, which is used here as a milling machine, was first adapted for cutting types toward the end of the last century.



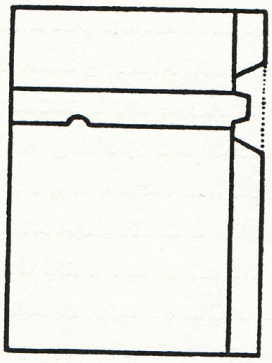
PATTERN FOR MATRICES

PATTERN FOR TYPE-CUT

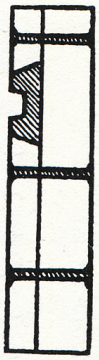
The invention of electroplating brought bad times to the field of typefounding. Nothing was sacred from the freebooters, until the [German] Design Patent Protection Law of January 11, 1876 brought a halt to the electrolytic copying of typefaces. Even today, although somewhat curtailed by international agreements, it still occurs that creations of German typefoundries are copied electrolytically. Scarcely noticeably the process of depositing copper or nickel-plating by electrolytic means became indespensible. At first the copper matrices sufficed, and the casting machines furnished great quantities

of tough material. The Company for Type-founding and Machine Building of Offenbach am Main—now merged with H. Berthold AG—eventually perfected nickel matrices, which are almost indestructable. Once in position on the casting machine and subjected to repeated exposure to the molten type-metal, they gradually acquire a dark patina which also colors the type. This is, however, only a fault in appearance and has absolutely no significance for the worth and utility of the types.

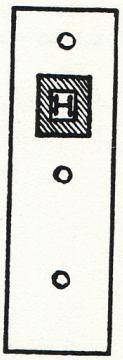
A number of finished type cuts prepared, up to 28 point mostly by hand, and above that size up to eight-line pica (96 point) with the pantograph, are placed in a row with shoulder-height slugs between, a thicker reglet placed on the back and nick sides and bound together with tin-solder. After that, glass strips of type height are placed on the reglet sides and the row of typecuts are affixed to a brass hanger strip, which serves as an electrical conductor. Next the surfaces other than the face are washed with a solution of celluloid dissolved in acetone (used as a resist), and the face of the typecut is washed with alcohol to remove any grease, and the whole strip is hung in the copper bath. In a short time a thin red copper deposit may be noticed. Next the unit is sprayed with hot water and hung in the nickel-plating bath. During the first twelve hours an agitator raises and lowers the bar with the typecuts to prevent the attaching of hydrogen bubbles. The bar now remains in the bath depending on size from 72 hours to three weeks. The bar remains in the nickel bath only until the nickel deposit has reached a certain hardness; during the remaining time it is strengthened in the copper bath. The following is another kind of preparation for electrolytic matrices which is especially used in America and which has been adapted by some German foundries: for



TYPE-CUT WITH ROUTED
BRASS PLATE



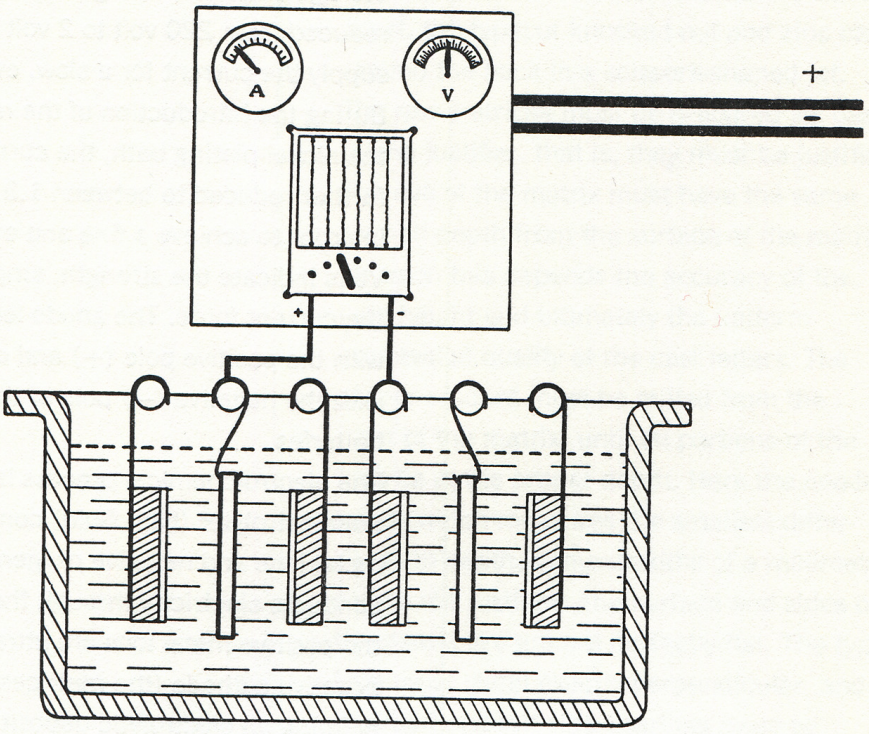
CROSS-SECTION OF
RIVETED BRASS MATRIX



BRASS MATRIX
READY FOR CASTING

each matrix a piece of brass, about 12 points thick, is prepared and out of this is cut a rectangular opening of slight cone shape—the smaller opening of the cone to be placed against the type. Numbers of such pieces are placed in rows, corresponding to the typecuts also placed in rows and the type face introduced into the conical cavity. The typecuts and brass pieces are now bound together in a fashion similar to that already described. In covering with the resist solution, the type face and the conical cavity in the brass piece must be kept clear. The unit is now put into the plating bath, the electroplating activity deposits onto the face of the typecut and eventually fills the entire opening in the brass piece. When taken from the bath, the typecut and the brass blank with its deposit are separated, and the latter is milled down, front and back, to eliminate all uneveness from the deposit.The front side of the brass piece shows the intaglio impression of the typeface inside the conical deposit. Now a second piece of brass, the same length and width as the first, is riveted to the backside and the matrix is finished.

The electrolytic bath is contained in an acid-proof vat. The copper bath contains copper sulfate, sulfuric acid and distilled water; the nickel bath, a sulfuric acid salt and distilled water, and acidified with chemically pure acetic acid, in exactly specified percentages. The copper bath must sustain a temperature between 20° C. and 25° C. (68° F. and 77° F.) and the nickel bath must be between 65° C. and 70° C. (149° F. and 158° F.). In order that the level of the bath does not become lower through evaporation, a Mariott flask of acetic acid and water is introduced into the middle. On the long side of the bath there is a bar of copper about 20 mm. thick fastened by clamps to the long electrical leads, and to it are



ELECTROLYTIC DEPOSITING BATH

fastened two cross strips. The third cross strip, which lies between, is attached to a long bar on the opposite side of the bath. The two outside copper strips serve as cathode, including the strip with the matrices bound to it. The two rows of types are then placed back to back, but each faces an anode. The anode is made of chemically pure, thick rolled copper or nickel and hung into the bath on large hooks. Storage batteries, charged by dynamos and reduced from 220 volt to 2 volt direct current, supply the current for a slow, even deposit. During the introduction of the matrices into the nickel-plating bath, the current must be further reduced to between 1.3 and 1.5 volts in order to achieve a fine and even deposit. Volts indicate the strength, amperes indicate the current force. The anode lead is connected with the positive pole (+) and cathode lead with the negative (—) pole of the storage batteries.

The electro-chemical process is as follows: the electrolyte[2] (bath fluid) contains positive metal ions and negative oxygen ions. If one conducts electricity through the electrolyte, the positive metal ions are attracted to the negative cathode (the matrices) gradually building an electrolytic deposit. The negative oxygen ions are attracted to the positive anode. Here they combine with the copper or nickel anode in the form of a salt, releasing more metallic ions into the solution. Thus the copper or nickel content of the bath remains constant. In time, the anodes are depleated and must be replaced by new ones.

When the electrolytic deposit appears strong enough, the group of matrices is taken from the bath, removed from the bar and the

2. The uniform control of the electrolytic bath is concerned both with the acidity of the solution and the salt concentration. For rough measurement of acidity, reagent papers suffice. Concentration of the bath may be measured with a Baumé hydrometer. Exact analysis is made with the Langbein-Pfaunhauser test kit.

resist compound is cleaned off. The type block and copper deposit are separated, and the deposit is backed up with lead in order to make it easier to machine. The deposited strips are ground between two-facetted carborundum stones in order that the "eye" of the matrix (i.e., the electrolytically deposited case with its intaglio letter impression) may later be firmly anchored in zinc. Then the individual deposits are sawed apart, the typecut knocked out and zinc cast around the back in a scissors-shaped jet.

The raw matrices must be prepared for casting by the justifier, that is, they must be justified. The eye of the matrix must have the same over-all depth from the surface of the matrix, for upon this depends the accuracy of the type height and ultimately the uniform impression quality of the cast letters. The proper amount must be milled from the front of the matrix, until all portions of the face lie at the proper depth. Here the needle guage which measures the smallest differences in depth, in hundredths of a millimeter, serves the justifier. The surface and sides of the matrix are ground perfectly flat. The type face must stand exactly perpendicular, and the right and left side bearings must be adjusted with respect to the width of character being cut. The position of the eye of the matrix must be adjusted with painful accuracy, since the eventual alignment of the type will depend upon it. The headbearing (distance from matrix head to type base-line) must be exactly the same for all matrices of a given size. Finally, the point size and series number are stamped on the foot of the matrix.

After the completion of these most exact preparations, the matrix is ready for casting. Through trial casts with a hand mold, the justifier satisfies himself whether his work meets with these strict specifications.

THE ENGRAVED MATRIX

The engraved matrix is prepared from an engraved pattern on the same machine as the typecut. From a right-reading pattern, which shows the character in simple outline, the stylus guides the pantograph arms of the engraving machine. The piece to work upon here is a long, rectangular piece of metal of either brass or nickel alloy. Both pieces, matrix blank and pattern are affixed to the pantograph tables exactly as in the case of typecutting.

After exact adjustment of the machine and a shallow engraving of the entire area (i.e. of the depth of counters when punches are cut), the machine is readjusted and the face is engraved to full depth around the counters. When the stylus is stationary, the cutter engraves a point. If, due to the tiniest inexactitude in adjustment or construction, the machine were to engrave a hardly visible circle, its product would be useless. Finally, the type contours are traced and the type face polished, having been produced by the manifold back and forth movement of the stylus in the pattern. The matrix is then checked using warm sealing wax.

The engraved matrix demands only slight adjustment on the part of the justifier to make it ready for casting. Many times engraved matrices are only helps for trial castings. From them several casts are made from matrices engraved too boldly. These casts are lightly polished and carefully reworked and lightened,

and then banded together on stringers and sent on to the electroplating baths for electrolytic matrices.

As already mentioned, all optical illusions must be identified and corrected through repeated checking. If all sizes of a type design were to be engraved from a single pattern, the smallest sizes would appear too condensed or light, the largest too bold and wide; and in the case of type faces of a restless design, the larger sizes would appear ragged. Thus, as far as practical, an even appearance must be attempted. One pattern may be used—at most—for engraving every three or four sizes, in order to make slight optical modifications between smaller and larger sizes. In the case of a few insensitive type designs, one may plan one set of patterns for six through twelve point, a second set for fourteen through twenty-eight point, and a third set for above thirty-six point; in which case a fair amount of eveness is achieved. For the decisive norm size, one usually chooses a middle size, since this allows the best judgement of a face's usefulness. For cutting the norm size, hand type-cutting is most expedient, and since the norm size of a type design lays the ground rules for the other sizes, it also determines the entire course of the production of a given type design. Only after the completion of all preparatory and experimental work may the engraving machine begin its actual productive work.

Although engraved punches are used little in Germany, and then only for typesetting machine matrices, in America huge quantities of such punches are in use. The number of steel punches for a single composing machine runs into the hundreds of thousands. In order to meet this demand, there have been developed, in addition to the simple Benton punch-cutting machines, double engraving

machines capable of producing two identical steel letter-punches in one operation. The punch-cutting machines of American manufacture engrave upward with the punch being cut situated above the cutting spindle. Also, the pattern is a raised electrotyped surface or is cut from a brass or zinc plate and soldered or riveted to another plate for use. For the sake of comparison, a steel punch for a text size of type demands a good half-day's work, while a type-cut, produced by hand, takes about half as long, and the production of either a type-cut or a matrix on the engraver can be finished in about one hour. The steel punch has the advantage that in the shortest time a new matrix may be driven, while either method of type-cutting demands the use of the time-consuming electrolytic bath. Because of the high production demands today, the copper matrix will soon become outmoded, although, as has already been stressed, the nickel matrix is virtually indestructable. All advantages considered, it appears that the engraved matrix alone holds promise for the future.

Its matrices constitute the most important and costly investment of any typefoundry and demand the greatest care in production. A fraktur type-face is comprised of 96 single letters, figures and points; a roman face has about 114 various characters, to which must be added about 60 accented characters for the major languages. Depending on the design of the face, matrices are prepared in a range of ten to perhaps eighteen sizes. Many designs also are developed in light and bold, condensed and extended, and italic forms, to become type families. These thousands upon thousands of matrices then await the moment of casting, when the countless individual types for printing will be formed by them.

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