Practical Typecasting

Theo Rehak

1993

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Practical Typecasting



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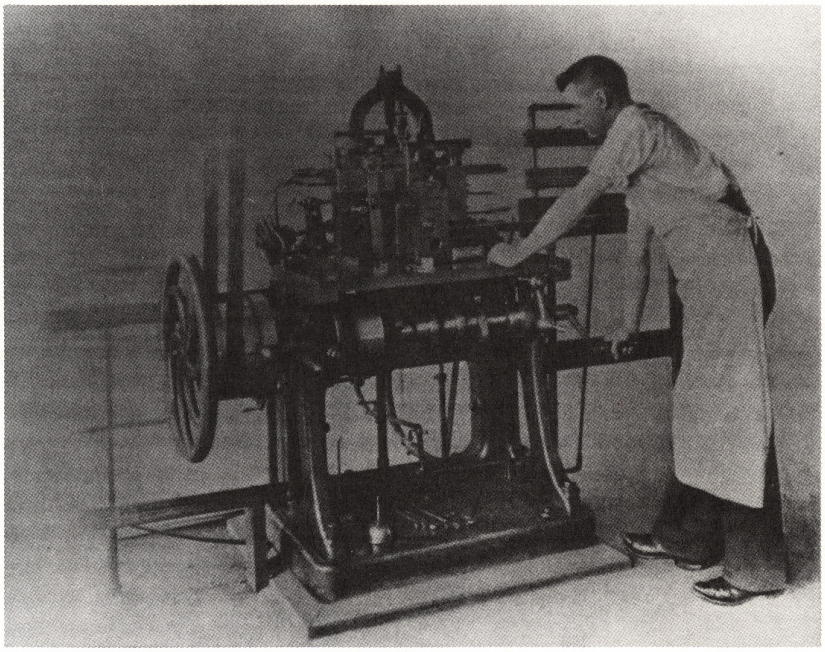
by Theo Rehak



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For my father

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Foreword

The earliest practical manual on typefounding of which we have record is *Mechanick Exercises on the Whole Art of Printing*, by Joseph Moxon, issued in London in 1683-84. In the preface to their 1958 edition of this book, Harry Carter and Herbert Davis write about Moxon:

> His book was by forty years the earliest manual of printing [and typefounding] in any language, and it put into writing a knowledge that was wholly traditional (i.e, not written down). Though he did not himself live in a great age of printing, he described with great care the tools and the skilled movements that had produced the masterpieces of the craft in better days. He did his work so well that it was appropriated [by many writers over many years thereafter].

Moxon, in his own preface to the section on letter-cutting, opens with the well-known passage so often quoted from him:

> Letter-Cutting is a Handy-Work hitherto kept so conceal'd among the Artificers of it, that I cannot learn any one hath taught it any other; But every one that hath used it, Learnt it of his own Genuine Inclination.

He then begins to describe in detail the cutting of punches, the making of matrices, and the casting and finishing of type. It is neither the work of a dilettante nor that of a mere observer; everywhere there is the ring of practical experience.

After Moxon, there was a hiatus of some decades until Christian Friedrich Gessner published *Die so nöthig als nützliche Buchdruckerkunst und Schrift-giesserey* . . . [The art of printing and typefounding, as necessary as (they are) useful . . .] in Leipzig in 1740. The author is far less extensive in his coverage of typefounding: a mere forty pages, twenty-six of which consist of type specimens.

There is only a brief account of the process, but this work does contain several casting bills and a very good engraving of the hand-castor's furnace, molds, and other tools. The next really extensive treatment of the subject was, however, the famous *Manuel typographique* by Simon-Pierre Fournier (*le jeune*), issued in two volumes in 1764 and 1766 at Paris. Fournier was, in a sense, the Mozart of typefounding: he started very early in life, he did it very well, and he was not adverse to telling others how well he thought of himself. Like Moxon's work, Fournier's *Manuel* is the book of a man with a huge background of practical experience. From his words on the composition of type metals to his description of the "castor's shake," we hear the words of a master craftsman.

After Fournier there was an increasing number of works dealing, in various depths of detail, with the art and science of typefounding: Täubel's *Wörterbuch der Buchdruckerkunst und Schriftgiesserey* (Vienna, 1805); Prechtl's *Technologische Encyklopädie* (Stuttgart, 1850); etc. All of these works dealt with hand-casting, but with *Die Schriftgiesserei* (Leipzig, 1869), we see the introduction of the force-pump and pivotal casting machine. This was the beginning of modern typefounding technology, and it foreshadowed the coming of perhaps the greatest overview of the field ever written: the monumental *Typographical Printing Surfaces* by Legros and Grant (London & New York, 1916). By virtue of its very breadth and scope, this work could not give anything in the way of comprehensive instruction in the making of type. That task was to remain until 1927, when Hermann Hoffmann wrote his *Der Schriftgiesser; Ein Lehrbuch für das Gewerbe* [The typefounder: A primer for the trade] for the Association of German Type Foundries. This ninety-six-page manual contains detailed instruction on troubles and remedies in operating foundry typecasting machines. There are suggestions for every part of the foundry process, and it is unfortunate that this information has never been translated. Shortly before the book was published, the author died, and it was finished by Gustav Bohadti of the Berthold Type Foundry of Berlin. In 1954 Bohadti wrote a greatly expanded and more detailed version of the same basic text under the title *Die Buchdruck Letter* [The printing letter] (Berlin, 1954).

Thus, the history of practical manuals on typefounding is quite short, a fact that supports what Moxon implies: the dominant tradition was on-the-job training. Now, in the 1990s, the commercial importance of making metal type is in decline, and large portions of this highly developed technology are in serious jeopardy of disappearing. The text that follows is a compilation of the accumulated technical knowledge of making metal types. The author of this treatise has been trained by the master founders at the American Type Founders Company

(ATF) in Elizabeth, New Jersey. This foundry has, through the development of the famous Barth Automatic Type Casting Machine, produced the finest, most solid, and highest quality type ever made. Although some of the described techniques that follow are based on the use of this machine, many of the procedures outlined are adaptable to making superior type on a number of other kinds of equipment. These are the operations that have been a part of the unwritten tradition at ATF for many years, and their preservation in this text is thus the single vehicle for their transmission to future generations.

The Dale Guild, by whom this work was originally brought forth, was founded in 1970 as a group of artisans devoted to the communal preservation of a variety of arts and disciplines, depending heavily on manual dexterity and largely dependent upon the oral tradition for their preservation and transmission to succeeding generations. The author has been a founder and guiding influence of the Dale Guild since its inception.

PAUL HAYDEN DUENSING
1990

Preface

The present work is intended to be used as a practical guide by those interested in typefounding. I have made an effort to preserve some of the methods and expertise peculiar to this waning craft: a most obscure profession whose roots lie in the Middle Ages, and whose regrettable decline—the result of economic rather than aesthetic considerations—has put at risk the survival of a considerable body of craft knowledge. The loss of that knowledge should not be allowed to continue uncontested.

I am indebted to many persons for their contributions to this book. At the American Type Founders Company (ATF) thanks are due to James F. Buckley, master engraver William C. Gregan, Edward P. Harwelik, and especially George R. Gasparik (for opening the door). At the Dale Guild, to former ATF master fitter Frank L. Walsh. For advice on nonferrous foundry techniques, to master founder Edward W. Griggs. I am also grateful to Paul Hayden Duensing for his foreword and lastly, Terry Belanger, for his invaluable patience and dedication in editing the manuscript.

To those for whom fine printing means well-cast type, carefully composed by hand, and meticulously imprinted, this book is respectfully addressed.

THEO REHAK
Howell, NJ
July 1992

Section I

Typecasting Machines and Techniques

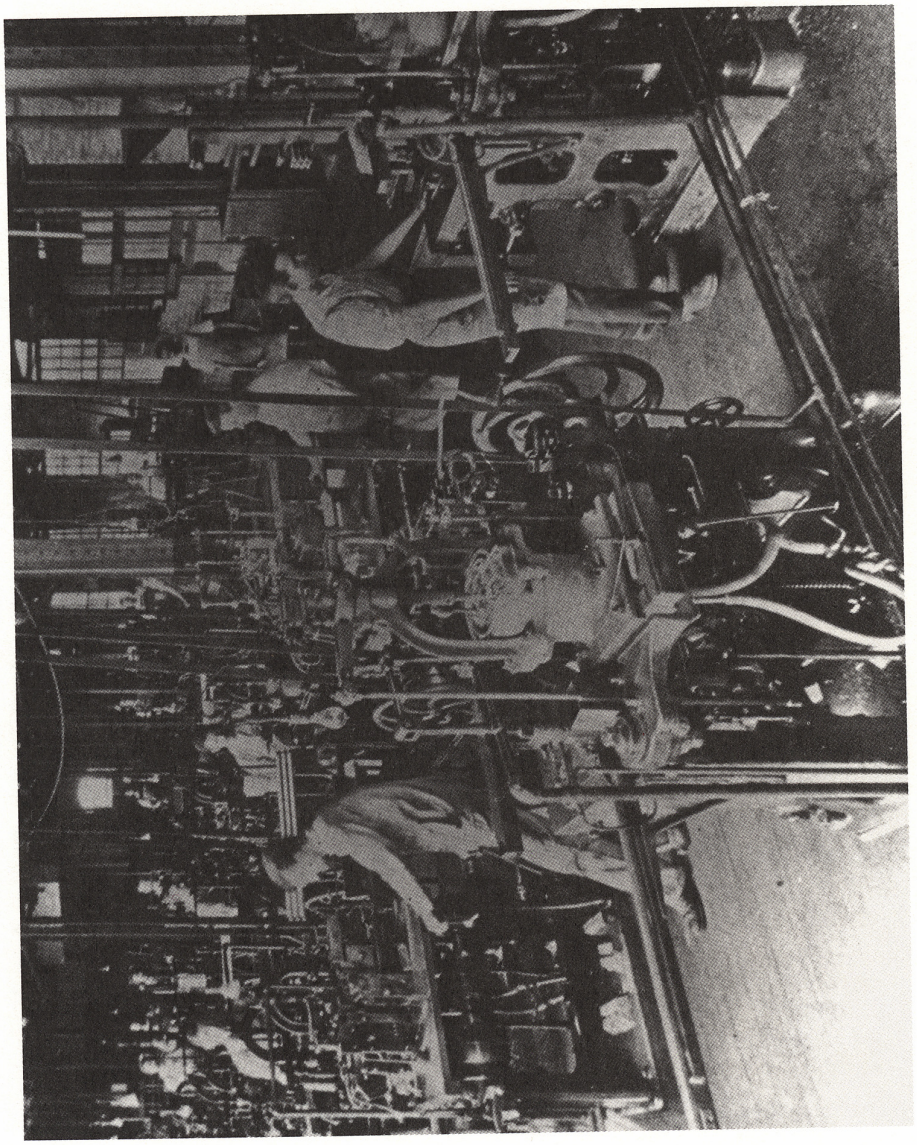


Figure 1. The Foundry Room: MacKellar, Smiths & Jordan, Philadelphia, c. 1896.

Figure 1. The Foundry Room: MacKellar, Smiths & Jordan, Philadelphia, *c.* 1896.

Chapter 1

Introduction

Historical Background

Individual American type foundries in the period before their consolidation in 1892 were secretive and insular, distinct and unique unto themselves.[1] The older Eastern cities had the largest type foundry operations, but any city large enough to have daily newspapers needed a regionally available supply of type, both for the newspapers and—as an important but usually secondary consideration—to supply the needs of local printers. There was no standardization of molds, matrices, or even type sizes among foundries; equipment was unique to each foundry. One reason for the vast variety was tradition; another reason concerned security: stolen molds were virtually useless except in the foundry of their origin. Nevertheless, the pirating of designs was common. A foundry would spend a considerable amount of money and effort to develop new faces only to have them offered, a few months later, by another foundry and at a discount. The plagiarist had merely to buy a font or two of each size of the new face; he assumed none of the burden of the initial design expenses and overhead. Thus by the middle of the nineteenth century, the security benefits of incompatible constants between one foundry and another was handily compromised by the electro. Nowadays, when we find ourselves faced with the provenancing of old type, the telltale marks of the matrix-maker's shaper reveal (like fingerprints) the dimensions of the original cast. The marks enable a type historian to ascertain at least *from whom* the copy was done, if not *by whom.*

The secrecy and "mystery" of the craft of typefounding perpetuated an environment of piracy and brutal price wars right up to the time of the amalgamation

[1] There is no single good account of the development of the American typefounding industry. A good account of the earlier period is Rollo G. Silver's *Typefounding in America, 1787-1825* (Charlottesville: University Press of Virginia, 1965).

of more than twenty separate foundries into the American Type Founders Company (hereafter cited as ATF) in 1892.[2] It was only when a larger view of the industry was envisioned by such men as Robert W. Nelson, the first successful president of ATF (he was appointed in 1895), that a true standardization and its inherent benefits were realized. Nelson recognized and used the unique and considerable talents of Henry Barth and Linn Boyd Benton. Barth, formerly the president of the Cincinnati Type Foundry, had been responsible for major improvements to typecasting devices, culminating with his own casting machine—swift, infinitely accurate, and reliable— with a complete body range from 4- to 144-point in size. The genius of Benton's successful punch- and matrix-cutting machines gave a mechanical superiority to the many products of ATF.[3] He was perhaps the person most responsible for bringing standardization to ATF. Benton's first refinement at the old firm of Benton and Waldo in Milwaukee was the introduction of type measured in units, thereby easing composition (this type was patented and called Self-spacing). At ATF his punch-cutting devices, and later matrix-engraving ones, brought a level of uniformity to entire families of type designs. Benton's son, Morris F. Benton, continued his father's work, enlarging and refining the vast ATF catalogue of typeface families. In this period many standard faces were also adapted to the ATF format. ATF published its first collective specimen book, reflecting its new levels of companywide standardization, in 1895, and by the beginning of the century it dominated the market for foundry type in this country.

The early decades of this century were idyllic and rewarding for both Barth and Benton. Both men had sons to succeed them in the business, and their mechanical engineering successes made ATF "theirs."[4] The type products of ATF began to come under ever-increasing competition from machine composition; but under

[2] A proper, detailed history of ATF has yet to be written. The best short account is Chapter I of the unpublished Columbia University dissertation by David Mallison, "Henry Lewis Bullen and the Typographic Library and Museum of the American Type Founders Company".

[3] ATF later absorbed a number of typefounding firms that had refused to join the amalgamated firm at the time of its formation in 1892, including George Bruce's Sons & Co. and A. D. Farmer & Son in New York; the Hanson Foundry in Boston; and Barnhart Brothers & Spindler in Chicago. See Mallison, 24.

[4] The Federal Bureau of Printing and Engraving would from time to time send government agents to check on the "nature" of work being done in the matrix engraving department, presumably to ensure against anyone engraving steel plates for the printing of paper currency. (In fact, without the proper patterns and certain other pieces of equipment it was [and still is] quite impossible to engrave such plates.) There is an amusing story of a government agent during one of these visits, encountering an uncooperative "shabby, sullen old fellow" who was behaving in such a

the leadership of Robert Nelson the firm was able to diversify and continually expand its line of typefounding, and printing products and services. Nelson's death in 1926 was the first great disaster to befall the ATF empire. The crash of 1929, and the subsequent Great Depression, forced the company to cut back its entire business, sell its old headquarters in Jersey City, New Jersey, and move to Elizabeth, New Jersey (into what was then its new Kelly Press building).[5] The enormous accumulations of equipment and stock took many months to move. The Library and Museum of the firm, Henry Lewis Bullen's domain, was the final holdout, parts of it remaining in Jersey City until 1936.[6] It must be said, to the credit of the company and Nelson's successors, that during the depression they persevered and did not forget their responsibilities to their employees. The firm was forced to file for bankruptcy in 1933, but at no time was the plant totally closed down, nor were any essential personnel laid off. An ingenious system of alternate work weeks and the shrewd use of manpower kept many families solvent in a time of bread lines, hungry children, and real deprivation. This managerial concern was remembered by the rank and file for many years thereafter—to the unfortunate undoing of the next generation of craftsmen, who had to deal with holding-company successors to whom they were mere economic variables.

The final decline at ATF is usually reckoned from the death of Morris F. Benton in 1948. From this time on, a gradual and relentless shift of power from the matrix and fitting departments to the piece-work castors in the aisles was allowed to continue. In earlier days, the most important workers in the foundry were the *fitters* and the *liners*. Next came the *hand-engravers* (punch-cutters) and, later, the *machine-engravers*. Finally there were the *castors*. With changes in managerial policies, castors assumed control of the floor, and the sales department increasingly directed the energies of everyone. Each succeeding set of owners extracted what it could from the business but returned nothing to it. World War II and its production demands forestalled the process, but in reality the life of the company was tied to the productive life spans of the old craftsmen. From the

suspicious manner that the agent considered having him fingerprinted and investigated. It was Linn Boyd Benton, of course, upset with the interruption of his workday.

[5] After the move, a former employee recounted that part of his job responsibilities required accompanying the aged Benton to and from the railway station (next to the building), so that he could get safely home from Elizabeth to neighboring Plainfield. Although he had become nearly blind, Benton refused to retire, and he worked forty-five-hour weeks until well into his eighties, when his final illness forced him to stay home: he was a most remarkable man.

[6] Mallison, 212, 266. The Library was put on deposit at Columbia University in 1936, and finally sold to Columbia in 1941; see Mallison, 286-87.

time of Barth's death in 1905 to the early 1960s, key personnel were not adequately replaced with any meaningful purpose. Despite this attrition, some third-generation craftsmen emerged with the requisite skills, but their number was low. Instead, politically motivated factions grew up, and the older men in the service departments retaliated by convincing an ignorant management that it took far longer to accomplish work than it really did. A standing premise was "three to four weeks" for a *rush* matrix replacement! Management was conservative, and haughty in the best Victorian manner; the employees in the service departments were easily manipulated. The real power was concentrated in the hands of the sales department, flamboyant merchant adventurers who told management that all you had to do to cast type was "throw the handle up."

Successive owners and managers completed the work of the destruction of the company, the seeds for which had been sown decades earlier. The firm still exists today (under the name Kingsley/ATF Type Corporation, Inc.)[7] as a maker of zinc type used for embossing; but ATF ceased to be a significant force in the world of letterform many years ago. From our point of view, perhaps the greatest disaster of all to befall ATF was inadvertently the result of Benton's contention that *anything* could be cut by his engraving machine in a matrix blank without the need for punches, coupled with the management's desire for "modernity" and consistency, and a decision not to rely on the erratic production of hand-engraved designs: ATF decided to scrap its entire holding of punches. Consequently, there are few remaining examples of production foundry punches, save those preserved by chance. On the other hand, a great many of ATF's *matrices* have survived; in the early 1970s, they were given by the firm to the Smithsonian Institution in Washington, D.C. What has also survived—though sometimes just barely—is a knowledge of ATF's matrix-making and typecasting machines, and the techniques for running and maintaining them. To those machines and techniques this book is addressed.

The Basic Principles of Casting Type

From the time of the first movable and adjustable type mold, the basic premise of typefounding has been simply to fill the void within the mold with molten type metal at an optimum temperature and even pressure, in order to create a solid,

[7] The corporation ceased operation as of April 23rd, 1993.

dense body casting. Properly cast, the density of the body of the cast type will be uniform throughout its volume and will carry over into the area of the cast that forms the printing face of the type. The contours of the face of the type are created by fixing a matrix (which contains the hollow image of a specific character or sort of type) firmly against the end of the casting void of the mold. The mold void and its sprue (mouth) are designed to ensure the efficient progress of the molten alloy through to the matrix at the end of this open area. It is important that the type metal strike the matrix first or at least simultaneously with the farther confines of the void, thus ensuring a satisfactory filling in of the face of the type. A well-cast piece of type is said to be "faced-up."

Using Bernoulli's theorem, at any point in a tube through which a liquid is flowing, the sum of the pressure energy, potential energy, and kinetic energy is constant. Thus, if *p* equals *pressure*; *h* equals *height* above a reference point or plane; *d* equals *density* of the liquid; *g* equals *gravity*; and *v* equals the *velocity* of the flow:

$$2p + hdg + \tfrac{1}{2}dv = \text{a constant}$$

For example, if the large diameter of the tube B measures 36 points, and the smaller end A is 9 points in diameter (thus having a ratio of 4:1), and as the area of circles varies according to square law, we have the situation depicted in diagram 1. In diagram 2 the liquid type metal is entering under pressure (through the jet sprue) from *p* (constant), and is flowing at a rate of 1″ per second: thus the liquid through the A end will have a velocity of 16″ per second.

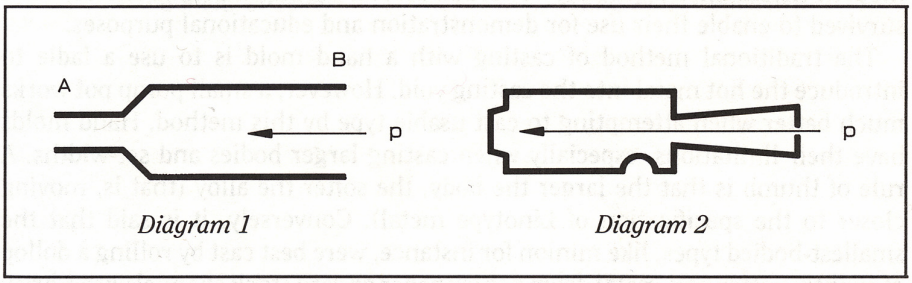


Diagram 1 *Diagram 2*

This phenomenon means that in order to cast solid, faced-up type the type metal must, on entering the casting void, be thrown against the matrix first. To create the necessary acceleration, the jet blades of the mold are shaped to form a

taper, the degree of which is designed with sufficient compensation for all possible proportions experienced by the mold when casting the various characters and the required set-widths of a given body size. Complexities arise when maintaining the optimum casting conditions required at the moment of each cast. These conditions vary subtly and are influenced by *(a)* size of body (including set-width), *(b)* specific properties of the alloy being used, and *(c)* method and/or device being used to cast. The requirements for optimum casting conditions are universal. They are *(a)* proper rate of cast (speed), *(b)* proper mold temperature (water flow; cooling), *(c)* proper metal temperature (eutectic), and *(d)* proper casting pressure (pump inertia). It is the precise awareness and proper monitoring of these factors and the physical manipulation of certain other conditions, varying in each casting device or technique, which ensures uniformity of cast quality. Each of the various techniques presents a unique situation that must be dealt with specifically.

Hand Molds

The earliest devices for casting type were hand-held molds. These have survived in modern type foundries as fitter's molds in the matrix department. They are used to prove new matrices for justification and alignment. Antique hand molds are priceless artifacts that belong in museums, but a sufficient number of modern fitters' molds (usually reworked pivotal casting machine molds) have survived to enable their use for demonstration and educational purposes.

The traditional method of casting with a hand mold is to use a ladle to introduce the hot metal into the casting void. However, a small pump pot works much better when attempting to cast usable type by this method. Hand molds have their limitations, especially when casting larger bodies and set-widths. A rule of thumb is that the larger the body, the softer the alloy (that is, moving closer to the specification of Linotype metal). Conversely, it is said that the smallest-bodied types, like minion for instance, were best cast by rolling a dollop of slightly hotter type metal down a thick paper or card stock channel with a brisk swinging motion. Indeed, the physical gyrations and contortions employed by traditional hand type founders to offset the effects of gravity and lack of constant pressure are said to have made unwary visitors to a type foundry believe that they were witnessing the antics of spastic lunatics.

Generally speaking, it is neither necessary or practical, except in rare instances, to cast large quantities of type by this method, although hand molds with ejection-trigger devices and cored bodies for special products that cannot be produced any other way still exist. When demonstrating the mysteries of typefounding, however, hand molds are useful and entertaining.

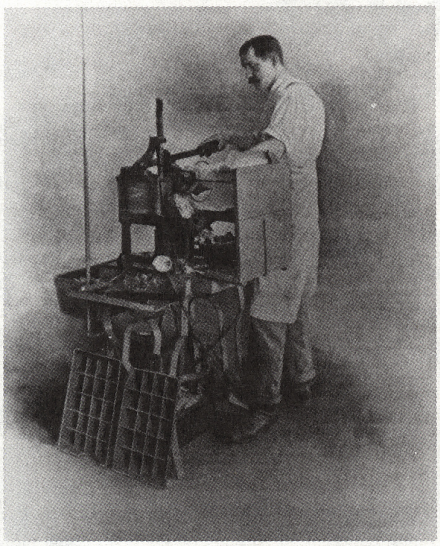


Figure 2. Casting with a hand mold, *c.* 1896.

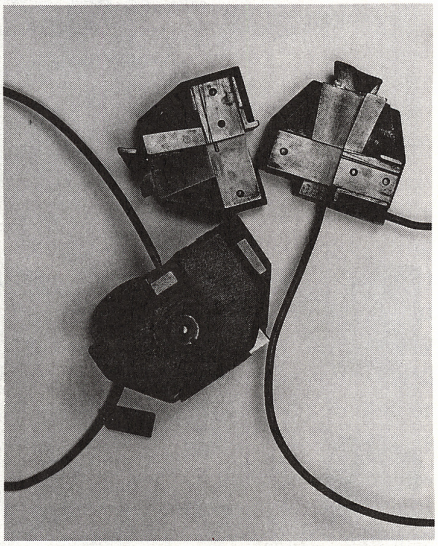


Figure 3. Hand molds (Benton Engraving Company).

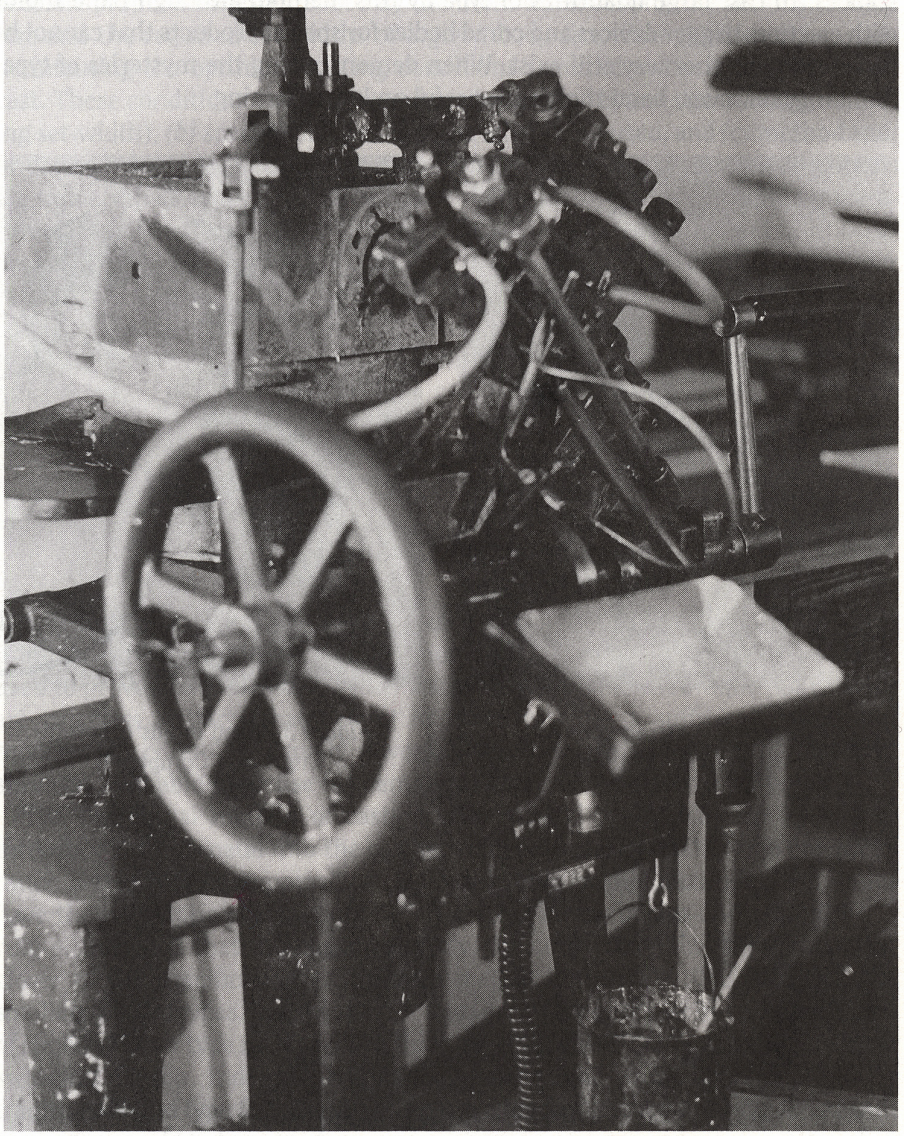


Figure 4. Hand casting machine (Howell Foundry).

Chapter 2

Pivotal Casting Machines

The pivotal caster is basically a mechanized hand mold with its own pump pot. The machine casts unfinished type of superior quality. Finding a usable specimen not already on its way to a museum is a remote possibility, but occasionally casters turn up. Many of these machines spent their last days casting jobbing work in unusual sizes or casting from Monotype display (or even Linotype) matrices with dangerous, cobbled-up adapters. Getting solid type bodies cast to proper height (.918″) to paper from often mismatched molds is the primary obstacle. Any molds that remain with the machine are likely to be peculiar and made for specific jobs: they are usually unique with regard to body height or matrix drive. The line-up of the jet aperture, centered in the nipple plate, is crucial to type quality. Adapting blocks to maverick molds is a tedious business, but when casting large bodies, many molds that are not matrix-drive/body-height compatible can be used by changing the side-bearing abutments and machining down the newly cast type to .918″ afterward. To ensure the type so produced is "overheight," the depth of drive of the matrix must be *greater* than that called for by the height of the mold. This works also in reverse, as with a mold with a greater body height than that called for by the matrix-drive. It is important, however, *not* to alter drives on original matrices, as they have historic value.

In the halcyon days of ATF the largest, busiest, and most intriguing casting bays were those in the Hand and Steam Department. Here, side by side and row after row, were the hand-cranked pivotal casting machines and their powered "steamer" counterparts (driven from pulleys and flat belts) which could cast *anything* in a myriad of matrix-drives on 3- to 208-point bodies. The centralization of the many foundries absorbed (willingly or not) by ATF contributed to this vast accumulation. Most of the molds used were correlated by "family" (foundry) and were mounted on their respective blocks, ready to install on the particular caster designated to receive them. Without such a forest of these machines now available, molds from different families will constantly need to be reset upon their blocks.

Resetting is always done off the machine in a large vise. Adjustments must be made with care so that the mold opens and closes without jamming or causing damage. Riser shims that raise the mold away from the bottom block (or the top block) are useful for altering the scope, or swing, of the yoke, or *top fork,* enabling the mold to close with proper tightness when the cast is made. Machining, such as drilling, tapping, or milling clearances, as well as hand filing must be done carefully when adapting a strange mold to its new block in order not to interfere with the unalterable water-cooling ways cut into the upper and lower mold blocks. Sometimes the mold blocks must also be modified when they are being fit to the stool of the machine. Series of sizes close to each other by reason of provenance are safe bets, and should be used whenever possible. There may be locator pins fixed to the mold plates or the block itself; these too, may need removal. Mold adjustments are rare, since the side-bearing usually remains constant. Head-bearings vary; they require a simple change of abutments. Alignment of the head-bearing is accomplished by shimmying the abutments with brasses. *Pawls,* or heel-stops, support each half of the mold when the machine brings them together at the moment of casting. These may be moved or changed to compensate for extremes in set-widths.

It is unlikely that a small founder would need to run a pivotal caster under power. Hand power is sufficient and safer. A splash from an automatic machine is serious enough; with a pivotal machine it could make for a genuine disaster. A pivotal caster can suffer the most outrageous abuse, and after a tune-up still cast excellent type—a tribute to the genius of its inventor, George Bruce, and the practical philosophy of his age. Simple cams fixed to the machine's crankshaft operate the pump, mold arm, and choker valve. The mold opens and falls back from the nipple plate with each cast, ejecting the type. The type falls down a chute, and is protectively guided into the collecting box, or *butter dish*. In the case of large-bodied type, each cast is caught or removed from the mold with a gloved hand, usually that of an assistant or apprentice. This procedure, called *catching type*, is second only to jet-breaking in tedium.

Operation

There are two primary concerns for the pivotal *castor* (the operator) in dealing with a pivotal *caster* (the machine): *(a)* rate of cast, and *(b)* careful monitoring of pot temperature and heat dissipation between casts. Pivotal casters are water-cooled except in the case of the largest pivotal machines (where one measures

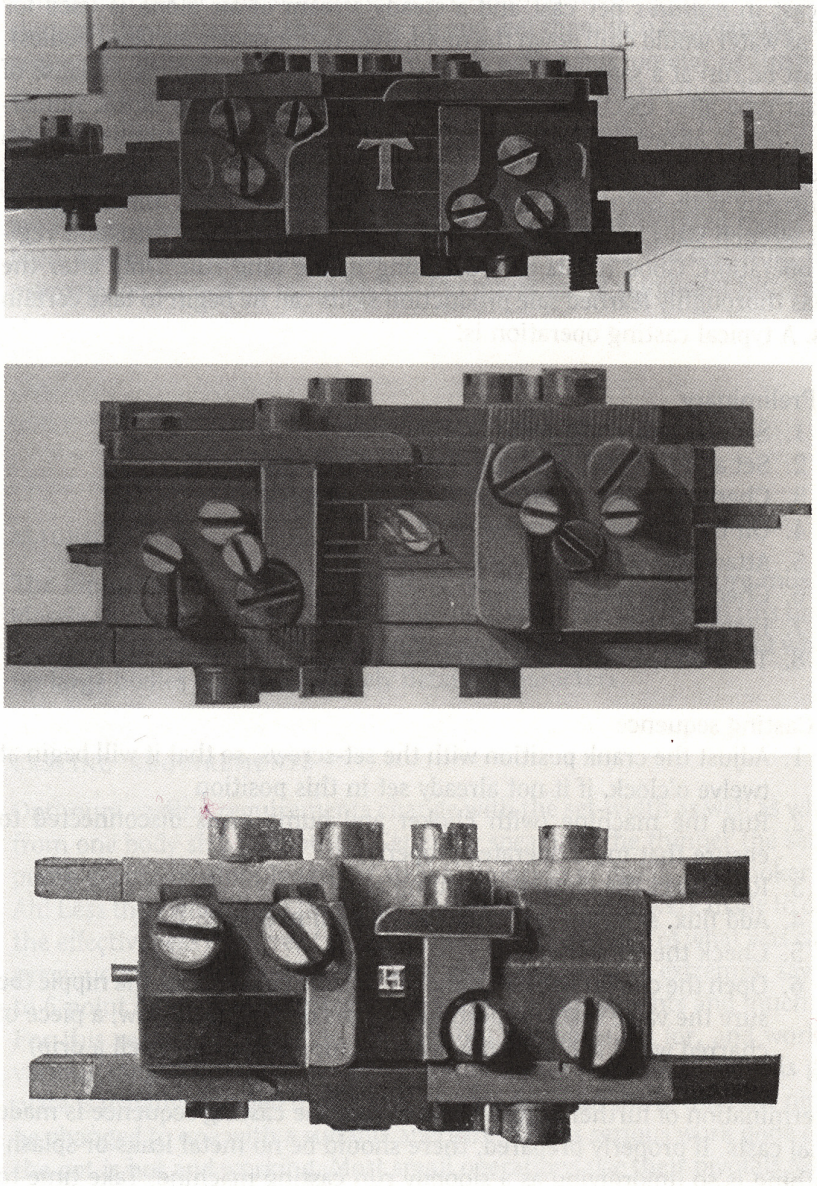


Figure 5. Pivotal molds: *(a)* regular; *(b)* script (left-handed); *(c)* cored.

rate of cast in *minutes* per cast and a steady stream of air alone is used for cooling, as water would chill down the mold, making for poorly surfaced bodies). They must be run at a safe speed to ensure against splashes and the collapse of newly cast type after ejection caused by an insufficient *cooling dwell*. Adjustments are nearly always tedious; nevertheless, they must be accomplished with patience. One corrective change usually sets up at least five or six other adjustments, usually with cap screws, bolts, and stops which are all, annoyingly, of different wrench sizes or dimensions. The castor must learn a consistent regimen of operation. Good habits are rewarding in the long run. Only after the castor has thoroughly learned safe production skills can he begin to take certain liberties. A typical casting operation is:

A. Preliminary
   1. Set and adjust the mold on the block
   2. Set and fix the block on the stool of the machine
   3. Check clearances with the pump disengaged
   4. Oil the cams and moving parts
   5. Attach the water lines and clamps
   6. Check clearances (again)
   7. Light off pot
   8. Turn on the water and check for leaks

B. Casting sequence
   1. Adjust the crank position with the set-screws, so that it will begin at twelve o'clock, if it not already set in this position
   2. Run the machine (with choker and pump arms disconnected to ensure that mold operates properly)
   3. Reconnect the choker and pump arms
   4. Add flux, skim the pot, and add metal if needed
   5. Check the choker valve
   6. Open the choker valve by hand into a ladle held against the nipple (be sure the valve seats properly and closes off the metal flow; a piece of charred wood rubbed stiffly into the nipple end will quell a drip)

The determination of further adjustments during the casting sequence is made from trial casts. If properly prepared, there should be no metal leaks or splashing. Nothing is so unforgiving as a sloppily run casting machine. Take time to ensure that the device is soundly adjusted.

Matrices are arranged in order of set-width. If there are no set-width dimensions on the matrix, lay them edge up and feel them into approximate set-width sequence. Measure in groups of five or six with a micrometer or turning gauge for precise order. Casting will begin with a lining character (usually a roman "H" or "m"), then continue from the widest set first down to the narrowest. Pin marks on the body of a piece of type usually indicate that it was cast on a pivotal machine. This mark, along with the nick scheme and body-height measurement, are factors used to provenance sample type. Some sophisticated molds have also been devised in which the pin actually aids in ejecting the cast from the mold, primarily on deep-drive script bodies. Pin marks are of significant historical value.

Machine Discipline

ALIGNMENT

The nipple center (and nipple plate hole) and jet sprue aperture must align as closely as possible to the center of the mold void. The farther off this line-up, the less good the cast will be. Proper alignment is particularly important when facing up large bodies and/or intricately detailed characters.

CASTING REQUIREMENTS

Optimum casting requirements change with the set-width as well as when going from one body size to another. Generally speaking, the thinner the set, the *less* pump-spring tension, length of stroke, duration of dwell, and choker opening. Ah! Less than what? Less than the sample trial casts that were made to determine the effectiveness of *current* adjustments. The knowledge of what was cast on the previous job is invaluable. Obviously, going from and to extremes, say from 60- to 6-point body size, will necessitate extensive adjustments and much patience. For this reason it is good to have several machines set for, and working at, a various range of body sizes. When the disparity regarding bodies is great, the plate is usually changed first. If this change does not work, then the nipple must be changed to one with a suitable aperture. This is serious work done only when the pot is hot and working. Most small operations use their pivotals for unusual sizes, and run common-size bodies on a different kind of machine. The melting

pot of the pivotal caster can also be changed; one or two additional pump sizes would come with a machine if it has been designed to cast many sizes of bodies.

FLASH

The nipple plate and its aperture must be kept free of metal flash and the little buttons of metal that sometimes form. A splash will occur if this condition is not dealt with. A tallow-laden swab is often used between casts to wipe clean and lubricate the mold-cheeks, plate, and nipple.

HOLLOW CASTS

Hollow casts and/or porous bodies indicate the need to increase pump spring pressure and to check and adjust the choker valve and dwell sequence. Excessive pump spring pressure can, however, negate the necessary physical casting conditions by causing excessive mold wear and a "plated" castor!

CASTING INERTIA

Casting inertia as applied to pivotal casters varies somewhat from that which pertains to other methods of mechanical type production. It can best be described as the inert force or power in reserve by which the molten metal floats with a sustained flow into the mold void. The physical properties of this flow are, at optimum conditions, uniquely equal in both the flow and return of the controlled stream of molten metal. Obviously, there is no return of the now-cooled metal within the mold void. The choker valve also prevents any return of hot metal when properly set. As the set-width changes, so also do the requirements for maintaining the correct physical casting conditions. The variance is subtle, even minute, between closely dimensioned set-widths; however, a point is reached during the casting scheme when it becomes great enough to affect cast quality visibly, and it must be dealt with. Only practice and experience will teach the castor what is to be done to make good casts. Three good reminders are: *(a)* check all adjustments, *(b)* remember the optimum casting requirements, and *(c)* invoke the name of Bernoulli whilst swearing.

CAUSES OF POORLY CAST TYPE

Poorly cast type (not faced-up) indicates the need for one of the following remedies: *(a)* increase the pump stroke, *(b)* check for a fouled pump (fouled with metal oxides, which have an affinity for the ferrous parts of the metal delivery

system), *(c)* check the matrix for casting surface damage or burn-outs, or *(d)* check for a faulty choker valve (although choker valves *do* wear and break, a faulty choker valve is not a common condition with pivotal type casters unless the cams are extremely out of adjustment).

PIVOTAL MOLDS WITH CORES

Pivotal molds with cores are rare, but the castor should be aware of their requirements and take extra care that they are not damaged by the fouling or jamming of the mold during the casting and ejecting sequence. The simple mortised mold is the easiest of this variety to use, but the castor must be careful not to accumulate flashes of metal on the sides and top of the core projection. A build-up here can cause damage, and it is dangerous to the operator. Sectionals (type cast with other than rectangular bodies: mitered or mortised, for example) must be cast very slowly and the cores removed and cleaned carefully by hand after every cast. Cleanliness is a necessity.

BACK-CASTING

Back-casting is a safe procedure for a multitude of casting situations. Among the most obvious are: *(a)* casting with worn-out molds that cannot withstand full casting pressure; *(b)* casting with worn or damaged matrices that are irreplaceable, and that are being cast from, to provide new electro models for the copper bath; and *(c)* checking for leaks in cranky molds that resist normal adjustments. For this technique the casting sequence is reversed. The crank handle starts at the twelve o'clock position and is drawn *backward* toward the castor somewhat more slowly than for a regular cast. The handle's travel is stopped at the point of metal flow through the open choker valve and is left for a time to dwell, with the pump descending slowly downward, before the crank handle is reversed and returned it to the twelve o'clock position. Pump movement is slow and minimal.

POSITIONING THE NIPPLE PLATE

A pair of pliers is needed to grasp and position the nipple plate with safety, as it gets quite hot on the caster. After cleaning, the plate is dipped in tallow and returned to its position on the locator posts on either side of the nipple. Any sort of pliers will do, but aficionados might consider small blacksmith's tongs, which resemble the hand-wrought "grippers" that are now so hard to find.

AUXILIARY MELTING POT

An auxiliary melting pot is necessary when casting large-body type because of the rapid depletion of metal in the pot, and an uneven temperature curve, caused by cold metal replacement. This auxiliary melting pot is run at close to the casting temperature, and its contents are ladled into the caster pot as needed.

HEAD-BEARING ADJUSTMENTS

Head-bearing adjustments are made by changing the abutment on the lower half of the mold. Side-bearing changes of severe proportions are difficult (and sometimes impossible), since the mold was designed for only limited adjustment of a specific dimension. Foundry matrices for the pivotal caster are fitted to the *left* constant (with the castor facing the casting side of the matrix), while automatics require a fitting from the *right* side-bearing constant. Pivotals cast with the matrix in a vertical (or nearly vertical) position; the automatics cast horizontally (i.e., on their side). It is rare to find a pivotal casting machine that casts in the opposite direction: that is, the mold opens to the right, rather than to the conventional left. This is a script machine and only script molds (molds specifically designed for this work) may be used on it, thus limiting its usefulness for any general foundry work.

RETURN SPRING ADJUSTMENT

The return spring rides on the pump shaft and exerts pressure to assist the return of the pump up out of the pump well after the cast. Depending on the length of the stroke and the condition and fit of the pump when entering its well, the spring is merely tightened sufficiently to handle the displacement needed. It is important not to force a stuck pump. It should be gently but firmly tapped out (up), or coaxed with a fulcrum-screw that pulls with a steady, even pressure. The castor must *never* twist the shaft.

RATE OF CAST

The rate of cast should always be limited so as not to burn out the matrix. Cranking by hand creates inevitable variations, but good hand-cranked casts can often be achieved with a lower pot temperature than that necessary for the automatics. Depending on the eutectics of the particular alloy being used, cast-

efficient temperatures can often be set as much as 5°F-10°F lower than those required for other casting machines—especially Monotype casters.

SMALL-BODIED TYPE

To facilitate safety in production runs of small-bodied type, a small tab-making recess inside the jet aperture casts a projection that is struck by a thin breaker bar attached to the back of the mold and is activated by each cast. (The mold opens and brushes against this projection, helping to eject the type and so clearing the mold for the next cast.)

Matrices

CHEWED MATRICES

Matrices can become chewed across their bearing surfaces by improperly set molds; if not caught in time, this problem can create gouges from which metal can flash out during the cast. New deposits of copper can be grown on such damaged matrices. Ancient ones should be rubbed gently only on a fine *lap* or with an eraser, being careful not to disturb the patinated surface. Any lowering of the bearing surface of the matrix will drastically alter type height.

MUSHROOMED-OUT SPRING PIN HOLES

Mushroomed-out spring pin holes, located on the back of the matrix and centered parallel to the character on the opposite side, can be filed down by drawing the matrix across a medium surface file (smooth set) if needed. This procedure is important if the matrix is to rest upon the adapter used on the Monotype Display caster at some later date.

JAMMING THE MATRIX PIN

When setting the matrix on the pivotal in its carrying position, be sure that the matrix pin, which is spring-loaded, is not set to jam too tightly in the pin hole. Jamming can cause damage to both the matrix and the pin. Evidence of this condition can be seen around the matrix pin hole (the mushrooming mentioned

above). The matrix-pin spring has a stop or projection a short distance out from the tip of the pin. An adjustable pivot bar swings over and fits behind this projection, forcing the matrix flat against the mold void to ensure a perfect seal, preventing leakage of metal during the cast. After the cast and cooling dwell, another rocker bar is activated as the pin now eases back. The bar pushes against the lower portion of the back of the matrix, creating a rocking motion, and pulling the matrix away from its cast, rocking across an *apron.*

ADJUSTING THE POSITION OF THE MATRIX

When making adjustments, be sure to: *(a)* keep the matrix firmly in position; *(b)* seal off the mold void during the cast; *(c)* rock the matrix back far enough to clear its cast; *(d)* maintain sufficient pressure on the matrix, ensuring its steadiness and placement for the next cast; and *(e)* prevent the mushrooming of the spring-pin hole and/or denting against the apron by checking for proper matrix spring and rocker arm adjustment.

MATRIX LENGTH

Through the era of the pivotal caster and into that of the automatic caster, matrices went through a continual reduction of length. Original matrices have sometimes been gammoned to fit the newer machines. When they have to be refitted for use on a pivotal, use either a *Pontil* or an *Extender Jig.*

In glass-blowing nomenclature, a pontil is the rod or spike of glass that is attached to the base of the glass object or vessel, securely holding it in place as the work proceeds. As a matrix extension, it is merely a brass or copper rod twisted into a tapped hole in the base of the bottom end of the matrix. This additional length enables the bar of the rocker arm to engage and work against the matrix. Pontils are also used as aids in electro repair of damaged or ill-fitted matrices.

The extender jig is a piece of tool steel fitted with pins, a set-screw, and a false matrix-pin hole. The bar of the rocker arm strikes the base of the jig, ensuring a good contact. Some matrices, notably those of the Philadelphia foundries and most modern European ones, are extremely short, requiring elaborate jigs or at least altering existing rocker arms. If the matrices to be cast are historically important, it is wiser to cast them on the Monotype display adapter, since good casts should in any event be used for making flat mats, which will serve more easily as usable "working" replacements. If such a choice is not reasonable, the

two small holes required for the extender jig are preferable to the more destructive large one needed for the pontil. In short, the jig is the preferred method in the modern foundry.

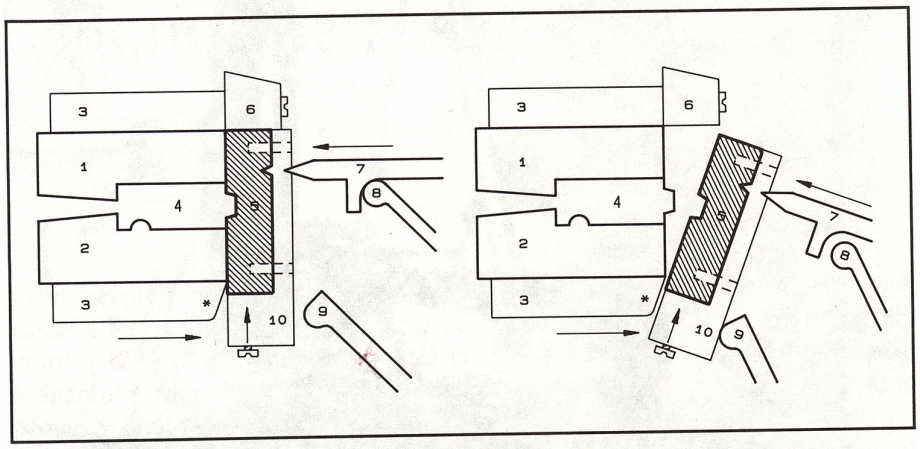


Figure 6. A matrix extender jig for pivotal casting.
1, mold-half (top); 2, mold-half (bottom); 3, mold plates; 4, casting void; 5, matrix; 6, alignment abutment; 7, matrix-pin; 8, matrix-pin pivot bar; 9, matrix rocker-bar; 10, extender jig (with pins into matrix and set screw); *, area of apron where matrix "rocks".

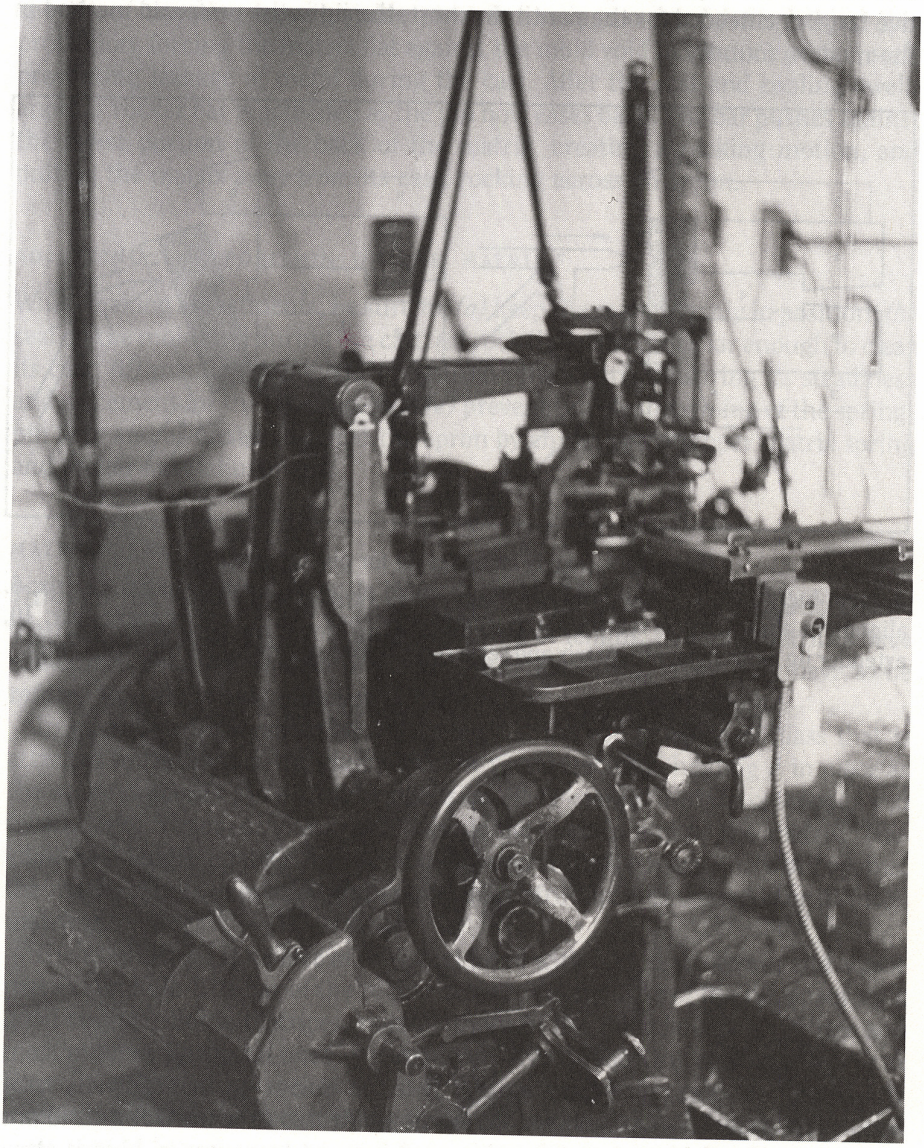


Figure 7. A Monotype OA Casting Machine (Howell Foundry).

Chapter 3

Monotype Display Machines

Many people scorn type that has been cast from *any* of the various Monotype casters. More poor-quality casting is perpetrated by amateurs using these machines than by all other techniques combined. Perhaps it is the widespread availability of used Monotype casters that has enabled so many well-meaning people, without the benefit of discipline or training, to gain access to the craft via worn-out equipment. The product they create only adds to the misconception that metal type of good quality cannot be cast from these machines. Nothing is further from the truth. Rebuilt Monotype casters, with replacement components as needed, will, when customized and used with intelligence, produce type that cannot be distinguished from foundry-cast type. On occasion, I have purposely cast characters from foundry matrices on a rebuilt Monotype display caster, dressed them, and offered them to fellow typecasting professionals who had always scoffed at Monotype quality. Even the veterans with many years' service could not reliably tell them from the best of their Barth-cast products. The problem lies in what might be termed the "comp-shop" approach to casting type. Monotype composition, although in itself noble and adequate of purpose, is a world far different from that of the true type foundry: to apply comp-shop values here is unfair and foolish. This section will deal with the production of superior type with Monotype machines.

Of the various Monotype machines, the OA Display Caster (nicknamed the "Orphan Annie," from its initials) and the Thompson caster are the only ones of value to us. I will not deal with the Giant casters, material-makers, and the like since these machines produce products akin to the composition caster. Type made with cored bodies for purely economic reasons may be adequate for ordinary work, but it is no match for well-made foundry type in quality; and it is repugnant to the practicing, conservative type artisan. The OA is superior to the

Thompson for our purposes.[8] English-made versions of the OA Display Caster are considered to be superior, though not critically so, to their American counterparts.

The huge plunder resulting from the demise of the ubiquitous Monotype shop is finally beginning to dwindle: this is a very important point, because this once seemingly inexhaustible supply of casters and parts will soon be no more. England may still supply parts but at often inflated prices; and the few sources of supply in this country are all but gone. During the course of rebuilding and customizing an OA, parts hunting, casting new parts from broken or worn-out originals (used as patterns in a green-sand, nonferrous foundry), and outright begging must be employed. Fabricating a new part in a machine shop can be costly. Gone are the days when you could carry off an entire shop for a pittance, or even for the mere effort of its removal—and in some ways, better so (it was always horrible to witness a wily collector dumbfounding the owner of a defunct shop by offering him five dollars cash for a mold worth several hundred). The one constant rule when out on a "search and seize" mission is to get at least *two* of everything. If both are not needed, sooner or later you will nearly always encounter a fellow pilgrim in need of the same item. Parts trading is an art; and, happily, most people are honest and sincere.

Customizing

The recommendations outlined in this section are useful for all casters. When looking to assemble a foundry-compatible sorts caster, try to find one that has been used for a specialized purpose. If the caster has not been abused or run into the ground, much effort will be saved in restoring it. Check the amount of play in the camshafts and speed box. Gear slap can never be eliminated entirely, even on newly rebuilt machines. Avoid machines with lateral motion in the shafting. Avoid machines where the handwheel rocks up and down. Aside from these faults, an OA with a mold in good condition will cast excellently, even when rather worn, if it is run in the slower speed range. When casting high-quality sorts, you cannot be concerned with blasting out type bodies as is a composition castor who continually worries about time and how much the job is going to pay.

[8] The many Thompson adherents may argue this contention: my arguments in favor of the OA will be presented elsewhere.

Quality, not quantity, is the goal. Avoid the "hammers of hell" approach: the slower speed range is safer, and what seem like obvious defects and wear in the transmission can be reduced to insignificance.

Once you have obtained a machine, run it through the casting sequence by hand, taking note of missing and damaged parts. Drain and clean the oil pan. If the machine is fouled with grime and metal, it may be wise to strip it down and immerse the whole thing in an automotive-type cleaning bath. Count on redoing the water lines and reaming the waterways in the mold stand. An ideal power supply is the 1/2 hp Kimble variable speed motor, the one supplied on certain composition and composition/display (combination) machines. This motor uses a pressure plate device and lever to adjust RPM, making frantic use of the gearbox speed control unnecessary. Kimble motors may sometimes appear worthless, but they have remarkable resurrective qualities, perhaps because they were so well engineered. Rebuilding is not complicated if you can find another motor to cannibalize. The brushes may have to be made by hand and ground to fit—no problem for a competent motor repair shop. Other cobbled-up drives will work with varying degrees of efficiency.

The various devices having to do with comp-casting should be stripped off and discarded. Cams and levers that were used to activate the composition gewgaws, air lines, paper tower, etc., are not needed. The machine must, however, have a genuine display bridge. (I have rebuilt a composition bridge with extra springing, but only for 12- or 14-point casting.) English and American display bridges vary in one important aspect: the matrix pin, which locates and firmly presses the matrix carrier assembly against the mold cavity, differs by the length and taper of the point at its end. For our purposes, the American style is inferior by reason of its extreme length, its sharpness, and its tendency to become damaged. The English taper will work in American apertures, and will seat much more accurately for the range of applications to which it will be subjected. You must determine which provenance is being dealt with in the restoration work described here. In a pinch, American pins can be reground to the English taper specs quite easily, but when obtaining new parts, be careful not to order by mistake an English pin for an American bridge: the diameter of the shaft of each style pin is considerably different.

Once the useless parts are removed, it is easier to drive the machine through its casting sequence. More power will be delivered to the pump stroke, and the machine will make better casts, especially on the larger body sizes. If the alternate-cast device is damaged or removed, it will be impossible to run the larger set-widths of the 30- and 36-point bodies for long periods, because of heat

build-up in the mold. This problem is not overly serious, except when attempting the widest extreme of set (I have successfully cast 20-point 2-em quads without the alternate cast device, using a good mold). In fact, 36-point is not an easy body size to cast on *any* kind of machine. For bodies 20-point and up, the oversize pump assembly ($1^{1}/_{16}$″ diameter) is very necessary. It should be noted that you can rarely cast anything under 12-point body on these machines, although smaller bodies (namely 10- and 11-point) have been customized from the 14-point display mold. The difficulties arise in delivery and handling of these smaller bodies, which are better done on other kinds of casters. Composition molds should not be considered, as they produce inferior type. A copy of the *Display Caster Operator's Manual* (Philadelphia: Lanston Machine Company) is necessary for adjustments, along with a good copy of the *Monotype Machine Plate Book* (Philadelphia: Lanston Machine Company), to aid in part identification. Adjusting the type carrier to place the jet sprue exactly in the middle of the base of the body is needed only when you intend to groove the type in a dressing stand. It is, however, beneficial to make this adjustment for the larger bodies, thus making a more even distribution of the molten metal in the mold void. Rarely, a character will require movement of this jet and its spray of metal to fill extremes or hard-to-reach ("cast-up") areas of the face. The ability to make this adjustment is a subtlety accorded to castors with the finesse acquired by long practice.

Most rebuilders content themselves with storing a few casters which are periodically mined for parts. It is better, of course, to begin with a genuine display caster; but an excellent machine can also be made from a combination caster as well. The set wedges used for composition casting must be changed to genuine display wedges (Normal and Justification wedges b21D1 + a11D1). When casting "to set," use the ATF Standards Chart for converting points to inches (see appendix 1, pp. 186-87). The Monotype standards for casting display set-widths vary somewhat, as the intention was to round off and simplify the casting protocol. If the machine is fairly constant in its accuracy, by all means observe the settings indicated on the brass plate gauges fixed to the machine. On my own "combo," I removed them, because they did not hold to a constanty—the result may seem like playing a guitar without frets, but with practice a discipline and accuracy will develop that is far more rewarding than trying to trust an unreliable factor. Nothing is so disheartening as being compelled to dump type that was cast defectively because of carelessness.

Fine tuning of set-width by $^{1}/_{8}$-point increments can be accomplished by adjusting the C Block adjusting screw (b14C1) wheel with a pin wrench. Certain modifications as described in the *Display Caster Operator's Manual* must be

made before casting the larger bodies and set-widths. These adjustments increase the throw of the type pusher and carrier alignments in order to facilitate delivery. The *trip plate* (a24B2) nearly always needs replacing as the result of wear. A worn stop on this part will not allow the type carrier to extend far enough when aligning the jet opening in the middle of the base of the cast type, especially with the 24- to 36-point sizes. New stop surfaces can be brazed or welded on the plate, but generally they do not last long. It is better to find a less-worn replacement or fabricate a new one in the machine shop. The galley mechanism should be removed entirely—saving, however, the useful tool tray and welding a support to receive it. The type stand or delivery area should also be made more permanent, with a cast or fabricated curved channel fence to present a neat discharge of newly cast type. It should be made adjustable by slotting the retaining bolt hole for travel to accommodate the various size bodies (14- to 36-

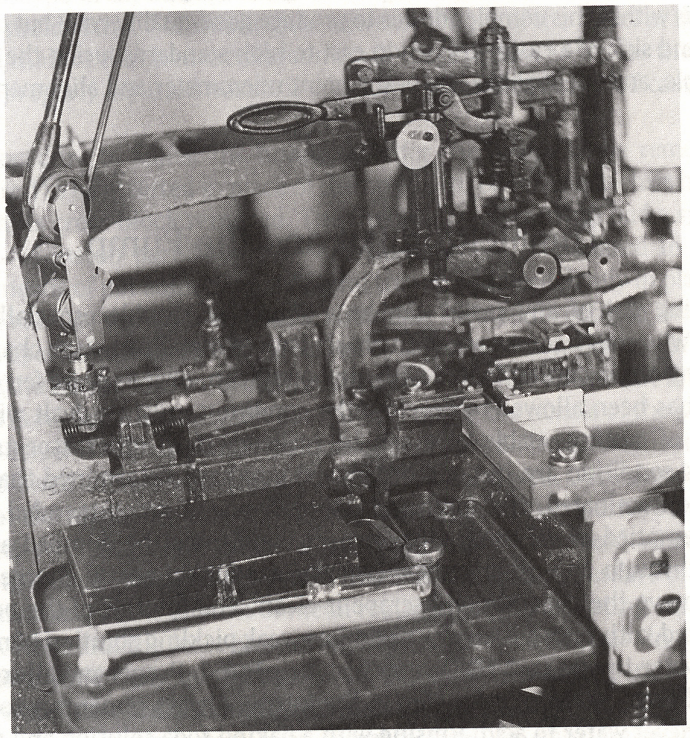


Figure 8. An OA Caster type stand (Howell Foundry).

point) being cast, and it must be easily removable for casting *dropouts*—that is, casting from engraved matrices or on kerned characters such as italic swash caps that do not rest flat against their fellows in the type delivery channel.

When casting from *any* engraved matrices, but especially from foundry matrices (with a special adapter), a beard is always to be expected. Unless such bearding is minimal, as from electro matrices, such unfinished casts must be finished by hand to maintain tolerances required for accurately cast type. There is, after all, no such thing as "automatic" typecasting, although the foundry automatics come close to this. Much of the worn Monotype equipment that has survived, and is still in use today, cannot hold a minimum .002″ tolerance for alignment. (The bridge wanders.) This is also true of the set constant (right sidebearing) that positions the face on the body. If these adjustments are always compromised and unreliable, all casts must be monitored closely. Expectations of supreme accuracy are unfair: recall the original purpose of the machine. The potential is within this complex device to produce good-quality type, but only under the care and skill of a castor trained to cast to high standards, using the points-to-inches table, and adept at the use of the point micrometer and alignment gauges.

The Melting Pot and the Pump

The melting pot of any caster can be a source of trouble especially for the amateur, who may be unaware of the basic laws of metallurgy (see chapter 6). If the melting pot is contaminated with zinc or silicon, or if a severe ferrous oxide build-up has been allowed to develop, the condition must be dealt with before any hope of casting usable type can be realized. If all other aspects of your machine's condition are in good order, and you have determined that the pot may be contaminated, the following maintenance is recommended. The pot must be emptied of *all* metal; the suspect metal must be dumped and never recycled through any other caster. Before introducing a new charge of clean metal, remove the pot liner and scrape it clean. The interior of the pot can be sand-blasted, although a soak overnight in a weak pickling solution of nine parts distilled water to one part HNO_3 may also be needed. Proper metallurgic disciplines will eliminate contamination in the future. Always remember to add acid to water, never water to acid. Rinsing with a baking soda solution and drying by heating with a propane torch or other method will dispel any fumes when heat-

ing up the pot afterward. Wear appropriate safety apparel, and respect the situation by being cautious.

The casting temperature of the OA must be set somewhat higher than that of other kinds of casters. The higher temperature has to do with assisting the pump to overcome the effects of gravity (the delivery is vertical). There is a greater amount of wasted energy (overkill) in the casting of solid type with these machines. Casting pressure must also be higher, and for the same reasons. The production of consistently solid bodies and crisp faces requires: *(a)* scrupulous cleaning of the pump before and after the run; *(b)* vigilant pot skimming; and *(c)* correct charging habits. One of the most important adjustments when restoring an OA to good casting condition is the squaring up of the nozzle so that it is presented properly into the bottom of the mold. When casting, the nozzle must fit the mold aperture exactly and firmly, thus eliminating conditions that cause poorly cast type or an outrageous (and dangerous!) accumulation of type metal below the mold stand. Considering the extreme length of the travel of the molten metal and the fact that it must overcome a 90-degree turn as well as the effects of gravity, a properly adjusted nozzle is your only insurance of a good cast with this machine.

The procedure to adjust the nozzle calls for the bridge to be removed, a 6″ threaded rod to be inserted in place of the nozzle (to be removed while hot), and a mold with its cross block removed. The threaded rod (Lanston had a special rod or gauge—Lanston part No. 15H—for this purpose) is squared to the mold stand by means of pot adjustments (lateral travel) and fixed firmly in place. When the pot is run up, the squared nozzle should be located directly in the center of the mold aperture. This can be observed by sighting down the top of the mold aperture (the reason for removing the cross block). When the nozzle-lifting lever in the pot is replaced (usually the pin that fits under the nozzle of the pump body is worn out), this adjustment should also be checked. The lifting lever and the travel and dwell adjustments should be recalibrated as well. Care should be taken to see that the nipple is clean, squared up, and trued to the aperture in the mold base plate. A poor fit will cause a splashing below the mold when casting. Depending on body size and set-width, increase the spring pressure of the pump with the increase in the volume of metal required to fill the casting void. *Dwell* is very important and the least easy to regulate on these machines. In an effort to cast a more solid body at the narrowest set-widths, many operators wrongly decrease water flow and attempt to elevate mold temperature by also increasing speed. The correct procedure is to increase dwell by shortening the vertical movement (upward) of the pump assembly. Casting at temperatures in excess of

725°F will ruin matrices quickly; the frequent monitoring of pot temperature is a good discipline to observe. A contaminated pot needs excessively high temperatures in order to overcome the sluggishness and lack of flow of the hot metal up into the casting void of the mold. Continued abuse is pure foolishness and extremely dangerous to both operator and equipment. Never leave the pump in the pump body when finishing the casting run; it should be rested in the pot alongside the pump unit before the metal solidifies.

Casting

CONSTANCY

When casting a new character, do not depend on the alignment remaining true. A good castor always checks the last few types of the previous character, as well as the first few of the next one. The order of a castor's inspections are:

1. Alignment: last of previous character
2. Set-width: at the same or new dimension
3. Jet sprue: appearance, solidarity
4. Rate of cast: change if needed
5. Alignment: first of new character
6. Repeat

FOUNDRY-STYLE MATRICES

It was the cellular matrix holder for single cellular matrix casting on the OA that inspired the design for the foundry-matrix adapters now used by the Dale Guild. Stated simply, it is a machined holding device fitted for use within the standard cellular matrix case.

The device depicted in figure 9 is one of three successful designs I have developed. These adapters broaden the horizon of the OA caster to accommodate many old faces, which could not otherwise be cast from their original matrices because of the loss or unavailability of the required type molds. To mate the exotic drives of the old foundries with a cast that will be type height (.918″), the need is evident for a stockpile of extra display molds available for reconditioning and grinding down to the proper height. It is important not to alter matrix drives to match a mold. This practice destroys electro matrices (by loosening the rivets

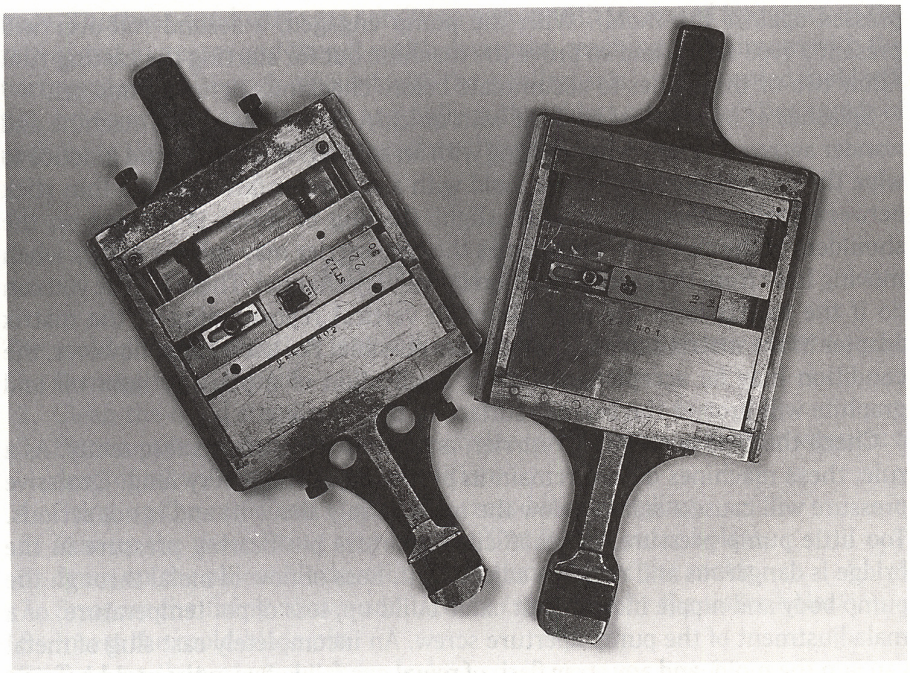


Figure 9. OA Caster foundry-matrix adapters.

that secure the laminates), and it also alters and ruins the matrix as a historical object, destroying its value as an instrument for attributing provenance. A tension bar within the adapter is applied against the matrix by means of screws and stops. Pressure must be exerted evenly to minimize unnecessary wear to the matrix. Then the entire assembly is positioned in the bridge over the mold void and its bearing surfaces, making it ready to cast. Before starting the caster, roll the machine over by hand for the first cast to be sure the line-up over the mold void is entirely covered by the matrix surface. Foundry matrices will vary in length and are limited only by the clearance within the adapter. These devices are useful for making successful casts from damaged or rare matrices to be used as models for new electros (see chapter 9).

When first starting up *any* powered caster, always roll the machine over by hand, first with the pump locked out, to check all adjustments. A slip of thin paper held between the bearing surface of the mold and the matrix will ensure that you have a good seal (if you cannot remove the paper when the matrix is

pressed against the mold). With the pump engaged, a second roll-over will present a type safely, and so prove the machine out for starting the casting run. Allow two or three lines to accumulate before checking alignment and set.

Splashes of metal must be dealt with quickly. Do *not* leave this machine and wander away, especially when casting with an adapter. It is also a good practice to wipe the bearing surfaces of the mold with a rag wiper fastened to a thin stick between matrix changes or when slight flashing of metal is noticed on the shoulders of the cast type. Sometimes the type carrier may rub the matrix when moving to or from the casting position or delivery channel. There is little you can do if the matrix is in the way, although vertical repositioning of the matrix adapter in the matrix carrier is sometimes possible. For a few casts, however, the condition may be acceptable, and the application of a paste of light oil and graphite will protect the bearing surface of the matrix.

Check the type pusher, type carrier, and pump adjustments frequently. As a rule, these machines do not remain in proper adjustment very long. Excessive pressure will cause a splash below the mold (rarely above it) and is not serious. Too little pump pressure, or insufficient aperture pin-bearing pressure in the bridge is dangerous and requires adjustment. Loss of flow of metal through the pump body and nipple indicates an oxide build-up, loss of pot temperature, or a maladjustment of the pump aperture screw. An incompletely cast slug of metal can jam the mold, and any stray flash of metal can fall between the mold-bearing surfaces and matrix, causing a serious splash. Familiarity with the correct disassembly and maintenance of the display mold is an eventual necessity; being able to do your own maintenance saves time and money. The *Lanston Mold Maintenance* folders are invaluable for this purpose. Unless there is severe damage, cleaning and maintenance should involve only the procedures to remove the cross block, gate pusher, top guide, and its shield (see chapter 8). Display molds are still repaired and rebuilt to specification by the Hartzell Machine Co.[9] A regular program of disassembly and thorough cleaning will eliminate destructive wear and expensive repair costs. Holding type height with the casts from an ancient display mold is considered a success if the tolerance is .0005″ or less; more sane and less fastidious castors usually live with +.001″.

Venting of a display mold is accomplished by grinding minute channels into the working surfaces of the mold, by which the gas carried in the molten metal ("melt-up") can escape from the mold void during the casting sequence. Without such relief, this gas has nowhere to go, and it creates holes within the solidified

[9] Hartzell Machine Works, Market and Bethel Road, Twin Oaks, Chester, PA 19014.

body. This heat-conductive gas condition occurs with increased frequency as the rate of cast increases and the set-width decreases, reaching a maximum with the narrowest sets. Although efficient with the smallest sets, such a vented mold will not, however, cast as crisply or as solidly at the widest set-widths. Two molds of each body size (one vented) is therefore the ideal.

Changing Molds

The mold change operation is as follows (do not overtighten any screw):

1. Remove the old mold
2. Clean the mold stand
3. Place a paper gasket over the water holes (preperforate with a pin wrench: a drop of oil will help hold it in position)
4. Bring up the mold and engage the cross-block coupling
5. Run up the three fixing screws (start first by the water holes)
6. Snug up the pillow blocks on the front and side of the mold
7. Snug up the fixing screws and tighten (start first by the water holes)
8. Insert the mold-blade pin
9. Turn on the water; check for leaks
10. Oil the cross-block coupling
11. Oil the mold ports; run the mold

When running at optimum casting conditions, the water temperature can get quite hot (130°F); but when it is checked, it should not be hotter than the fingers can stand. A condition of excessive casting temperatures within the mold will eventually lead to a serious splash, not to mention serious damage to the mold and matrix. Lower water temperature through the mold is a must for casting the largest sets, and anything over 40-point in set-width must be cast on another kind of machine, usually a pivotal.

* * * Disclaimer Note * * *

The procedures outlined in this section are hardly standard operations as Monotype would describe them. They are intended solely for the convenience of those brave souls contemplating customizing an OA caster.

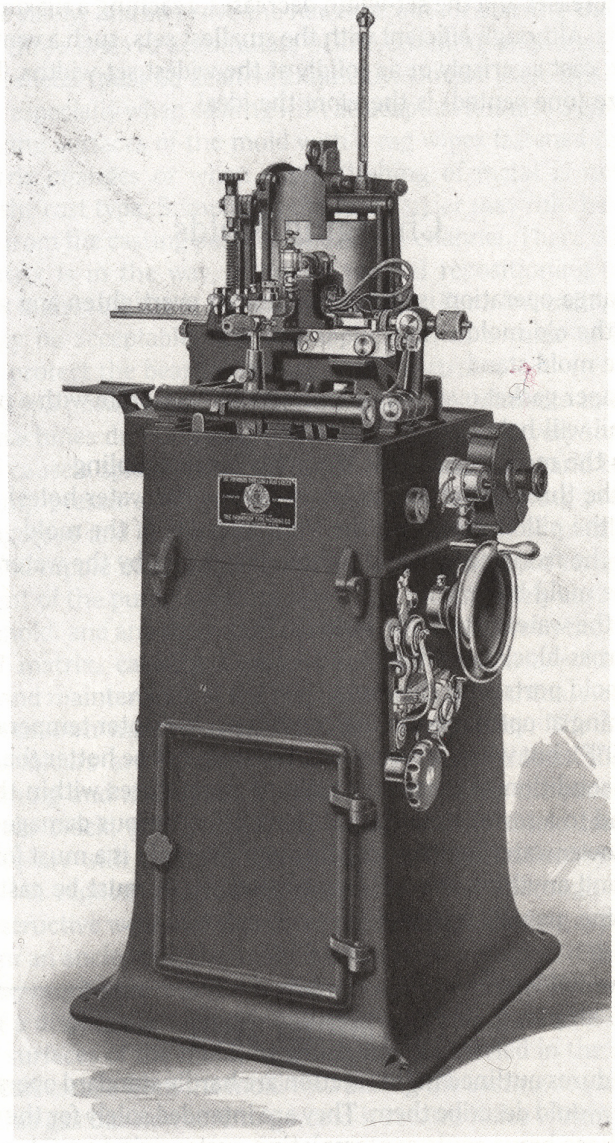


Figure 10. The Thompson Caster.

Chapter 4

The Thompson Caster

There are many who consider the Thompson machine a very close second to the foundry automatics. In many ways this machine might have developed into something more positive if it had not been assimilated by Lanston who thwarted its future. (The directives issued by Monotype to its field reps are very telling, always downplaying the Thompson and offering more service and better terms for its own products.) As with the foundry automatics, the Thompson's metal delivery is horizontal; it has an astonishingly simplified and tight casting sequence plus good metal-casting dynamics. Yet it is unfinished in many ways. Perhaps too much is asked of the many and complicated moving parts of the mold; it casts much too slowly for narrow sets and small bodies to be cost efficient—for even the most impractical of craftsmen; and it is a dangerous machine when taxed to the limits of its casting range and pressures. It is an unforgiving machine! One can always identify the career Thompson castor: he has a permanent area of scar tissue on his forearms caused by fending off its frequent sprays of hot metal. When used with patience and respect, the Thompson casts good type, delivered grooved (center jet molds are preferred for appearance's sake) and trimmed on top and bottom. At one time, an experimental four-way trimming apparatus was engineered, but it was impractical for the smaller bodies. Adapters were also developed for various kinds of matrices, including foundry-style.[10] The ideal situation, as with the pivotals, is to fit an entire range of machines (three or four) for a specific size group, adjusted to the particular needs of those body sizes within the given range of the machine. Having a range

[10] Caution should be used with the particular Thompson adapter that uses pointed set screws. This device has a tendency to press apart and ruin the weak laminates of old and worn-out foundry matrices. Only the shortest and smallest foundry matrices can fit within the adapter. Anything over an STL-2 18- or 24-point matrix usually cannot fit. European-style matrices work very well, however, if the drive is right. (It seldom is.)

available effectively reduces mold changes and extremes of adjustment, excluding the variations of drive. Unfortunately, the Thompson was never as common as the OA, and good machines are difficult to find today.

A number of the Thompson's working parts are relatively delicate and precise, and in all fairness it must be remembered that many founders used to depend on machined replacements for these critical components, made by mechanics and shops far removed from the standards of original manufacture. This situation accentuates the negative potential of engineering flaws inherent in the Thompson's design. It is rather too late for a full-scale redevelopment! As with the automatics, and even more so, one cannot take liberties with a Thompson. Familiarity with the operator's manual is mandatory, and the following precautions should be followed: *(a)* ensure the mold is intact and firmly snugged up, *(b)* ensure the pot is seated on the nipple plate,[11] and *(c)* never attempt to remove or replace a nipple when the pot is cold, and always use the seating tool when rapping it back into place.

Thompsons cast 5- to 48-point bodies from their own flats, display flats, and Giant Caster matrices (with adapter). With the use of special adapters, they can also cast from cellular (comp), Linotype, and certain foundry-style matrices. Trim knives should be kept stoned sharp and clear of flash and metal debris. Oil rates should be checked regularly, just as with foundry automatics. Many castors still prefer the original Thompson oil, but it had a tendency to build up burned deposits on mold surfaces. A nondetergent SAE 30 works well when cut with a small amount of DAE or SAE 10, the resulting deposits being easier to remove. Use a tiny flat piece of fine Arkansas, being careful to remove *only* the deposit.

The casting sequence differs for the English machine, which runs opposite to the American machine. Always adjust set-widths while in the neutral position *only* (that is, the English machine with its handle up; the American machine with its handle down), since serious damage can occur if the stroke of the machine is not extended to its farthest limit during this operation. Never trip the pump lever without having the machine properly engaged to cast: you will damage the critical pump-stop lever. Correct water flow is essential, especially at the far extremes of body size and casting pressure adjustments. With the smaller bodies, fairly good-looking type can seemingly be produced without care for a short time: but eventually the toll on the mold and matrix is severe. Depending on eutectic, pot temperatures can be maintained lower than those needed for the OA. Thompson-cast type that has been cast too hot in the mold shows a glassy

[11] Fels Naphtha soap will quell a slight drip from the nipple; however, serious dripping indicates a need for adjustment and/or cleaning of the nipple and choker valve.

surface on the body and face. Heat-dross deposits on the face or just below it on the surface of the newly cast type cannot be tolerated. Such type does not last long under normal usage and is virtually useless as forms to make electros for new matrices. Proper metal handling and maintaining optimum casting conditions will eliminate this problem. Even more helpful is to familiarize yourself with what good type looks and feels like. It is worth the effort to search out and observe the protocol and disciplines to be found in a competent typecasting foundry. There is no substitute for hands-on learning experience. To this end the Dale Guild and certain other firms and individuals will sometimes offer tours of facilities. The Dale Guild holds infrequent, but usually well-attended, casting clinics. Those who participate are rewarded with fonts of sound type made under direction, but by their own hands. Those interested may contact the Guild.[12]

[12] Write to the Dale Guild, Inc., 4621 Route 9 North, Howell, NJ 07731-1913.

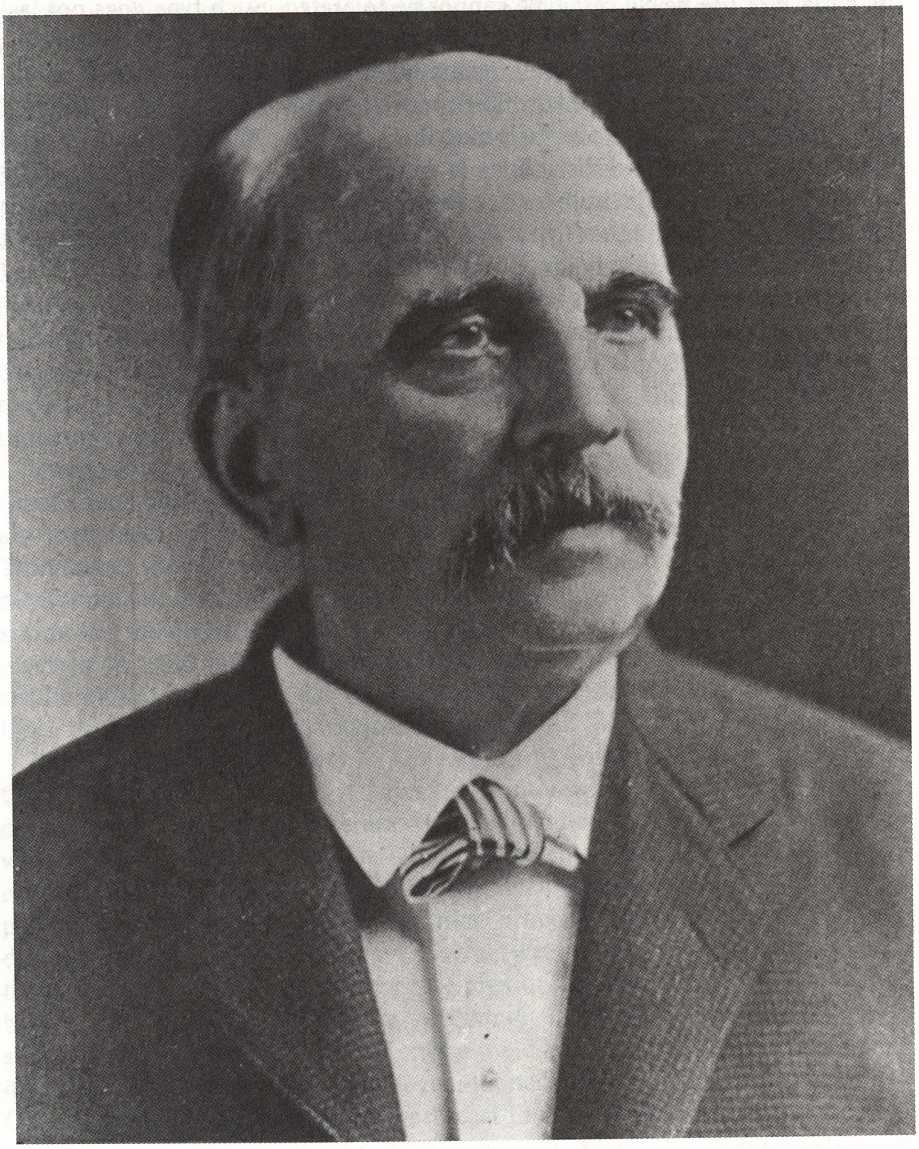


Figure 11. Henry Barth, 1837-1905.

Chapter 5

The Foundry Automatics

Historical Background

Automatic typecasting machines were developed in the 1870s and perfected in the next decade; they attained their high-water mark with the 1905 Barth conversion model (Old No. 1), and reached final development with improvements by Linn Boyd Benton and the ATF engineering foreman, Frank Peters. Henry Barth and his foreman/partner Ernst Lietze had designed several prototypes, the best qualities of which were brought together in the "Cincinnati" machine. Barth was the mechanical engineer and Lietze was a practical genius (it was rumored that Barth was the entrepreneur, while Lietze was the inventor) who worked with the peculiar properties of molten type metal in a logical manner, programming the casting sequence, inventing automatic finishing components, and synchronizing the dynamics of the various casting operations. The machine was perfectly balanced; it ran with an even, steady torque at all speeds, and was, by present standards, superbly overengineered with tremendous bearing and wear surfaces, minimal tolerances, and infinite fine-tuning potential. This magnificent machine and its various unique devices were works of art. The patents assigned to Barth and Lietze are dated January 24, 1888 (No. 376, 765); and November 13, 1888 (No. 392, 710).[13]

Barth died in 1905; Linn Boyd Benton further refined and added to the machine. A virtuoso practical craftsman with a remarkable ability to "see" with his hands, Linn Boyd Benton, along with his son, Morris Fuller Benton, continued to improve the machine with various devices, holding patents from 1905

[13] See appendix 3, p. 198.

through the 1920s.[14] Perhaps Benton's most intriguing achievement was his success in designing an efficient finishing operation for the angle-body typecasting machines, which finished each type on all four sides. The knives "float" over the curves of the body at precisely the correct depth at all sizes from 24- to 72-point.[15] The final major innovations were completed before 1949. Frank Peters' contributions were essentially Benton's unfinished work in hand, but done in a manner befitting the old craftsman's skill. Peters is remembered primarily for designing and implementing an adjustable nicking device, which could imitate *any* nick scheme, new or old. He died in 1962, before he could equip all the casting machines with this new device. Variations of Barth's design and Benton's refinements were incorporated in several European automatic casting machines, primarily in the direction of ingeniously combining various functions simultaneously, thereby reducing inefficiency and wasted energy. The most common of these machines, the Kuco KV, served the many fine Continental foundries, and could produce casts that are very nearly equal to those made on the Barth.

Engineering

The mold of the Barth Automatic Casting Machine is mounted on a fixed pedestal, actuated by a cross slide (head-stock) and served by remote cams and levers. A horizontal-swing melting pot (originally gas-fired; later electric) supplies metal through the nipple plate and into the void of the mold. When the casting sequence is engaged, the choker valve opens as the head-piece/mold alignment is reached and the void fills with great force in a fraction of a second. Also at this moment, a previous cast is already on its way to the type channel, and the pump (piston) is poised for the next cast. Each cast is pushed up through the water-cooled mold by the body piece; it is caught momentarily and propelled by the head piece, pressing against the tail-piece resistance; the jet is broken off and the cast stops at a position over the type channel. It is then pressed down the type channel by the type pusher. When casting, the machine synchronizes the new cast and an opposite delivery of the previous cast to the type channel. Every

[14] In contrast, Henry Barth's son, Otto, was a genial but ineffective corporate executive, made head of the Type Casting Maintenance Department for nepotistic reasons.

[15] Unfortunately, most of these machines have been scrapped, two of them right before the author's eyes.

function required to serve this casting sequence must be adjusted through its levers, springs, and cams with great care and precision. Once calibrated and locked into permanent "fixed" adjustment, the machine casts well for many years and needs only to be minimally adjusted to compensate for wear in bearing surfaces.

The type body is cast on its side (nick to the left on the Barth, but to the right on the Kuco), and it then passes through adjustable knives on top and bottom (the machine's top and bottom, *not* the type's) which can easily be changed or adjusted to suit the needs of the cast for proper dressing of the beard and any other kerning, if required, for complete finishing. These finishing knives are set and ground to a degree of slope (5-65 degrees) and in narrow to wide depth on height of body dimensions. They produce a clean cut trim at the beard, right down to the shoulder edges of the body. For the remaining two sides of the cast (the type's top and bottom), a fixed pair of rubbing knives cuts a similar trim as the casts are pushed farther down the type channel. Finally, a grooving knife cuts the metal remaining at the base of the jet sprue, making "feet" at the bottom of the finished type. The resulting product is ready to use or ship. Once the machine is fixed for casting and is set correctly, it can produce perfect casts at an astonishing rate.

For any set-width change of an em or more, some adjustment of the pot and its carriage is usually necessary. The object is to center the nipple and its plate with the aperture of the mold void. The horizontal adjustment is done by first loosening the four set bolts that fix the pot carriage in position. A lateral set-screw allows for movement left or right. To check this alignment, back off the head piece and secure the tail stock in its fully open position with a tail-stock brace. This will enable the castor to observe where the aperture of the nipple plate is located in relation to the top and center of the mold sprue (into the mold void). After centering the aperture, the pot may be raised or lowered the amount required to bring the nipple aperture to just slightly below the set-width level of the body piece. This is accomplished by fitting a pin wrench to the boss of the leveller-screw, at the rear of the carriage. After adjusting and before recommencing casting, the four bolts should be retightened. A few casts will reveal if the adjustments are satisfactory by allowing the castor to examine the newly spent jets. The aperture marks should appear as a moonshaped disc, approximately three-quarters "full." The pot-locking handle usually needs to be reset after this adjustment. It should always hang straight down when engaged and hold the pot in a snug position against the mold. Simply loosen the set-nut with a wrench and let the handle drop straight down; retighten the set-nut.

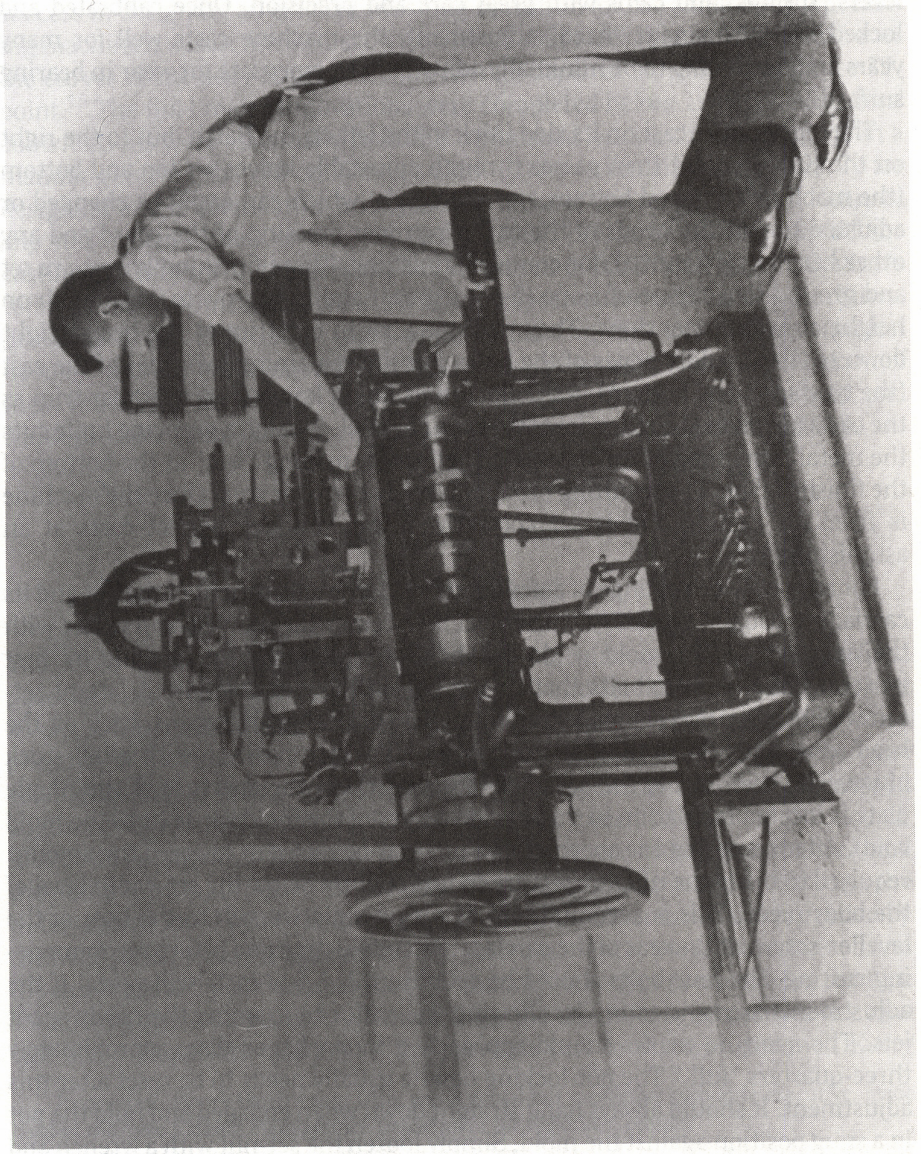


Figure 12. No. 1 Barth Casting Machine, *c.* 1896.

It should be noted that in any designs where there are kerns at the top and bottom of the body of the type (sometimes called vertical kerning) one or both rubbing knives must be loosened and backed off (or removed entirely), as the type will not pass the knife without damage. Such type must be dressed by hand on the dressing stand. Rubbing knives cannot be ground to more than 3 degrees, and, other than cross-kerning, this is the only concession to hand-finishing by the automatic casting machine. Some of the older faces (pre-1892) contained characters with vertical kerning, but modern occurrences are confined to certain accented caps, especially the roman cap "N" with tilde for Spanish (Ñ) and a few cases of extremely lengthy descenders of lower-case characters. Using characters from other fonts to supply characters not normally sold with the face being cast can also create vertical kerning.

The matrix is held in position on the matrix carrier by two studs (the matrix has two corresponding stud holes drilled into its side) and is pressed against the bearing surfaces of the mold aperture by an adjustable matrix pin, which, when properly set, holds the matrix firmly by entering the matrix-pin hole (directly behind the eye of the matrix, on the back of the matrix body), but is still capable of revolving in its linear orbit when not engaged to cast. The matrix rides to and fro on this "shoe" assembly. A "slipper," which fits between the shoe and the matrix, has a right-angled bearing surface of appropriate dimension, which maintains correct alignment for each particular suite of matrices and provides a constant by riding against the alignment abutment. A "bump," or dimple, in the base of the slipper permits a limited amount of rocking of the matrix, aiding in the release of the cast—an important feature at high speeds. If there is no bump on the slipper, a brass shim with a bump and stud holes is also fitted between the matrix and the slipper to ensure the rocking movement.

In regular casting, alignment is not usually changed on a specific machine. Under certain conditions it can be adjusted, either by changing the machine's regular slipper and its specific bearing surface dimension or by adjusting a set-screw wedge device at the alignment abutment. Such adjustments are made by supervisory type craftsmen known as *liners,* who loosen the locking nut with a special wrench and recalibrate the setting of the wedge with a special tool that measures in increments of .0002". When the adjustment is satisfactory, it is once again snugged up, and a cast is checked by the liner for accuracy. Only rarely are mold changes made. The changing of a mold on the Barth is not accomplished quickly, and these machines are capable only of receiving molds with body sizes within the designated range of the caster's mold stand.

There are four sizes of Barth casters: No. 1, which handles from 4- to 18-point

Figure 12. No. 1 Barth Casting Machine, *c.* 1896.

bodies; No. 2 (extinct as a species); No. 3, for 36- to 72-point bodies; and the huge No. 4s, for everything else, culminating with the great 144-point caster, a dangerous machine that was dismantled in the late 1930s after some dreadful disasters, much to the relief of its potential victims. There are variants of each size group that are distinguished by fractional identifications stamped into the left side of the apron of the frame, in the top lower left corner. For instance, you may see a No. 1¼, No. 1½, No. 2¼, No. 2½, No. 3½, etc., (in inches) fixed on the height of the mold stand; a corresponding mold plate height is needed to bring the base of the mold surface to the proper height on the pedestal. There are also wide-set variants of the No. 1¼, No. 1½ and No. 2 machines (all of which were scrapped by 1960).

The No. 1 Barth has a casting range capacity of approximately 20-60 casts per minute. There is an infinite overlapping of speeds, adjusted by the control wheel and a pair of four stepped belt pulleys. To determine the correct speed or rate of operation, examine the jets. The larger end (the plate "end") of the jet should show a discernable melt area or hot spot around the aperture mark. Shininess or tear marks indicate insufficient speed. Too fast a rate of cast will be indicated by a burned or melted end. A back splash will occur if the speed is not reduced. In the largest machines this can occur after the second cast. Too high a casting pressure (i.e. pump spring) will cause flashing of metal at the rear of the mold around the jet itself: this is called "winging." A slowness of casting rate creates wormy, uncrisp faces and bodies. Overly fast casting rates can also cause *cap-*

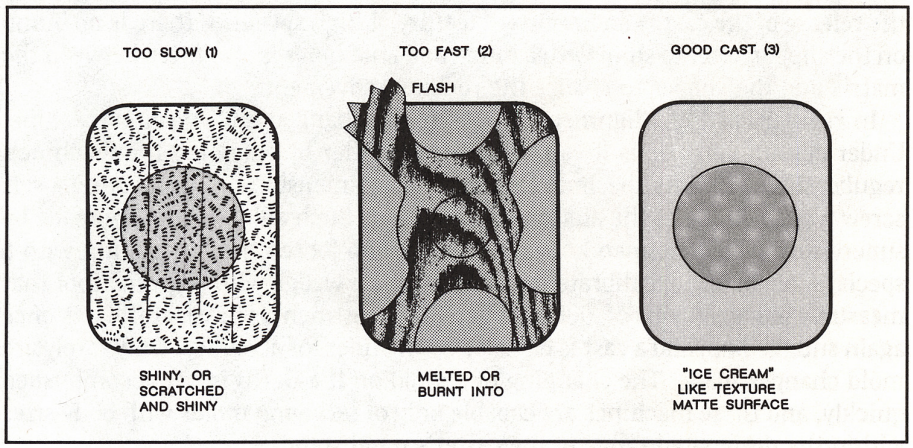


Figure 13. Typical appearances of jet-ends.

ping, or flash, at the upper body, between the matrix and the mold. If not caught and corrected in time, capping can produce a serious splash. The capping condition can also be caused by the matrix pin being set overly loose: the matrix pin must revolve in its linear axis, *inside* the matrix-pin hole of the back of the matrix, so that it presses the matrix with sufficient firmness when the carriage is moved to the mold while the cast is made. Insufficient flow of cooling water to the mold will likewise cause capping and an eventual splash.

The Barth caster is so well engineered that it can cast at both set extremes without serious compensations. The larger machines feature a double-drop pump cam action, thus ensuring solid type in the larger bodies and set-widths. A micrometer wheel adjusting the set-width is graduated in 1/8-point increments: one revolution of this wheel makes a 3-point set-width change (although some of the maverick larger machines are calibrated slightly differently). Remember that slight variations may occur with even the finest of equipment: this is not a problem for the competent castor, who always checks his casts against the ATF Standards points-to-inches chart. When making a change in the set-width, always draw the wheel beyond the desired setting to remove any play, then bring it back to its proper setting, and tighten the stop screw ("thumb set-screw").

The most critical adjustments for the proficient castor all deal with the pump. During the cast, a drop cam releases the pump, which moves down into its collar under spring pressure where it is held against the friction of the seal made by the packing, pushing the molten type metal trapped ahead of it into the mold void via the choker valve. The narrower the set-width being cast, the more the spring pressure is increased. Fat, wide faces also need extra spring pressure in order to make a dense surface on the face of the type. After continued use, collars occasionally need to be tightened.

To tighten the collar, locate the collar wrench firmly on the collar (but enter the molten metal slowly at first, to avoid causing a splash of metal off the cold iron of the wrench). Next, loosen the collar slightly; then firm it up so that it is snug, but not so tight as to stop the pump in its travel; then back off ever so slightly again. This adjustment should improve the cast quality immediately. At the start of the run and at intervals during it, the pump should be rotated freely with a wrench to seat it in its well. Before starting up, always determine that the pump is free. Rotation helps prevent the pump and its well from becoming elliptical in shape and reduces the need to have these parts trued by a machinist. An elliptical pump or well will always betray itself by returning to the same position no matter how many times it is rotated, usually after the first pump drop.

Unlike pivotal casters and the Kuco Automatic, which do not have packing around the pump, the Barth must have its well repacked at certain intervals because of wear. The material used is old-fashioned graphite-impregnated asbestos wick, 1/4″ flat or oval, now almost impossible to obtain. Cotton and cotton/wire products can be substituted, but they do not last as long. To replace the packing, remove the pump and its fixed parts, along with sufficient molten metal to allow access to the well. After picking out what is left of the spent packing, swab the well with tallow. Clean the pump carefully by running it on a lathe and rubbing it down with fine *used* emery cloth. Then dip it in tallow and reinsert. If the pump is frozen, it can be carefully pulled out with a fulcrum spacer, using the pot arch and pump nut. When reassembling the pump ensure that the "X" mark on the arch spacer is facing you. Now pound the packing around the pump (already lowered into the well) into the clearance around the collar aperture. A piece of wire will hold the collar up out of the way during this procedure. Pack tightly and uniformly, but not so tightly that downward movement of the pump is prevented. Done at casting temperature, this work can be daunting. The more effort expended in correctly applying the packing, the longer it will give good service. It is wise to turn off the heat in the pot when not casting, to increase the life of the packing.

The choker valve must seat properly at both ends of its stroke: at the nipple end to stop outward metal flow, and at the back stroke to seal off the metal trapped in the well, thus ensuring that the flow of metal can go only up the gooseneck in the pot, through the nipple, and into the casting void of the mold. Metal oxides and dirt can build up in these areas, and they must be dealt with. Always pull a nipple only at casting temperature. Proper spring tension and clearance for the choker activating arm must be maintained. When the choker is extended (fully open) at the farthest limit of the pump stroke into the well, the space between the locking nuts on the choker arm rod must be 1/16″ to 1/8″. Any adjustments made to raise or lower the pot must be compensated for: be wary and look for a nipple alignment that wanders off its casting sprue center. Always ease the machine towards extremes in set-widths *gradually*. Running in when adjusting to great divergences of set should be of longer duration; by casting extra bodies, the machine will have time to seat surface meets on its various bearing surfaces. Remember the wise words of Edward Wehrle (1915-83), foreman at ATF Elizabeth: "A properly cared-for machine gives less trouble and casts more type. An accurately set machine, plus this good care and a neatness of work habits, is fundamental to casting safety."

Operation

STARTING UP

1. Clean the nipple. A slight drip can be quelled by rubbing a piece of charred wood against, and into, the nipple aperture.
2. Put the plate in place. Clean the plate by heating it in the pot, first dipping it in tallow. Check and rub off any metal with a cloth wiper. Ensure the plate is firmly seated on the nipple and is snug against the mold aperture. Tighten the locking nut on the pot stand.
3. Check everything: true up the plate/mold aperture alignment; rotate the pump; check and adjust the water and air. *Note:* Do not oil mold areas until machine is underway and making casts.
4. Practice matrix etiquette. Place the matrix on the shoe. Check the slipper. Engage the matrix spur pin and adjust it if necessary. Cast the sequence of set-widths from widest down to narrowest, casting the alignment character first.
5. Roll over by hand. Check the casting sequence, matrix clearance, matrix-pin rotation, and type pusher/pump/choker action.

STARTING RUN

1. Throw up the lever and engage the clutch drive to start. Observe the casting sequence again.
2. Check the knives. Check the speed and adjust it as necessary. Check the jets.
3. Apply oil to all lubrication points. Inspect the first casts for cold shunts in the face and holes in the groove.
4. Check a sample cast in a type height gauge. Check the set with a set micrometer, and adjust if necessary.

CHANGING SET

Determine the amount of set-width change by examining previous casts in the channel and comparing them to the dimension marks on the new matrix. To "make" set:

1. Loosen the set-width wedge lock with a pin wrench; also loosen the thumbscrew on the set-width handwheel.
2. Make changes in 1/8-point increments; then retighten.

3. After a few casts a sample (obtained by holding the tail stock back and carefully removing the cast) is checked for the new set-width dimension. Adjust again if necessary.
4. Adjust the type-pusher: the type should be held firmly but not overtightly, in order not to mark the type body.
5. The adjustment of finishing knives completes the last settings above the type channel. (Top and bottom knives are adjusted up and down.)

POT LOCATION

1. Check the aperture mark on the jet sprue end.
2. Pull the pot back from the mold and loosen the pot fixing nuts.
3. Raise or lower the pot as needed (with a pin wrench to the boss on the rear of the pot stand).
4. Check the height of the pot by bringing it back to the mold with the plate held loosely in position.
5. Adjust the nipple along its horizontal tangent if necessary (with the set-screw at the side of the pot). Tighten the pot firmly.
6. Check the choker arm clearance and spring tension.

CHARGING

1. After start-up, as the type metal liquifies, break up any lumps remaining on the sides and near the front of the pot by using a pry bar. (Be careful of the heating elements if the pot is electric.)
2. Move the lumps to the back of the pot.
3. Skim off the dross, placing it in the waste metal pan.
4. Stir the pot clear to the bottom.
5. Clean the molten metal surface thoroughly, especially in the front. Wear safety glasses, and be wary of splashes.
6. Always charge new metal at the *rear* of the pot. Charge often and in small quantities, to help maintain pot temperature.

STICK HANDLING

The delivery apron of the machine holds the machine stick on which casts move along from the channel. Follow this procedure:

1. Ensure the machine stick is under the delivery plate and up against the solid

end of the delivery apron; also check that the outer end of the machine stick is resting solidly.
2. When sufficient type has accumulated to fill the machine stick, carefully lift it off, holding it at the ends with your thumbs and forefingers, and place it on the *lower* bars of the type rack.
3. Place a turnover stick over the type, and turn both sticks over (*away* from the castor).
4. Put the machine stick back in place on the delivery apron.
5. Inspect the feet of the new casts (facing the castor).
6. Put spaces and quads up on the *top* bars of the type rack with their feet (grooves) facing the castor.
7. Put faced type onto another stick and place it on the *top* bars, facing outward, toward the castor.
8. Always keep a turnover stick handy on the lower rack.

SHUTTING DOWN

1. Turn off the pot heat, nipple heat, and motor.
2. Set head piece to the left of the channel, just before the top knife, and jack up the pump.
3. Loosen the pot locking nut and unscrew the pot closing screw. With the right hand, remove the plate as soon as it is free and place it in the pot. Continue unscrewing the closing screw until the boss releases.
4. Jack the pot up above the pump actuating-lever surface, so that it will not spill metal through the open choker valve. (I have disengaged the choker by failing to do this.)
5. Push the pot back out of the way *slowly*. If the pot is electric, take care with the flexible heater conduits.
6. Wipe off excess dirt, metal debris, and surplus oil from the back of the mold.
7. Wipe down the rest of the machine and put away tools.

Machine Discipline

Box gauges measuring a 144-point constant are used to check the set-widths of casts in conjunction with a special standards table which indicates the number of

sorts of type needed to fill the gauge, regardless of set-width dimension, some of which may also require a metal dimensional standard to be added to the odd-numbered type to "add up" to the 144-point dimension needed (see appendix 1, p. 185). Type should fit snugly, but should never be forced into the gauge. On the other hand, the sorts should not be so loose that they can be shaken gently out of the gauge. An ordinary machinist's micrometer may be used to check set-widths by cross-checking with the ATF Standards table for converting points to inches (see appendix 1, pp. 186-87). A genuine set-width micrometer is indispensable but may take some getting used to by a craftsman more familiar with a machinist's micrometer (the set-width mike has fractional increments). When thin set-widths are being measured, it is sometimes easier to read two or more casts held together at one time: this makes for more accuracy and a swifter determination. As for the type height gauge, a cast that has been made from a burned-out matrix cannot enter it easily, as it will be of greater height than allowed for by the gauge.

An unacceptable condition is *edging* which is caused by the head piece working out of adjustment at the extreme end of its travel across the machine. Check first to see if there is any debris stuck to the bearing surfaces of the forward throw stops; then loosen the locking nut and turn the travel adjustment screw, repositioning it over the type channel. Retighten the locking nut after adjusting. Type that has jammed and rubbed into the type channel has its crisp edges ruined. It is called edged type and is not fit for use.

If not correctly and sufficiently lubricated, the mold surfaces, pedestal-bearing surfaces, and the type channel will begin to load up with deposits of type metal, accumulations that will eventually mar every cast that passes over them. These accumulations should be stoned away with fine arkansas, wet with light machine oil. Be careful not to alter the lapped surfaces; merely remove the deposits. Be most vigilant thereafter with the mold oil.

Type cast with a burr along the edges of the body (bisectorially) indicates a severe problem in the mold infrastructure, and casting should be stopped immediately until the problem is resolved. A flashing of metal around and about the jet sprue ("winging") is usually caused by excessive casting pressure (too much pump spring), or a worn-out mold with poor bearing surface meets, or both. A flashing of metal occurring at the mold end (*capping*), where the matrix/mold bearing surfaces meet can be caused by one or a combination of: *(a)* worn surfaces at the mold/matrix meet, *(b)* Worn matrix bearing surface around the character, *(c)* insufficiently cooled mold (i.e., water flow/rate of cast), *(d)* excessive metal temperature, and/or *(e)* sloppy matrix-pin fit adjustment to matrix-pin hole. An odd flake of metal is not serious; however, a severe flashing of metal

flakes and the lack of air flow through the air cleaning ports can result in a serious splash, should a flake of metal become trapped between the matrix and the mold. Matrices that have extremely wide sets will often have a tapped hole in the back of the matrix body by which a right-angled machined shoulder can be attached with a screw and so prevent the "tipping out" of the matrix when it being carried to and fro during the casting sequence.

Automatic casting machines must not be run at excessive speeds, merely in the interest of increasing production. They should be run only at the optimum rate of cast that will ensure solid-bodied, crisply faced-up casts. The nipple heater is controlled by means of a rheostat.[16] Normally it is set to its maximum temperature, but under certain conditions, where, for instance, wide sets are being cast, the temperature must be somewhat reduced. The eutectic of the particular alloy being used must also be figured into this adjustment. If one of the harder, high-antimony alloys is being cast, a correspondingly higher pot and nipple heater setting must be maintained. Always remember to secure the Barth's pump when backing the pot and pot stand away from the machine. The pump cam trip must be made higher than its bearing surface. This adjustment is accomplished by jacking up the pump with a thumbscrew and its locking nut (located on the pump beam), which contacts a flat surface cast into the pump arch. The purpose of the adjustment is to ensure that the choker arm cannot fall open and empty the pot of its metal. Also remember to release the pump and drop it down again, with a turn of the pump wrench, when casting begins again. *Never* leave a casting machine unattended during the casting run. Splashes of metal must be dealt with swiftly to avoid possible serious damage to both caster and castor. When a splash does occur, you must remove and clean up the waste metal. The procedure is as follows:

1. Pull the pot away from the mold; remove the plate and place it in the pot.
2. Center the head piece over the neutral position (that is, just before the type pusher reaches the top knife).
3. Remove the head-piece bearing bar by prying the boss down with a pin wrench, and remove the cross-key. (A notch and/or arrow will indicate the correct position for its return.)
4. Remove the head piece and gently lay it on the apron of the machine, being careful of its water hoses and cushioning it on rag wipers.
5. If the splash is extensive, remove the tail stock by loosening and removing its cap screw and carefully laying it, too, on the apron.

[16] This control is only on electric-fired pots. Gas-fired barths do not need them, as the temperature is easily controlled with the gas-cock.

6. Remove the matrix carriage by its fixing nut and lift it out of its channel and actuating lever.
7. By chiseling with *brass* picks, blowing air, and wiping, remove all the waste metal from the working surfaces of the machine and the above-mentioned assemblies.
8. Oil all these parts, inspect, and then reassemble them. It is convenient at this point to make an inspection of all top mold surfaces and the type channel surfaces. Remove metal deposits and burrs by lightly rubbing them with light oil and fine arkansas stone, being careful not to injure the lapped surfaces.
9. Determine what caused the splash, and ensure against its recurrence.
10. Once underway, the finishing knives, groover, and especially the alignment must be rechecked.

Additional Notes on Casting

BARTH LORE

Changing side-bearing on the Barth is accomplished easily by the manipulation of the side-bearing abutment (held by three screws) and by removing or changing the side-bearing shims of various thickness. Head-bearing changes can be accomplished by changing the slipper, or—for fine-tuning—adjusting the wedge and screw-bearing constant of the mold.

The pins or studs on the matrix shoe must be tight and firmly fixed in their place. Loose or fractured pins will result in "pull-ups," or fractured face type. Failure to adjust the orbital matrix pin will create severe wear at the contact point of these pins and will cause them to fatigue and eventually break. In addition, these pins must be square (true 90 degrees) in all directions with the base of the shoe, which is also the surface upon which the matrix and its slipper rests. If out of true, the matrix will be presented unevenly against the mold bearing surface and will cause a splash of metal. If the matrix does not seat easily on these pins, the holes must be reamed out and/or deepened to provide the necessary clearance. You need to have a small matrix-hole reamer for this purpose.

The matrix spring, adjusted by a set-screw, exerts pressure on the base (bottom) of the matrix shoe. It must hold the matrix assembly firmly but not

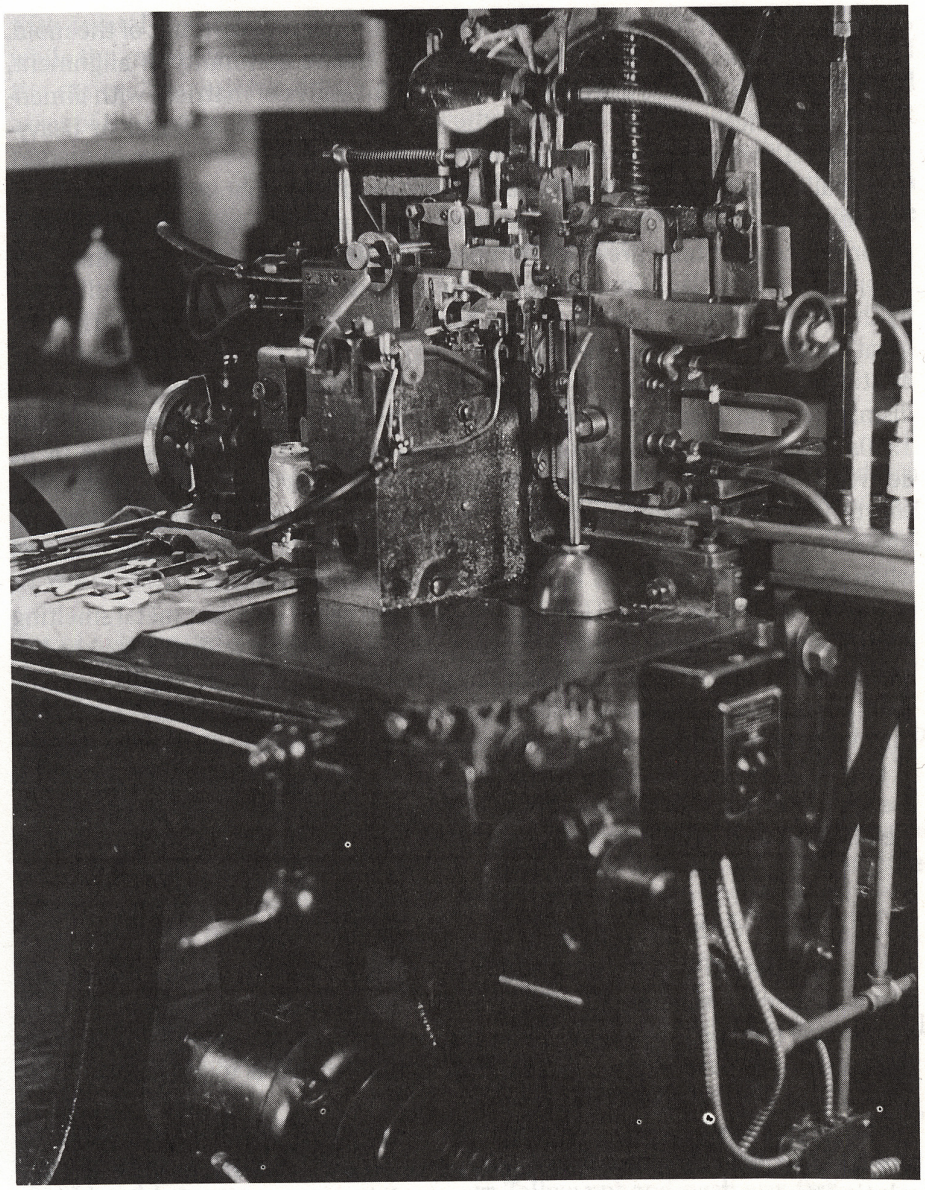


Figure 14. A restored 16-point Barth Casting Machine (Howell Foundry).

overtightly against the alignment abutment of the bearing constant of the mold. It should be checked when starting a run to ensure continuity of alignment, especially when slippers are changed for different suites of matrices with dimensional differences. The matrix spring is nothing more than a finger or heavy-gauge steel spring bent to form an arc.

So-called obsolete machines have been scrapped continuously throughout the history of the ATF, especially when the many used machines acquired from absorbed competitors grew in number. In 1947 twenty-seven Barths were shipped to Amsterdam Continental in Holland but were never successfully used by the Dutch firm. By 1950 most had been returned to ATF/Elizabeth. The first great purge of Barth casters resulting from demands for the consolidation of existing space occurred in the late 1950s. More than thirty-five Barths were dismantled and eventually scrapped. Yet another purge took place in the late 1960s, when nearly a third of all surviving machines were scheduled to be destroyed. This time, however, a few of these machines were saved through the efforts of a coterie of dedicated employees, who quietly removed work orders and mislaid paperwork, hindering the destruction. These actions were later justified when the need for parts and rebuilt machines became evident.

In the earlier days of ATF (1896-1948), the firm relied on a vast metal smelting operation for producing the ATF alloys. Early ingots were "waffled"; they had to be broken up by the castors with special hammers. When electrically heated pots were introduced in the mid-1930s, a narrow ingot was produced and automatically lowered by a special device into the pot. A neon bulb at the top of the bracket of this device would indicate when the pot heaters were activated. After 1955 these devices were removed, leaving the indicator bulbs. After World War II, metals were supplied by outside contract.

MATRIX DOPE RECIPE

When casting from worn, heat-damaged matrices, the application of this concoction will enable a seemingly hopeless matrix to be used for a few good casts. A matrix may then be grown from these casts or an order filled without delay. The technique is also useful for preparing large-bodied matrices to produce an even, opaque face without "hot" spots.

Take one part silicate of soda to two parts dry Kaolin clay (both by volume). Mix the two thoroughly with a sufficient amount of clean water to make a solution the consistency of thin soup. The result is a concentrate; it is further cut 50 percent with more water before use. The object is to apply a water-borne film

with several applications, by dropping the solution into the "eye" of the matrix, while the matrix is being heated on the edge of a hot plate or the melting pot of the caster. The water is driven off, leaving a sealing deposit into the damaged areas of the matrix. Be careful not to overheat the matrix! The ingredients do not remain in suspension very long, and need to be agitated frequently.

The application of a minute amount of beeswax two or three times between casts and the application of Matrix Dope is always beneficial. Be certain the matrix and its surfaces are thoroughly dry before casting.

Tools and Supplies

The following list has been extracted from an incomplete document started as a job study/description by Frank Taylor in 1939-40. Taylor held a supervisory position at the foundry at the time. This treatise was interrupted by the outbreak of World War II and was never resumed.

Set of open-ended wrenches
Set of Allen-screw wrenches
Packing collar wrench
Ferruled knife-setting tool (for bottom knife adjustment)
8″ screwdriver with 3/8″ blade
6″ screwdriver with 1/4″ blade
4″ screwdriver with 1/8″ blade
Small and large pin wrenches
2 ounce copper hammer
Tweezers
1″ and 2″ paint brushes
Four wiper cloths (per day)
1/2″ brass strip with ground chisel edge (for scraping)
Brass picks for cleaning metal from Machined surfaces
.918″ height gauge
144-point body and set-width gauge
Set-width micrometer
Set of Standards
Pot bar (for breaking up metal in pot when starting up)
Small iron ladle
Oil cans for SAE 30 nd machine oil (general lubrication) and SAE 10 nd machine oil (mold lubrication)
Skimmer and pan for dross
6″ smooth file (fine cut)
Loupe (5X or 10X)
Air cleaning hose with brass nozzle (5″)
Belt grip substances
Steel or brass sort-line stick ("slice")
fine Arkansas stones
Tallow pot and swab wax flux

Das Kuco Schriftgiessmachinen

The subject of these notes, a Kustermann KVsg (serial no. 299), has a curious history. Bought new in 1962 for the ATF Experimental Department, it was acquired by the Dale Guild in 1982. This particular machine was not successful at ATF. After a period of time it was relegated to an inactive casting bay and was used for a while to cast a variety of spacing material. Its melting pot capacity was decidedly too small to keep up with the Barths, and only a halfhearted attempt was made to maintain consistent type quality tolerances. It might also be added that it was not popular with the shop union, which feared its presence threatened certain job hierarchies; the machine was thus, so to speak, a victim of benign neglect. It came equipped with two molds: No. I, adjustable for 18- to 36-point bodies at a fixed drive of .0968″ (B-3; see the drive tables in appendix 1, p. 183); and No. II, which cast 48- to 72-point bodies at a B-4 drive. It was intended for scripts, italics, and Didot faces. Its use, as a last resort, for making spacing material was accomplished with a fixed stop, or blank, matrix. It has been completely rebuilt by the Guild, and its missing and damaged parts located or refabricated. The machine now casts high-quality type very well indeed. It is owned by Henry Weiland of Milwaukee, Wisconsin.

At first glance, the Kuco resembles a sports-model Barth; but, like the Thompson, it was designed with a multiple-body, adjustable mold. As a result, more adjustment and trial-and-error casting are involved. The type is presented with the nick to the right, unlike the Barth, which presents its type nicks to the left. As with other multiple-body casters, there were three sizes of the KV series, each for a specific body range (although all molds fit interchangeably, it is just too much effort to change the machine over to a completely opposite extreme in body size). The sizes went from small (4- to 16-point); medium (18- to 36-point); and large (42- to 72-point). A complete range of graduated size nipples (apertures), pumps and collars (diameters), nipple plates (apertures), and tension springs (lengths) complete the adjustable accouterments.

There is no packing for the Kuco's pump and collar, and the pump is nonrotating, being fixed to the pump beam by means of a clevis and pins. The machine does not have a choker valve mechanism but relies instead on a foot valve in the base of the pump. Setting this foot valve in place is not easy to master when reassembling the pump into casting position. The easiest way is to keep the metal level high in the well and, with a quick movement, place the pump in position

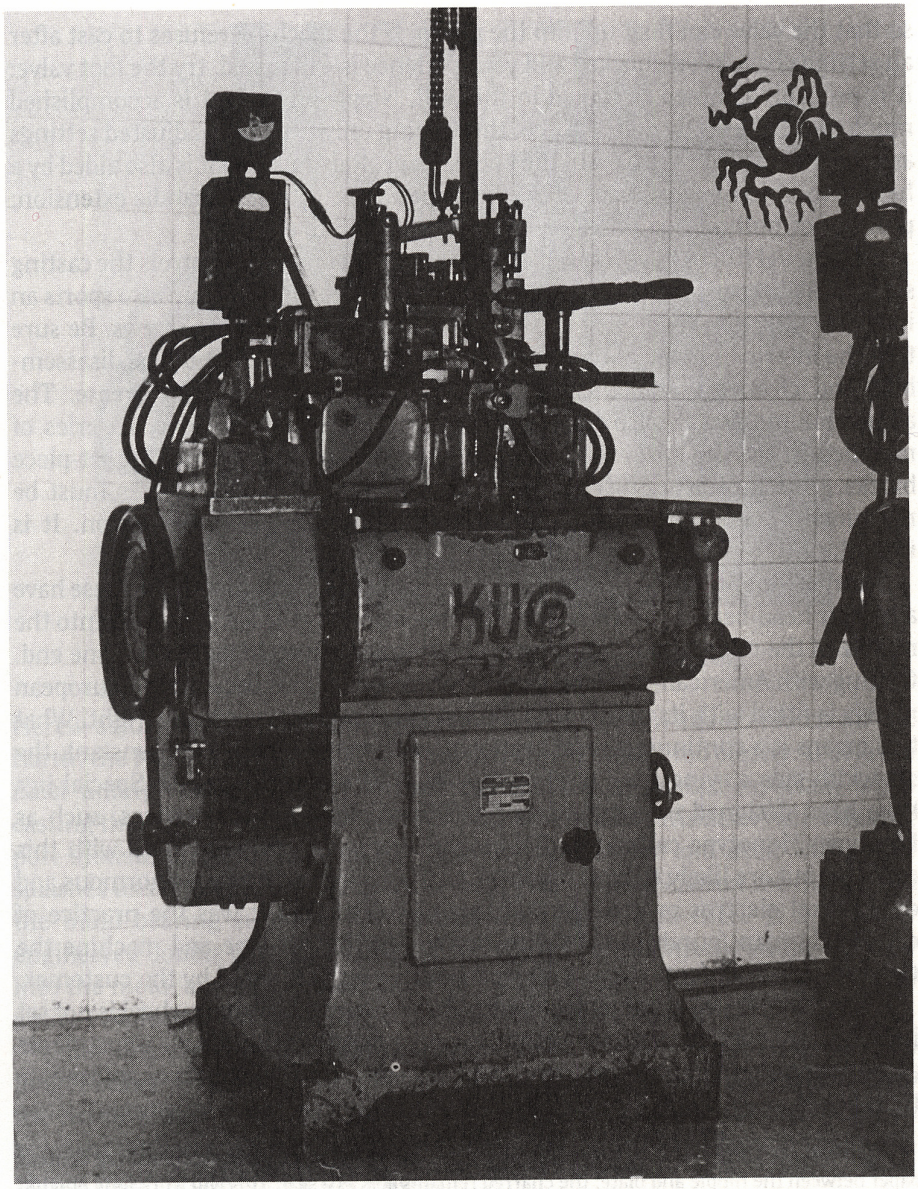


Figure 15. The Kustermann KVsg.

so that the valve can float up into the pump. If the machine refuses to cast after all settings have been checked and your patience is exhausted, try the foot valve: it is probably jammed or fouled in the well. Nipple alignment is accomplished much more efficiently on the Kuco, there being only two easily adjusted settings and two lock nuts at the base of the pot carriage. Raising the pot is also aided by a handle to which a short piece of 3/4″ iron pipe can be fitted as a handle extension; pushing or pulling this raises or lowers the pot quite easily.[17]

Late-model Kucos have a speed cone device that efficiently controls the casting speed in a manner superior to step pulleys. The driving mechanism also sports an indestructible flat Neoprene belt that is secured firmly with set-screws. Be sure that the interior surface of the speed cone is *dry*; otherwise it must be disassembled and cleaned with Penetone to remove any trace of oil or grease. The adjustable molds can also be made to cast at virtually any drive. A series of matched shims can be laminated between the interior mold and the jet-piece blocks, thus increasing or decreasing mold height. New body pieces must be machined or altered to accommodate the new mold height dimension. It is important to remember to allow for shrinkage.[18]

The machine, of course, was meant to use European-style matrices: these have a greater head-bearing and side-bearing dimension, by reason of casting into the middle of the matrix body, unlike the Anglo-American style that favors one end. Casting with American-style matrices can become tedious because the European matrix is fitted with its constant to the left; the American's is to the right. What this means is a continuous recalibration of each matrix change for constant, the set-width side staying fixed (and so this must be changed as well). Special jigs have been designed to compensate for this problem. Other matrices, such as Linotype, Monotype cellular and Monotype display, can also be used with this machine but are likely to be short-lived, as the casting pressure is enormous and only nickel electros or steel can withstand such force. It was the practice of certain German foundries simply to cast an overheight type and machine the finished galleys of fonts down to the particular height ordered by the customer.

A micrometer wheel adjusts set-width, but be careful that your wheel is not set in Didot- or Metric-based increments. Exercise care in checking all adjustments and constants during a casting run. There are fewer fixed constants or abutments than on the Barth caster. You must continually check the alignment stops

[17] To seat a spitting nipple in the nipple plate, simply press a piece of single-folded rag content paper between the nipple and plate; the charred remains acts as a seal. This will work long enough to finish a set or character, after which the problem can be corrected in the machine shop.

[18] Refer to the matrix drive tables in appendix 1, p. 183.

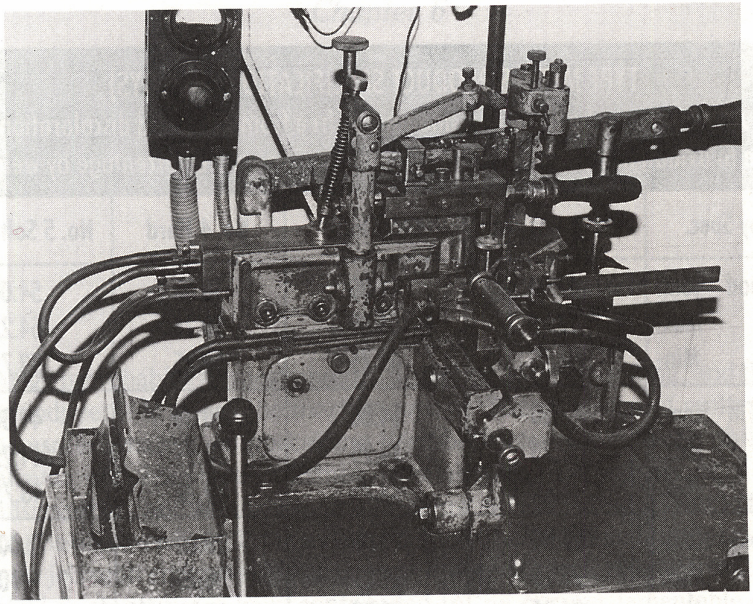


Figure 16. The casting apron of the Kustermann KVsg.

(screw-adjusted) to ensure uniformity and type quality. While no match for the Barth, the Kuco is capable of producing fine type if monitored closely. It also is a most unforgiving machine: I recommend the use of shields, especially when casting the largest bodies and sets. The machine lacks a satisfactory air-cleaning port system; stray flakes of metal must be watched for and dealt with. Most splashes usually occur when a piece of flash gets caught between the matrix and the mold bearing surfaces. For casting the largest type there is a superbly engineered double drop cam device, which pumps an additional stroke of metal into the mold, and an alternate cast stop, which enables the mold to cool for an entire revolution of the casting sequence, for safety's sake.

Unfortunately, Kuco *Schriftgiessmachinenfabrik AG,* in Gross-Gerau, no longer either makes or services its typecasting machines, having diversified into the manufacture of meat-shearing and processing equipment. A recent search revealed no parts available on the continent. Restoring or adapting these machines means reinventing the wheel.

TYPE METALS PRODUCT SPECIFICATIONS (ALLOYS)

All alloys must be clean and smooth and free from dross and discoloration due to oxidation and overheating. Quantites as shown are percentage by weight.

Alloy Spec.	No. 1 Regular	No. 2 Italic	No. 4 Hard	No. 5 Soft (Lino)
Lead Nom:	62.00	64.00	50.00	54.00
Max:	62.25	64.25	50.25	64.25
Min:	51.75	65.75	49.75	53.75
Tin Nom:	12.00	14.00	20.00	44.00
Max:	12.25	14.25	20.25	44.25
Min:	11.75	13.75	19.75	43.75
Antimony Nom:	25.00	21.00	28.00	2.00
Max:	25.25	21.25	28.25	2.10
Min:	24.75	20.75	27.75	1.90
Copper Nom:	1.00	1.00	2.00	
Max:	1.10	1.10	2.10	NONE
Min:	0.90	0.90	1.90	
Zinc Max:	NONE	NONE	NONE	NONE
Arsenic Max:	0.10	0.10	0.10	0.10
Impurit.* Max:	0.10	0.10	0.10	0.10
Identification No.	1	2	4	5

* Maximum allowable of other impurities.

There were in all 9 classifications of type metal alloys: of little value to the foundry at the present are No. 3 used for Quads; No. 6, used for metal furniture; and the last three antimonial leads Nos. 8, 10, & 14 indicating the amount of antimony in the alloy (%). The Guild uses No. 1 as Primary which is suitable for the finest casting and for charging a heat of smelted metal to improvement. The No. 2 is used for all other casting. The No. 4 used only on customer demand, and the Lino only for special casting; as for an electro specimen and large ornate initials, etc.

Figure 17. Type metal product specifications for Alloy.

Chapter 6

Alloying

Metallurgy is probably the most obscure discipline of typefounding, and the least understood; yet it is one of the most important. The mysteries of molten metal and the esoteric nature of typecasting itself both contribute to the philosophy and behavior of the old type craftsmen, who labored under conditions of secrecy and conservatism, and who believed, toiling in a sweatshop atmosphere, that the job must be preserved at all costs: "Do not show the new man *anything!* He will have your job soon enough anyway: the less he knows, the longer you will remain valuable!" Such attitudes have contributed to the current lamentable state of typecasting and have caused the loss of much craft knowledge. The situation can be likened to the pigment formulas of the old masters: too often, their secrets died with them.

Disciplines

As a general rule, you cannot use the same alloy for casting small body type to cast the larger bodies. Further, if the casting qualities of an alloy are poor, all other factors required to produce high-quality type are negated and made useless. Realistically speaking, alloying today simply means operating on the principle of making the best of it. Few operators can afford to purchase virgin metals to maintain optimum quality. What you end up doing is what all foundries have always done: using scrap "dump type" of varying provenance made better by the addition of *some* good metal under carefully controlled conditions. To this end, this chapter will show how to refine and alloy such metal competently, economically, and above all, safely, thereby assuring a stable supply of good metal for the products of our casters.

A castor *cannot* refine or alloy type metal in the melting pot of the caster. To

understand why, one must be aware of the physical properties of the metal and the eutectics of a given alloy when melting down and mixing a new heat.[19] Consistent high-quality alloys can be made only in a large melting pot specific for the purpose. Under controlled conditions, metal contaminants can be dealt with safely and permanently. Melting 750-1000 pounds at a time has an obvious advantage: uniformity. A contaminated pot on the casting machine assures a shoddy product; sweeping the floor of the foundry for additional metal to charge, and seasoning tired metal with dump type, are both a waste of time.

If you are casting a substantial amount of type, you will save much effort and money if you do your own alloying. The serious type founder need not spend a great deal of money for this equipment. If a large alloying pot is not readily available (the best are free-standing furnaces with wrought steel pots), there are many surplus Linotype melters that will work nearly as well although they yield less quantity per heat.

There are some safety factors to be considered. It is wise to take precautions when fluxing a heat with volatile waxes. In order to render the dross efficiently, it must ignite and burn, thus freeing the harder constituents of the alloy—primarily antimony, which combines much too readily with the oxides of other metals and has an uncanny attraction to the iron surfaces of the casting pot and its metal delivery system. For this reason, many craftsmen elect to do their smelting out of doors; some set up a portable furnace at a convenient time of the year to work their yearly needs for metal all at once. The metals industry may not be what it once was, but the practical type craftsman can always count on the production of his own hands and control. *Never* purchase unprovenanced ingots, no matter how good the price. It is not worth the risk to prove the integrity of strangers.

Good metal has a sheen and consistency that are unmistakable. The meniscus around the edge of the pot has a firm, rounded bead: it is bright and shiny. Poor, contaminated metal, on the other hand, is dull and opaque, pouring raggedly from the ladle. Its ingots are brittle and weak, with noticeable porosity. It is this porous condition that is death to the quality of cast type.

There is no way to remove *all* impurities. Complete removal could be done only with complex electrolytic techniques far beyond economic feasibility. What

[19] The primary rule of metallurgy concerning nonferrous alloys is that such variable alloys cannot be properly used for a specific purpose at the time of their initial smelting or alloying. They must be poured into ingot molds *(pigs)* and be allowed to cool down and so form homogenic crystal linkage *(patterning)*. Then, and only then, can they be remelted at their new eutectic temperature in the casting machine pot. This explains why you cannot "season" a pot while casting.

can be done is to layer the heavier metals and leach out or skim off the silicon, zinc, iron oxide, and "organics" (inks, etc.). Fluxing and a steady temperature curve will accomplish these objectives. The aim is to bring the amount of contaminations below the level at which their presence affects the normal properties of the alloy's ideal condition. For some time to come, type metal will still be available as dump type. It is relatively cheap and, if care is taken to balance the lesser quality scrap—i.e. Monotype and Linotype—with good quality foundry type, a very passable alloy can be obtained from it. No two heats of metal rendered will ever be exactly the same. For insurance, the addition of some ingots of primary metal, bought at a premium and held for this purpose, can be added to improve further the quality of the alloy. The effort involved to sort dump type as to provenance and the removal of as much foreign material as possible (brass thin spaces, wood, floor dirt, and especially rubber bands), will do away with most of the potential smoke. Persons sensitive to metal-rendering fumes—that is, everybody!—may wish to wear a surgical mask or respirator when working close to the pot. It should be noted that the oxide of *any* metal is toxic. The fumes that rise from the molten metal and its dross must be regarded with respect and caution. If the rendering is done indoors, provide adequate ventilation. For an analysis of various alloys developed by ATF, along with other specific tables which are of value to the castor see appendix 2.

Running a Heat

The Guild alloys all of its casting metals in a wood- and/or gas-fired brick furnace, and it will infrequently alloy a special heat of metal for a patron by contract. The thick-cut, limestone top of the furnace is fitted to support a 1000-pound capacity wrought-steel melting pot, which was originally made for the Barnhart Brothers & Spindler foundry. All dross skimmings and foundry-room accumulations of splashes, sweepings, etc., are recycled through this pot during the heat. The scrap and dump type are cleaned and sorted; bars of primary metal are placed near the furnace, and the pot is fluxed with wax. We find the coarse beeswax from a neighboring apiarist to be the most economical and satisfactory for this work, although ordinary paraffin works almost as well. We start with 2-3 ounces, and add more depending on the amount of dross produced.

It requires two or three armloads of dry oak firewood (we use the waste from a

local pallet factory) and, at the least, two hours of gentle, steady heat to liquefy the contents of the alloying pot. Once the fire is kindled, the flue must be monitored regularly in order not to create a "runaway" heat-up. When firing with gas, be careful not to burn the metal with too rapid a heat curve: avoid drastic increases in the melting temperature. A slower heat curve will slow down oxidation and dross production, thus wasting less good metal. The pot is charged continuously as the contents settle, and an occasional ingot of primary type metal is added. Metal destined for large body type and script faces should have a greater measure of clean Linotype metal and less of the primary. A final examination before pouring will reveal any need for additional primary. Large body type and large intricate initials are always cast with a softer alloy.

If there are any lumps of metal that do not melt down in a reasonable amount of time, be suspicious and examine them. Usually the lumps are merely some high-antimony content alloy (ATF No. 4, for instance, or German-made alloy type) mixed in with the dump type; but if the suspect type has nicks on both the top *and* the bottom, remove it and throw it away immediately! It may very well be zinc type. Agitation is accomplished by plunging a freshly cut green stick of a tree branch to the bottom of the pot—briefly! (Be careful of splashing molten metal.) The smoking flux and dross should be ignited and allowed to burn away completely. Regulate the flue setting, keeping the heat rising slowly and steadily. Because our foundry room exhaust fans are too powerful to be operated during a heat (they will pull fumes and smoke from the burning chamber *down* the flue and into the room), the windows and doors are kept open for air circulation, even in the winter.

When the metal is completely melted, charged with primary, and given its final skimming, a large ladle is heated in the coals of the furnace and the ingots are filled. Take care not to let the temperature of the metal rise above 800°F. At such temperatures the metal will "cook" and burn, causing new oxides and dross to form. The iron ingot forms must be clean and dry. Ideally, you should have to pour only once or twice into your many empty forms. Few shops have the benefit of such a luxury, and so each ingot mold must be cooled with water after the solidified ingot is ejected, dried out with a propane torch or placed in the coals of the furnace (no water can be present in the form when pouring molten metal), and poured into again. The pot usually yields about thirty ingots of metal weighing approximately 25 pounds each. The reason for cooling down an ingot mold is to reduce the amount of time needed to solidify the ingot. Heat the form only enough to drive out the water each time. Insurance for a building used to render metals is astronomical. The few insurance representatives one dares to

allow to witness such a spectacle usually leave, laughing heartily. A craftsman alloying *al fresco* may be at an advantage for obvious reasons. Never leave the furnace unattended. Remove ash and embers frequently from the grate and ash pit, and hose them down in the compost pile. In the old days, type foundries burned down on a remarkably regular basis; this is one of the few habits of the ancients that we need *not* emulate.

Type Metal Alloys

Type metal alloys are too variable in composition for any single method or procedure to suffice for a complete quantitative analysis. For the Guild's alloys, which contain a moderate amount of tin and a small amount of antimony, the scheme for determining content as found in *Scott's Standard Methods*[20] is quite useful. With alloys containing somewhat higher antimony and/or tin percentiles, such as ATF No. 4, a hydrochloric-nitric acid solution or a hydrochloric acid solution containing an oxidizing agent, such as potassium chlorate, is used. Upon evaporation, lead may be separated as a chloride. Subsequent treatments will depend on just what metals are present or desired to be determined. A procedure followed for the determination of one constituent may be unsuitable for the determination of another metal in the alloy. Some metals are determined by insoluble portion, whereas others are measured by dissolving in acids or by colormetric comparisons.

It is the exception rather than the rule that a complete analysis of an alloy containing several elements is carried out in a single weighed portion. Determinations are decided upon not only by the actual metals desired but also upon the extent to which they are expected to be present. Because of this circumstance, any extreme deviation is to be considered suspect and the unknown factor referred to as contamination—a very helpful approach in ascertaining the presence of zinc. The presence of copper and other trace elements in type metal alloys is so minute as to be insignificant. A popular claim of the old foundries was that they used a "copper-mixed alloy"—this probably meant stirring with a copper bar or the infusion of a handful of copper shims when charging. Such "Bullenisms" were in reality the creation of the sales department. In making an

[20] *Scott's Standard Methods of Chemical Analysis* (New York: Van Nostrand, 1939).

exact metal analysis, the chemist should bear in mind that many of the separations can be incomplete. Solutions may require further treatment for the recovery of unprecipitated portions, and these precipitates may be contaminated, necessitating a second or third separation. The accuracy of the analysis depends on the use of this procedure.

In general, an analysis is conducted in duplicate, and the results expressed in percent of the alloy should not differ by more than one unit in the number to the right of the decimal point. This tolerance applies to components that are present in appreciable amount—5 percent or more. Usually a determination for a component present in such an amount is made on 1 gram of sample, and results that differ by just one unit in the tenths position represent a good accuracy, whereas the same difference would represent a poor percentage of accuracy when a component is present in a small amount, for example, 1 percent or less. Conversely, the same percentage of accuracy is not to be expected when a minor constituent is present only to the extent of about .05 percent; in such case duplicates as close as .04 percent and .05 percent would be satisfactory.

The sum of the components of an alloy should, for exact work, total within .2 percent of 100 percent. When for commercial or legal reasons, a total of 100 percent is expressly desired, the difference plus or minus between summation and 100 percent must be proportionately taken from or added to the several components. (This is not strictly accurate, since the individual errors may vary in amount as well as in direction.) Occasionally, a main constituent is obtained by difference so that the summation is exactly 100 percent. In reporting percentages of major components, only four significant figures are retained.

To save time, a busy analyst will frequently chip a piece from the ear of a pig of metal or rasp a few grams of filings from the edge of a bar. Most of our alloys are not sufficiently homogeneous to be sampled in this manner. In a molten mass of alloy there are constituents that have a wide disparity in their melting points, and upon cooling, the more infusible ones solidify and attain a noticeable crystalline deposit, while the bulk of the mass is still molten. (Antimony is a good example.) It is advisable to stir the alloy thoroughly while it is in a completely molten state before extracting the sample. Samples admitted to the lab may be in a variety of shapes and conditions. When in the form of a pig, ingot, or bar, they may be drilled, sawed, or filed. Filings taken from a single edge of an ingot are likely to be unrepresentative of its components as a whole; unless the whole bar is rasped, filing from an edge is therefore to be avoided. Drillings as a rule are too coarse for portions of 1 gram to be weighed out. Sawings are more easily weighed out in 1 gram portions, and this method is preferred.

Even with correct sampling, care should be exercised when weighing out the portion for analysis. In the case of a high antimonial alloy (ATF No. 4 has a mean antimony content that can run to 28 percent), cubic crystals of antimony can form. These crystals are hard and brittle, and will pulverize when sawn. Consequently, when such an alloy is sampled, the sawings obtained will be a mixture of coarse particles and fine dust. The coarse particles are appreciably lower in Sb content than that of the original alloy. Sawings of this nature must be screened and the fine and coarse material weighed separately. Each portion may then be weighed out proportionately and either combined or run separately and the results calculated back to the original basis. If a large quantity of sample is taken, screening would not need to be done, but a different procedure would be followed: the material would be quartered down by a riffler sampler to approximately the weight desired. Before weighing out a portion for analysis, pass a magnet through the sample to remove any iron that may have come from the cutting tool.

Two regimens for the determination of constituents are available in the laboratory. The first method, known as the General Determination, is somewhat slow but is more accurate if testing infrequently. The second method, called Rapid Determination, is swift and suitable for most control work, giving good results after the technician has become familiar and proficient with it. Most techniques vary somewhat but usually involve the precipitation of solutions in combination with electrolytic procedures. Sample charge cells are also used, especially for determining levels of tin. The Rapid Determination and electrolytic tests are usually the more expensive, however.



Figure 18. Type Dressing: MacKellar, Smiths & Jordan, Philadelphia, *c.* 1896.

Figure 18. Type Dressing: MacKellar, Smiths & Jordan, Philadelphia, *c.* 1896.

Chapter 7

Finishing Type

The accomplished castor must be aware of and proficient at the disciplines of proper type finishing (preparing cast type for use). Even with automatic casters there is still a need for hand-finishing type from time to time. As one becomes more productive and adept with Monotype display casting, a subtle desire to improve letter space tolerances (as with the lower-case roman "f" and "j", and most italic kerned characters) begins to grow. If the castor cannot finish the type in his own shop, then that shop is not a type foundry in the true sense of the craft.

When finishing type, there is a regimen of operations. Rough casts and automatic caster "drop-outs" are taken from the castor in "dishes"; type on sticks is taken to the finishing department racks. Pivotal cast type needs its jets broken off. Many type craftsmen began their career as young apprentices called "breakers." All rubbing is done next, and the type is then sent to the vise for grooving. Extra nicks if required are cut next; kerning is the final step. The type must then be inspected by "pickers" who examine and cull rejects (first inspection). Next the type is "palmed" onto hand sticks, and so ends up at the paging and dividing tables. There should be at least two more inspections before packing and shipping.

RUBBING

The bulk of type finishing is done by rubbing. The cast is drawn carefully across the flat surface of a stone or file. Good stones can still be had cheaply; a pair of flat fine Ohio sandstone slabs, 2″ or 3″ in thickness and 18″ or 24″ square, from the stonemason's yard will work excellently. Traditionally, the slabs were round, and supported by a fitted oaken frame that formed a table; but the fabrication of this arrangement will increase costs, and will therefore be unnecessary except for the

purist.[21] There must be *two* stones: the rubbing of the two together will accomplish, with the aid of screened fine sand or emery between, the renewal of the stones' cutting surfaces. The rubbing process should be done regularly to prevent the stones from becoming fouled.

FILING

Files can be expensive, and they are now becoming very difficult to find in the correct cut and quality of manufacture. They must be smooth and with an open set so they will not load up with metal. They must clean easily with a brass or steel brush; stubborn clogs can be rubbed with a piece of 6-point lead driven parallel to the teeth of the file: the lead, thrust into the valleys of the teeth of the file, will push out the accumulation of dirt and metal. This process will not work with a cross-toothed file; the abrasion of brushing will wear down such a file too quickly. For these files, a bath of dilute nitric acid (HNO^3—reagent grade: 1 part to 10 parts distilled water) should be used. Files should be soaked overnight or for a few hours, depending on ambient temperature; they should then be rinsed off and allowed to set in another container (use a Pyrex baking dish) containing more water and a tablespoon of baking soda to neutralize the acid.

Never oil files! Instead, dry them on a hot stove or near the working pot of a casting machine. Remember: one adds acid to water; *never* water to acid. Files can usually be cleaned in such an acid bath at least twice before a noticeable deterioration occurs, making them unfit for use.

THE TYPE VISE

A finishing stand or type vise is a necessity. They are rare items today, but perhaps one can be borrowed and disassembled in order to be used as a pattern for casting a new device.[22] A serviceable vise can also be constructed from seasoned hardwood (oak or maple) by a cabinet shop or amateur woodworker. Likewise, the various plows, hand planes, shooting sticks, and type sticks used by the *dresser* can be copied. Indeed, the dressing tools used in the old foundries were commonly made by itinerant workers who moved from job to job, and frequently made replacements for worn tools.

[21] These type-finishing stones must not be confused with the surface stones of the fitter.
[22] For instructions on casting a new part see "Replacement Parts" in chapter 8.

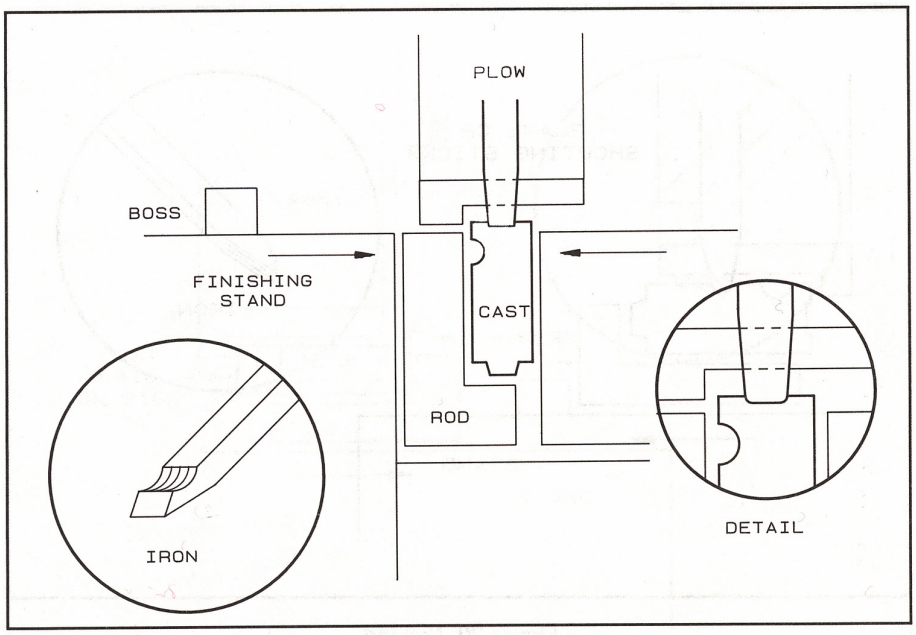


Figure 19. Grooving.

GROOVING

The easiest operation to master is grooving. Pivotal casters create type that must be grooved as well as dressed. Although not strictly necessary, Monotype display casts can also be grooved if they are solidly cast. The type is positioned on a holding stick called a *rod*, with a viselike screw and abutment to hold it firmly.[23] The whole assembly is then locked in position, feet up in the vise, and a grooving plow is adjusted to remove only a small quantity of metal at the point of the jet sprue break. This creates a shallow channel in the center of the type, making the feet upon which the type will stand. Large foundries had a plow for every body size. A reasonable dressing station should have a range of four or five and a handful of steel cutters that can handle the sizes being cast in the shop. The larger the body size, the wider the cutting tool needed.

[23] Finishers were paid "by the rod."

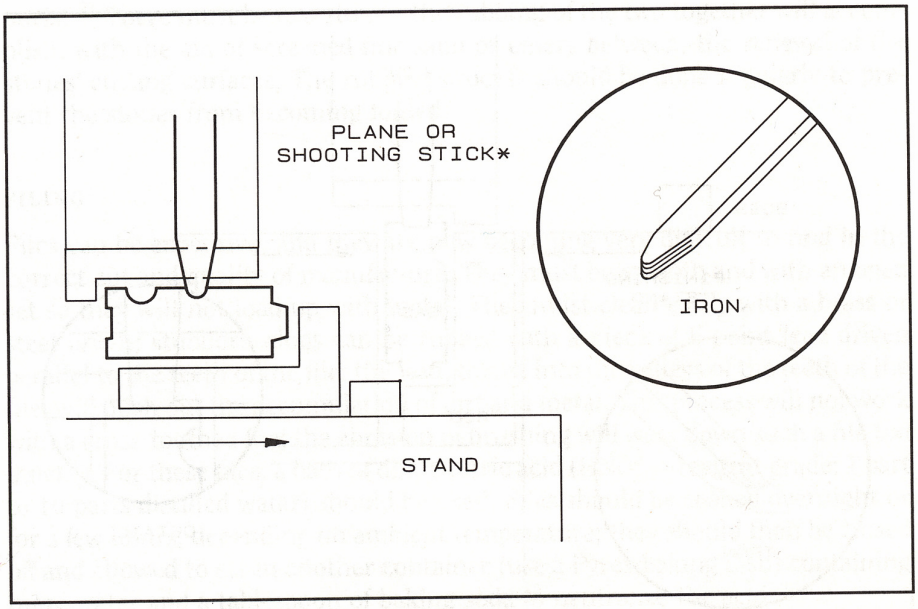


Figure 20. Nicking.

CUTTING NICKS

Nicks are cut with the aid of *shooting sticks,* planes with extended bodies to help keep the cut true and consistent.

KERNING

Type with vertical kerns must be "dressed." The type is held in the rod, and the whole assembly is laid up against the bosses on the top of the vise. (This area is referred to as the *stand.*) The kerning plow and its cutter, called an *iron*, is gently run over the kerned protrusion. A substantial kern is first rubbed over with a worn file (acquired from the fitting department) to prevent breaking off the projection. After trials on the first few types, (to be discarded later), final adjustments to the cutter are made. The cutter is set to cut just beneath the face or printing surface of the character. Cutters of various degrees of slope are ground, their dimensions determined by the amount of metal to be removed. The object is to produce clearance in all directions when set with their fellow type.

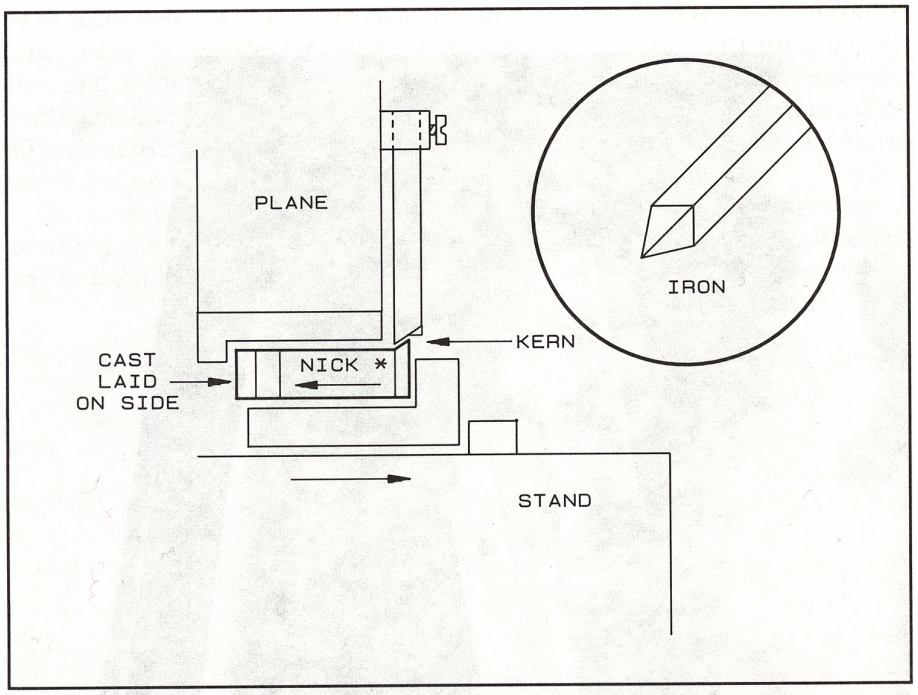


Figure 21. Kerning.

One must not undercut the kern, making the type easily broken when composing. There should remain a strong web of supporting metal directly behind the kern. Remember always to check adjustments: the cutters are held merely by driven wedges. Keep the cutters sharp by stoning from time to time. Never force the plow over the kern; take many small light cuts to prevent breakage. Making light cuts is especially important with the harder alloys, which are quite brittle. A dull iron will drag and chew its way across the work, leaving burrs and ragged edges. Hollow and flat-ground cutters should be wiped with a cloth and mineral spirits frequently. Finally, to burnish and clean any flash, a sharp-edged tool (a block of tool steel) and a block of wood with fine emery cloth wrapped and tacked upon it are lightly drawn across the flat body surfaces of the type in the rod. Then use a soft hand brush to clean the type and stand, in preparation for the next rod of type.

It is to be expected that the endmost pieces of type in the rod are not as cleanly

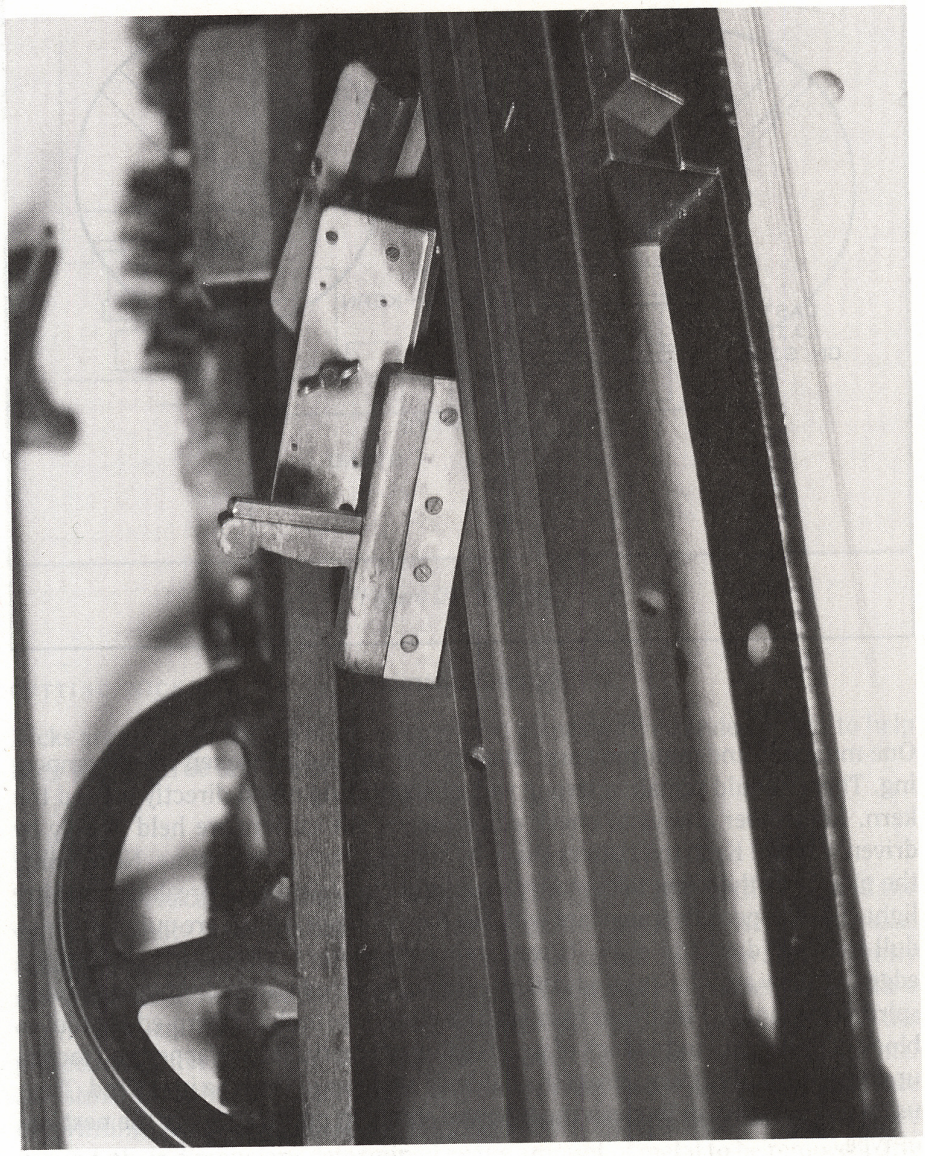


Figure 22. Type vise, rods and plows.

or as accurately cut as the others, and so they are discarded to maintain consistent quality. Allowances for culling must be made when ordering casting quantities, and a compensatory overage of type is cast. For a face that requires a considerable amount of dressing and finishing, as with scripts and certain italics, 20 percent over the quantity required is not unreasonable. For large quantities of script dressing, a special gang plow with several irons is used.

Competent dressing is successfully learned only by doing the work firsthand. A short but effective apprenticeship at the bench of a skilled craftsman is the best way to learn the process.

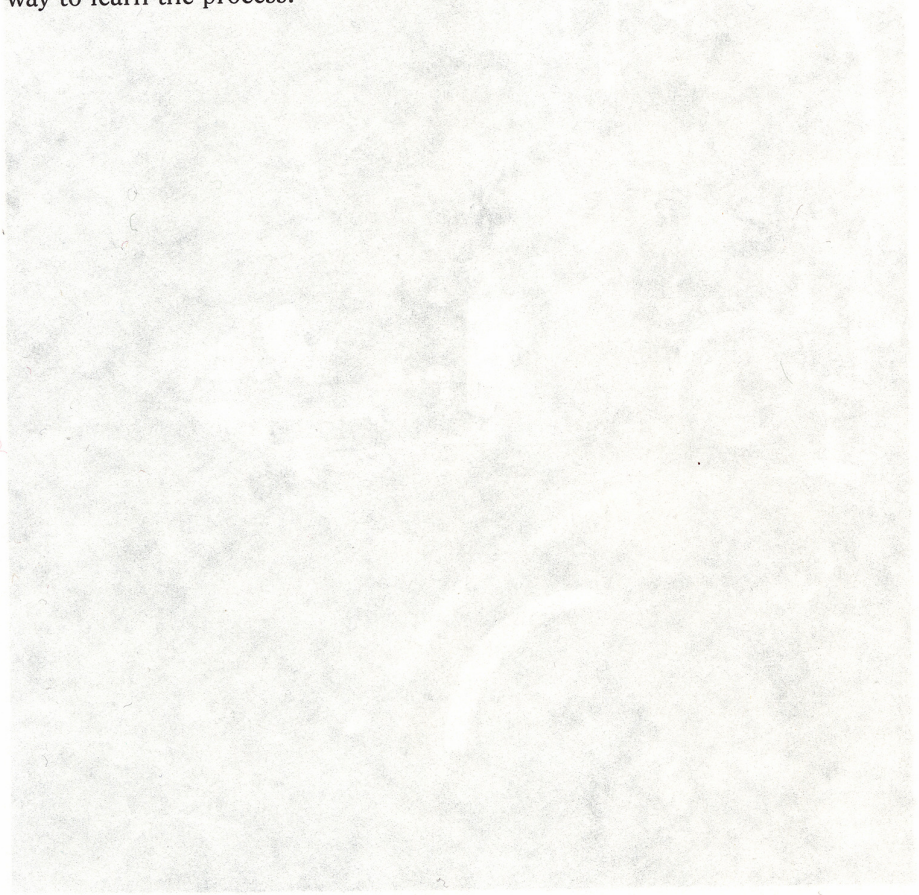


Figure 22. Type vise, rods and plows.

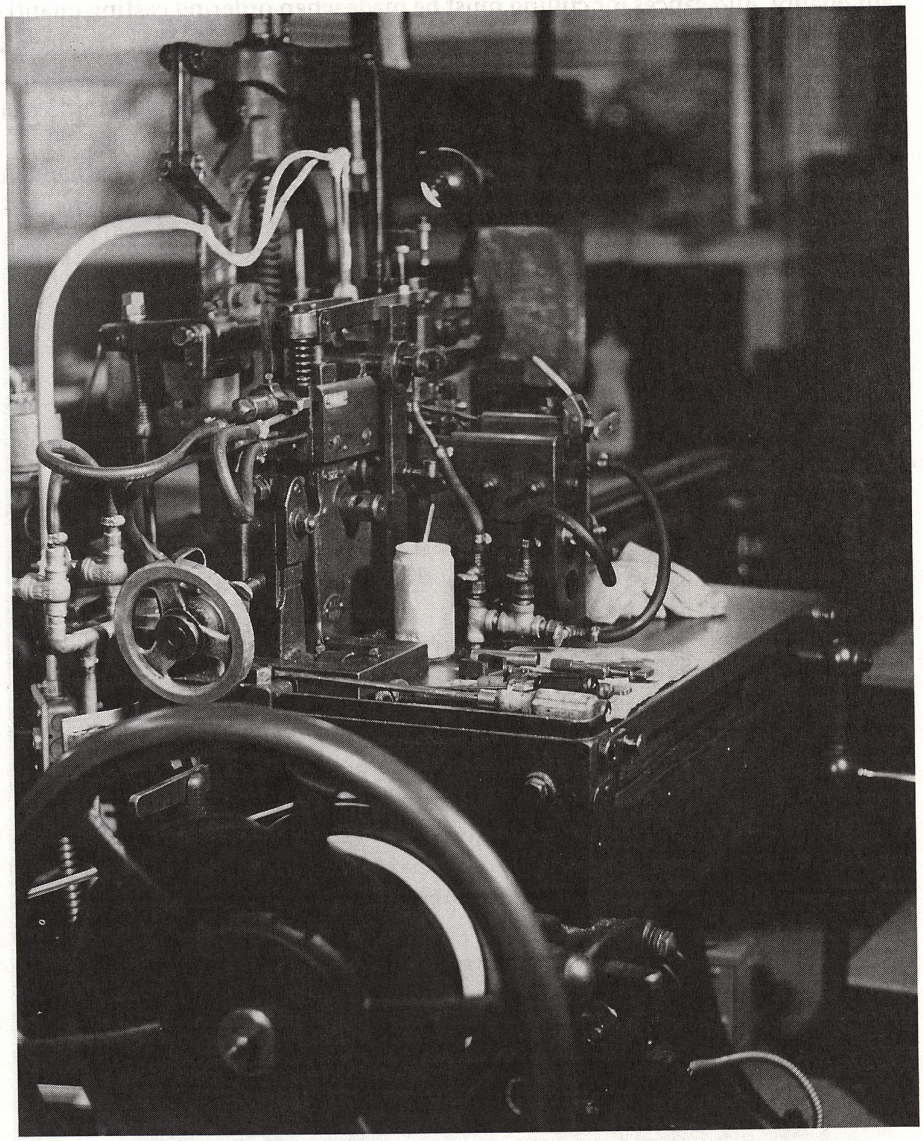


Figure 23. A restored 14-point Barth Casting Machine (Howell Foundry).

Chapter 8

Maintenance of Equipment

Maintenance is not merely a matter of lubricating moving parts and sweeping the floor. Most of our equipment is second- or third-hand, and unless it has been completely rebuilt within the last ten years, it needs to be coaxed, threatened, or cajoled into making high-quality casts. What wear and abuse existed at the time of its acquisition is irreversible, except by readjustment or replacement of critical parts and surfaces. Replacements must be found (which is unlikely) or fabricated. Wear on mold surfaces can be ground out and trued (not body height, of course), and jet pieces and type channel surfaces should be checked with a machinist's straightedge. Jet pieces can be packed with shims to correct mold height; access to an accurate surface grinder is indispensable for this work. When casting with matrices having exotic drives, such a machine is also needed for grinding down Monotype display molds for the OA caster.

The goodwill of a precision machine shop is a handy asset, and although it may be difficult to explain your *raison d'être* to an uninterested machinist, it is good to cultivate such a contact. Simple errors, such as damaging the edge of a machined surface, will ruin a mold, so break in your new associate slowly; pay your bills immediately in cash (*Gelt gesprechen:* "Gold speaks"); and do not try to tell him how a job should be done—just *what* should be done. If you are fortunate to find a sincere, competent craftsman, cultivate him: he is also an endangered species.

When the point is reached where living with the wear-faults of a piece of equipment is no longer tolerable, the offending device must be dealt with. In many cases simple improvements can be made. The OA, for instance, would benefit by the re-engineering of the type delivery stand and the rebuilding of the power train. Bearings are easy to replace when you can find the correct size, and modern replacements are sometimes better than the originals. Parts that cannot be found or repaired can be cast in a green-sand foundry. I have had many cast-

iron parts recast in gun metal, cam bronze, and red brass, which are superior in all respects to the originals. A cast replacement is infinitely superior to a welded, brazed, or silver-soldered repair. Often aluminum can be substituted for less critical parts, such as brackets and trays, saving weight and money. When painted flat black, they assume a less garish appearance.

Replacement Parts

Just as type foundries have dwindled in number, so too have nonferrous foundries. Compelled to conform to new health and safety standards, environmental legislation, and the erratic (and just as deadly) influences of the present economy, such small operations are rapidly disappearing. Like typefounding, nonferrous work has not changed greatly in principle from the time of its inception; in this case, however, the beginning was thousands of years ago: to enter into a bronze foundry is to walk again among the Hittites. I am indebted to master founder Edward W. Griggs for the following overview, both as advisor and craftsman; without his many years' experience, patience, and generosity, many a Guild project would never have been successful.[24]

There are any number of recipes for casting sand mixtures. One of the requisite variables is the amount of detail captured in the molding sand. The level of detail is primarily determined by the size and fineness (sharpness) of its granules. Most modern green-sand mixtures do not reproduce fine detail as well as the old dusty "Albany" or French-sand recipes, which were less structurally reliable and quite unhealthy for long-term exposure by workmen (it is said that a founder had all the hazards and unhealthy conditions of a coal miner but without the potential cave-ins). In the green-sand process, special sand, which sieves at 100-120 mesh, is mixed in various proportions with wood flour (fine sawdust), Bentonite (a clay), and finely ground cereal (called "binder"). It is mixed and mulled with only enough water to create the required plasticity: enough to hold its own weight structurally and any impressions rammed into it during the molding process.

An epoxy-repaired original or a shaped wooden facsimile is used for a pattern.

[24] As of this writing, Edward Griggs' firm still solicits work in this genre. The address is: Griggs Custom Casting, 500 New York Avenue, Point Pleasant Beach, NJ 08742.

In the case of an original part being used, all machined surfaces are built up with cardboard and plasticine clay to compensate for lost mass and shrinkage. A wooden pattern made by a pattern-maker will already have its dimensions enhanced to allow for this shrinkage. If the part requires a core or cores, it is best to engage a pattern-maker, whose use of shrinkage rules and whose knowledge of riser engineering is needed to make a successful cast. If the part has a flat surface, it may be mounted on a match plate; small items may be mounted together in the same mold and fed by sprues. Split patterns are turned or shaped up from a glued module, which is then split apart, and the two halves mounted on each side of the match plate exactly over one another. Finger gauges (not our typographic ones!) help locate each part exactly on the board and make for perfect seams in the finished casting. The match plate will also carry all the necessary sprues and gates with dimpled indicators for locating positions of down sprues and risers, thus saving much labor for the molder. This sand mixture is pounded around the pattern in a boxlike hinged flask of metal or wood, which splits apart into a top and a bottom section (the *cope* and *drag,* respectively). The flask is removed when the two halves are put back together, sans pattern, in preparation for pouring. The pattern must have sufficient *draft* (that is, a shape capable of releasing itself without damage to the impression it is making) when tapped, vibrated, and removed from the molding sand.

To channel molten metal, a down sprue is cut, as well as gates to conduct the flow and reservoirs called *risers,* used to feed large cross sections of the body of the casting as they cool, in order to reduce shrinkage and cold shunts in the casting. These channels are all made during the molding process and before the pattern is removed and the mold closed up, ready for pouring. The mold must then be "weighted," or surrounded by heavy abutting-weights, to prevent the rush of poured molten metal from pushing apart the two halves of the mold, causing leakage of metal and ruining the pour. Since the various nonferrous metals vary by weight, bronze molds must be weighted heavier than aluminum-poured ones. After the pour, when the metal has solidified, the weights are removed and the casts emerge from the hot sand. (The molds "breathe," allowing casting gases—mostly water vapor—to escape from the sand around the rapidly solidifying metal.) Sprues and risers are cut off, and the new castings are rough-ground, sometimes sandblasted or "wheel-shot" to remove all traces of molding sand. (Deposits of such sand can ruin a machinist's cutting tools.)

The best bronzes for critical-wear parts and levers are the high-tensile manganese cam bronzes, which are very resilient and strong, having tensile strengths of up to 140,000 psi. Navy "M" and the old "gun" metal are good for wear but are

not so strong. Ordinary "red" brass (85-5-5-5) reproduces well for tolerance casting; it does not shrink as much as the manganese alloys. Aluminum bronzes are used for parts that are intended to be subjected to heat (typecasting temperatures) over a long period of operation, but these alloys tend to be brittle. If an iron foundry is available, by all means attempt to use it: but it must be *small* enough to want to do business with you. As we often appear somewhat deranged and our projects lack a certain profit factor ("just one of each, please"), many foundries do not wish to get involved. Quality of the work in hand is a factor also; there must be a molder with skills needed to produce loose-piece work, especially if the parts are not mounted on a match plate and must be done "floating" in the sand mold. In many areas of the country, these craftsmen are not merely endangered: they have already become extinct.

A PROBLEM SOLVED

The Barth Automatic Type Casting machine was originally designed with a gas nipple heater. By the 1920s, the machines were converted to electric heat. Shaped somewhat like a lamb chop, the electric nipple heater cycles independently of the pot heaters and has its own rheostat. Its purpose is to maintain sufficient heat around the nipple and so ensure the proper casting temperature of the molten metal flowing through the nipple to the mold void. It is merely a resistance cal-rod circuit within a cast iron body. The original engineering was done by Edison Electric (later General Electric); the devices were efficient, lasting up to a decade or more in service.

When these devices became obsolete and were no longer available for replacement, the redoubtable Frank Peters devised a means of manufacturing replacements by bending new cal-rods to shape, adding machined inserts in critical mass areas, and building up the bulk of the object with electric welding. The Peters contrivances were somewhat less successful than the originals, but they were acceptable at first; with the dwindling of the specialized ATF work force, their quality continued to deteriorate, eventually to a point where the mechanics who serviced the casting bays were compelled to move the few good remaining heaters from machine to machine, as one after another of the heaters failed. The latest efforts to produce them by Peters' methods produced heaters that would fail more often than not; these devices were not especially easy to machine because of slag and hardened areas created by the welder. Since these heaters must fit into a tight area, many of them were also ruined in the machining process, which reduced their dimensions too far (and cut into the heating

element encased in them), because of the need for clearance. Looking for a solution to this problem, I obtained a burnt-out heater and a new cal-rod bent to specification. At the bronze foundry, using the old unit as reference for dimensions, a pattern was fabricated in wood, according to the protocols outlined previously.

A mold was "rammed up," with parting[25] applied to pattern and mold halves. It was poured in yellow brass, the particular alloy being charged at the time (later, a more appropriate alloy was devised for production). This rough-ground device passed electrical tests, but failed to be machined accurately, in part because the cal-rod was not suspended in the void of the mold securely or accurately, and it moved about during the pour because of the turbulence created by the flow of molten metal. When machined, the milling cutter bit into the enclosed cal-rod, shorting out the unit when put into service on the caster. To correct this problem, tolerances on the pattern were adjusted and its core-print (the area destined for inclusion of the cal-rod into the finished mold) tightened up; also, chaplets (pieces of steel ground to shape and size) to support and hold the cal-rod during the pour were inserted into the mold. These pieces of steel remain as part of the device after pouring. The "new" technique (the originals, remember, were cast in iron) was entirely successful, and three sizes of nipple heaters are now produced in this manner. Few of the new heaters have failed, but what is more important, the units require less work to fabricate and cost nearly a third less than the old welded devices.

Casting Machines and Molds

Maintenance was humorously referred to as "pioneering" at ATF. The following checklist was hurriedly extracted from a much-decayed notebook, dated 1899, that once belonged to an anonymous ATF castor. I was unable to preserve the document because of its water-logged condition; when it dried out, it disintegrated. A sad loss, as there was what appeared to be an earlier section of handwritten notations made in a fine old-fashioned hand that dated even farther back, at least to the late 1870s; since the cover bore the Cincinnati imprint, the notebook could possibly have been Henry Barth's own. Portions of this checklist

[25] Parting is a dustlike chalk or talc, which is shaken on the pattern and mold halves: it prevents sticking and aids release of the pattern.

were reprinted (on an inferior card stock) in the early part of this century for the use of the ATF castors in the bays. Many of these aphorisms can be successfully applied to *all* casting machines, in some degree. The entire text is as follows (with my commentary in square brackets within the text):

MOLDS

Each morning, take out the head piece and run mold in oil for at least five minutes. Wipe off head piece, matrices, carriage, matrix shoe, rest, and mold, so that all parts are free from grit, metal, and excess oil. This will do much to prevent cut and scratched molds.

MACHINE PARTS

Oil all of the machine parts above and below the Table. [By 1905 the term *Table* was changed to *Apron* on the new drawings.] This will prevent cut cams and stuck and broken levers.

CHOKER

See that the choker point does not come through the plate and strike the body piece. If it is too long, the body piece strikes the choker point each time it comes up and makes a hole in the back of the jet from continuous hammering. This results in: *(a)* a leaking nipple, *(b)* bad faces, *(c)* defective matrices, and *(d)* splashing. [It is interesting that although the *effects* of this condition are elaborated upon, the actual corrective procedure, which is quite simple, is not mentioned at all. A castor was not expected to file the choker point with the plate in position and so make it flush; this was the maintenance department's job, and it illustrates the regimentation and strict division of labor in the foundry in the old days.]

NIPPLE

Before starting, a small amount of metal should be drawn from the nipple. [To discharge the nipple into a small ladle, back off the pot and place a wrench on the choker arm to lift it upward, throwing a stream of molten metal into the ladle.] After the metal has stood molten without agitation, the copper and tin in the alloy will separate and crystallize. These crystals plug up the nipple hole, spoil

the choker point seat, and in some cases pass through the nipple and are thrown against the matrix, damaging it and the mold also. This metal must be removed before damage is caused.

PUMP

Before starting, turn pump to loosen up any dirt that has settled around it. Also rotate the pump frequently during the run. This procedure will aid to do the following: *(a)* correct potential pump trouble, *(b)* eliminate cut pumps, *(c)* eliminate broken pump levers, and *(d)* prolong pump life.

MOLD AND HEAD PIECE

Oil the mold and head piece frequently while the machine is in motion. A systematic way of doing this is to oil the mold per stick of type for the small body machines and every half galley for the large body machines.

METAL

Stir the metal first thing in the morning and remove all dross. Do not let the metal level in the pot run low. When the metal runs low, dross and dirt work their way into the pump, nipple, choker, gooseneck, and eventually the mold and matrix. [The term *gooseneck* refers to the J-shaped bore machined *in situ* from the pump well to the choker barrel.] Damage is done at these areas, and the damaged part or parts must be removed, repaired, or replaced. [Low metal will also cause damage to the electric heaters in the modern machines and their thermostats.] A large quantity of metal charged when the level is low causes an immediate temperature drop. Charging should be done slowly, steadily, and continually during the run.

WATER

Ensure the water is turned on before commencing to cast and turned off after the run. [A machine run without cooling water can suffer severe damage when—upon suddenly discovering the condition—an inexperienced castor tries to send water through the mold, thereby cracking the hardened steel of the mold by temperature shock. (The steel used in the molds is "Hampden," an old alloy that can endure temperatures up to 1150°F without loss of hardness, but it cannot

take a cold shock.) The correct thing to do is simply turn off the machine, let it cool down naturally, and start it up again later (hoping all the while that no one notices, and that the condition did not cause any irreparable damage to begin with). Watch the water!]

BODY PIECE

Once a week the body piece should be lowered for a wide set and the body run in slowly, using plenty of mold oil. This will loosen metal and dirt that has accumulated at the bottom of the mold. [The procedure for cleaning a body piece that has become fouled is given on p. 85.]

CLEAN MACHINE

Always keep machine neat and clean.

Pumps (Pistons)

MAINTENANCE

Pumps (pistons) must be pulled and cleaned regularly, hence the need for using only the best metal alloys available. They should be rubbed with a piece of fine (used) emery cloth, taking care not to remove any of the dimensional surface. The pump should be cleaned hot, dipped in tallow, and replaced in the well. The well should also be swabbed out hot with tallow and the pot thoroughly cleaned (not merely skimmed) to remove as much dross as possible. If the well and/or the pump is not concentric, the well should be lapped round and a new pump turned and replaced.

The OA piston should always be removed after the run, cleaned, and stored upright in the melting pot when the machine is down. Maintained pumps will last a long time. Finally, always monitor pot temperature: do not trust old thermocouples. Just a few casts at over 750°F will ruin matrices and molds.

PUMP/WELL DIAMETER CLEARANCE

The iron or steel used in rebuilding collar and pot well inserts must be the same, to synchronize expansion and contraction during heat-up and thus prevent

binding. The tolerances are: for Monotype .0015″-.002″ maximum; for Pivotals .002″ maximum (slight taper); for Kuco (no collar) .001″ (slight taper); for Barth .0025″ maximum (packing takes up .0015″); and for Barth in zinc service (in stainless) .003″. Pumps worn past these dimensions must be replaced.

PACKING A PUMP

Square or oval asbestos, measuring 1/4″ or 3/8″, can either be packed as single rings (to pump diameter, staggering each joint and bottoming all together) *or* a single strand of packing is wound around the pump in the well and soundly driven down. The collar is tightened down until an even pressure is produced (oscillate pump *in situ*). Remove collar and add one additional ring of packing, no matter what method you use. Replace collar and tighten, but be sure not to break any teeth from the rim of the collar. Packing specifications: the material must be impregnated with graphite and have a working heat range of at least 1000°F. Some packings are reinforced with thin wire or mesh: these should not be used. Garlock Compression Packing Style 127 AFP has been found to work satisfactorily.

Automatic Casters

Barth Casters require a certain amount of head-piece and tail-stock maintenance. After long runs and many hours of operation, the tail stock needs to be removed (one large bolt) and the groover assembly cleaned. At this time the type channel should be inspected and the surfaces rubbed down with fine arkansas and oil. Remove just the deposits— *not* the surfaces. The head piece must be taken down (as with a splash) and cleaned. All type-carrying surfaces must be checked for burrs, deposits, and unnecessary wear.

To clean a fouled body piece: jack up the pot, securing the pump, and push the pot carriage away. Remove the access screw from the rear of the mold. Run mold oil down the front oil port to the body piece. Run the caster, adding oil continuously. Direct a stream of air from your air hose down into the port. Dirt and metal debris will exit the rear port. Continue to flush with additional oil until the oil flows clear. If the body piece remains fouled, it must be removed and cleaned. Such a condition indicates either that the mold is severely worn out and requires

repair or that maintenance protocols have not been observed. Maintenance protocols must be observed in the future to prevent its recurrence. The body piece must also be checked for trueness to the mold bearing surface. If it is not flat and true to the mold, type will be cast out of square. It should be carefully stoned down and levelled.

The choker pin must be checked to ensure it does not extend past the nipple plate bearing surface (the flat surface resting against the mold cheeks). File the point down flush with the nipple plate. The nipple must also seat well in the nipple plate. Emery dust mixed with oil is applied to the inside of the nipple plate and outside of the nipple. The machine is then closed up as if to cast, and the nipple plate is thrust back and forth to seat the nipple. The emery and oil must be removed after a satisfactory seating to avoid damage to the mold and surrounding area.

There are two methods that you can use to correct an underheight condition; but first you must remove the jet pieces from the rear of the mold. The first method is to add appropriate shims (on both sides), the dimensions of which are calculated from current casts. Add .0004″-.0006″ over what is needed, as the excess will wear and "work down" after casting begins again. This technique, called "packing the jet piece," is also used for pivotal molds. The second method is to determine the amount of additional material required, and plate nickel by electro-deposit. (Machine to specs.)

An overheight condition is dealt with by simply grinding down excess material. If the mold is in poor condition, it may be necessary to fabricate new parts. Small increments of adjustment for type height can also be made to the head blocks in the head piece. The bearing surface of the mold should be flat and parallel with the rest of the bearing surfaces of the mold. These blocks are adjusted by their mounting screws. Also adjustable are the body blocks of the pedestal (these control body size, i.e. em size). They are reached through a slot in the upper type channel assembly. There are two screws "top and bottom"; moving one by loosening will permit tightening the other. This adjustment allows an expansion or contraction of the body size. Anything over a 1/8-point correction is a serious matter, and other factors must be looked into. Abuse is usually the culprit for type height variations: usually the cause is too tight a lock-up of the plate on the mold. A splash can also cause accumulations of metal that will push a "head" block out of true.

The Kuco Automatic body adjustments and changes entail working over the body piece, type pusher, groover block, and type "tongs" (carrier), as well as the head piece throw dimension. Unlike the Barth, it has only fixed knives, and its

chip ejection is not as sophisticated. A major fault is a lack of air-cleaning ports for chips and casting debris. One shop went so far as to install a vacuum apparatus, but it would be better to install Barth-type air jets. The chips produced from engraved matrices and the deeper drives of certain faces can be overwhelming. The diligent castor cleans his equipment on a regular and thorough basis.

Lubrication

"If a little is good, a lot is better" is bad advice for oiling a casting machine. Rather than flooding the machine, using a steady, controlled quantity of oil over the entire run is preferable. When casting thin sets at high speed, over-oiling can cause a splash. The flooding of oil or tallow can cool off a mold past its optimum casting temperature and so cause the machine to stop casting type. Excess oil will create wormy surfaces on larger bodies and sets.

Use only a light, tough mold oil on the working parts of the type mold. An oil of heavy viscosity will leave burned deposits, which must be removed from casting surfaces or they will block the oil from running sufficiently to all areas of the mold, causing much unnecessary wear. The following is a list of lubricants and related substances required for a type foundry:

1. Beeswax (raw) for rendering metal; heavy pot skimming; and pump dip (optional).
2. Paraffin for light pot skimming; OA nozzle and other nipple cleansing.
3. Tallow for all mold plates; pump dip; well (pot) scarifying; and OA nipple cleansing.
4. SAE 10 ND, a light mold oil.
5. SAE 30 ND for all working mold and drive parts.
6. SAE 50 ND for OA transmissions.
7. Cup Grease for gears.
8. Belt traction compound for belt drives.
9. Mold oil. The finest oil for molds has traditionally been sperm whale oil. The Guild has a quantity (provenanced from an earlier, nonecologic legislative era). Still bright after over half a century, it is unsurpassed.
10. Penetrating oil to loosen heat-fixed or rusted parts, and old OA display molds.

11. Petroleum jelly for Benton Engraving Quills and Power Drives.
12. Silicone for storing molds, lapped surfaces and parts.
13. Penetone[26] (Inhibisol) for greaseless cleaning of mold parts and matrices (the Environmental Protection Agency's answer to carbon tetrachloride).
14. Sealing wax for impressions of matrix characters.
15. Plumber's candles to make smoke proofs of type and punches.
16. Mineral spirits as cutting fluid for engraving-tool grinding.

OA Display Molds

The multiple-blade (body) display molds designated 1T and 1U, and the single-body display molds 2T and 2U in the 12- to 36-point body sizes, are the only Monotype molds of value to us.[27] After you have removed the cross block, gate pusher, top guide (and its shield), apply some Penetone with a fine brush to flush out flakes of metal that have built up in the worn areas of the mold. Stuck-on deposits need to be (carefully!) removed with a sharp stick of hardwood dowel and a fine stone. When reassembling, be sure all parts are scrupulously clean and lightly oiled with fine machine oil. Never reassemble without cleaning and/or washing your hands first. Type that is not square dimensionally, nor true of body parallel, has been cast in a mold fouled with metal and deposits that have tipped the cross block. This fault *must* be attended to, so that serious wear will not continue and eventually ruin the mold. Unless a mold is so badly worn that it fouls up with flash after casting only a line or two, most well-cared-for molds (with proper oiling discipline) need be cleaned thoroughly only after extended runs of narrow sets. It is wise to clean a mold regularly, depending on usage.

Never fit or force a gate pusher. *Never* loosen the left type block. The only alteration that will not adversely affect the soundness of a display mold is grinding down the height of the mold aperture (top-bearing surfaces) to accommodate the exotic drives of ancient foundry matrices. Whenever a mold is removed from the mold stand, force all water out with air and blow oil into the mold's water passages.

All molds should be stored in a warm, dry place and should be checked

[26] Penetone is now being phased out due to the threat to the earth's ozone layer. Suitable (safer) substitutes are being developed.

[27] "The Lanston Sorts Casting Mold" (Folder 8095-11-49-500) is very valuable.

regularly for rust. Wrapping in wax paper and storing in tight boxes may be necessary in areas that are extremely humid. Never leave an OA mold on the mold stand for long periods of time. Water accumulated and left within the mold can cause rust or create deposits. If your foundry's water supply is laden with iron and other deposit-causing sediments, consider providing some measure of improving it.

Section II

The Service Crafts

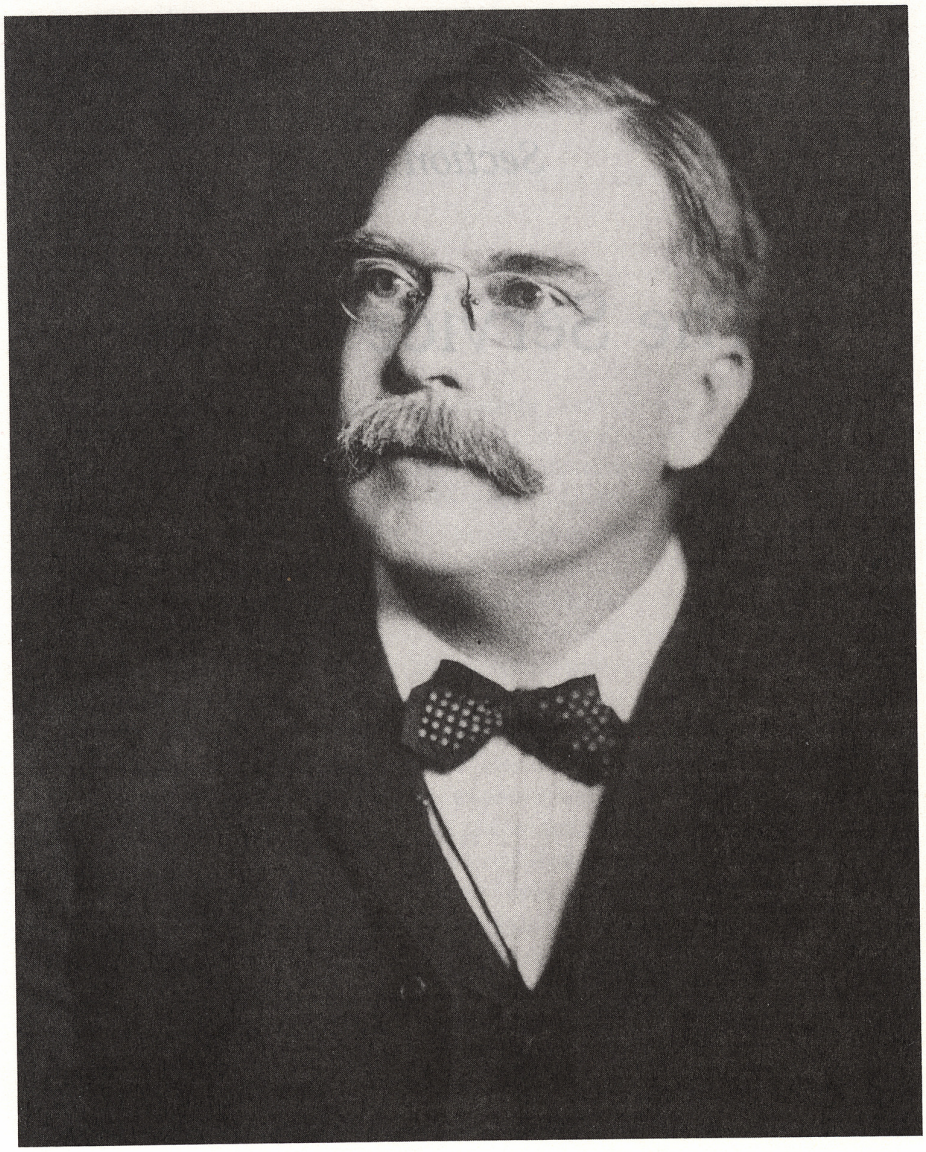


Figure 24. Linn Boyd Benton, *c.* 1885.

Chapter 9

Matrix Engineering

This chapter is devoted to the matrix: its many forms, its historical development, and the various protocols for its manufacture. Many early recipes and much of the craft of the small independent foundries have been lost. I have been fortunate in having an oral tradition and an occasional workbook saved from oblivion to aid me in my researches.

Raw Materials and Techniques

Various alloys of brass and bronze, steels, and especially copper have all been used successfully to create matrices. Other materials have been used, but the most successful alloy for ease of manufacturing and wearability is nickel brass. This alloy was once produced in bars and strips in many thicknesses, and it had the following analysis:

Brass for Type Matrices #S-773

Lead (Pb)	Copper (Cu)	Nickel (Ni)	Zinc (Zn)
(maximum) 1.03	63.40	7.35	28.76
(minimum) .95	62.90	7.31	28.30

Nickel brass is now virtually impossible to find. The alloy (or similar ones) still exists in ingot form for casting in green-sand, but there are no mills left willing to run small quantities. The amount of money it would take to produce a commercially profitable run would ruin a small shop. The next best material is "half-hard" alpha brass, also described as "free-machining" in its better grades,

but this alloy does not have the resistance to wear of nickel brass. Unless it is chromium plated, alpha brass fatigues and fails rapidly under adverse conditions or long runs, washing out entire counters and pitting the character's surface. In its lesser grades it may also contain inclusions of oxides and dross that float in the material, ready to ruin a finely engraved surface.

Dimensional copper is still abundant, although now refined to an unheard of purity, something that in itself is not overly desirable for matrix wearability. Copper engraves with difficulty, and it should be used only for striking with punches. A punch-driven copper matrix is thereby at once work-hardened and its molecules compressed sufficiently to achieve a sufficient tensile strength at the character area.

As to steel, there are many good varieties, both oil- and air-hardening, that are quite useful. Benton (and later Robert Weibking) pioneered the use of steel for matrices. The engraving and fitting of steel matrices is slow and difficult, costing nearly four times as much in labor and dull cutters. Steel matrices should be used only for projects that will warrant the extra expense, such as casting with zinc to make hot-metal stamping type. If not stored carefully, *any* moisture will quickly ruin steel matrices.[28]

Nickel brass alloys or the lower-quality German silvers can be cast in the green-sand foundry as rough planchets (close to the dimensional thickness required) and so may be shaped down or milled into matrix blanks. This has been done by the Guild, and the material so produced is infinitely superior to anything else available from nonferrous metals suppliers. Aluminum and its relative, magnesium, have been used in the past for type matrices. As these substances do not occur as metal naturally in a free state, they are continually oxidizing in our atmosphere, seeking to return to the dust they were extracted from. It is my opinion that they are poor choices for matrix fabrication, fit (typographically at least) only for house signs. Those owning any matrices driven or engraved in aluminum should store them carefully and make some arrangement to transfer the designs to copper or nickel electros.

The sections that follow deal with the various techniques of matrix production. Solutions for overcoming some engineering problems are also outlined. When contemplating the production of matrices, there are two primary questions to be asked for any project: *(a)* what equipment will the matrices be cast on? *(b)* what quantity of casts are expected? This information will determine what will be required of the matrix department. Often a combination of disciplines may be needed.

[28] To be fair, it must be remembered that *any abused matrix will eventually fail.*

Driven Matrices

Although punch-driven matrices were passé by the 1930s, Benton's punch-cutting machine and variants based upon it have continued to produce Monotype cellular and display punches. I will not deal extensively with these punches here, but I should mention that I have purchased several suites of punches from England and have produced fine foundry-style matrices for the Guild with them. Except for growing some special kerning characters in the electro bath and engraving a few accents over driven sorts, I have had little experience with cellular composition matrices. As for foundry-style driven matrices, Frank Peters had begun a program of pressing hardened steel Benton-cut punches of certain popular commercial faces into steel matrix blanks. As the result of his death, the project was never carried through. The surviving material shows his great ability for improvisational engineering and a high standard of precision.

The last of the ancient ATF punch-cutters, Hermann Becker, died in 1949. Born in Germany in 1873, he was retained for many years at ATF to cut replacement characters for certain faces that existed only in electro. These faces, mostly scripts, had been acquired with no supportive artwork and were difficult to replace. Becker's death left serious problems in supplying replacement matrices.[29] Becker's forte was in direct letter-cutting onto carefully cast blank quads. More tangible objects of his craft and immortality are fractional punches cut by him to mark set-widths on the faces of matrices. Despite continuous hard usage of many years' service, they remain crisp and jewel-like—examples to be followed. For those interested in pursuing hand punch-cutting, Paul Koch's famous piece in *The Dolphin*[30] and R. Stan Nelson's delightful videotape[31] on the subject are well worth having. Becker left no written records, and the notes that follow are drawn from the reminiscences of his contemporaries. The tools and other artifacts he left behind remind one that the craft has not changed greatly since the time of Moxon or even earlier.

The proper selection of steel stock for punches can be difficult. The alloy must "work" crisply, harden evenly, and draw well. It must not fracture or shatter

[29] For engineering solutions to this predicament see chapter 12.

[30] Koch, Paul. "The Punch." *The Dolphin* 1 (1933): 24-57.

[31] *From Punch to Printing Type: The Art and Craft of Hand Punchcutting and Typecasting* (New York: Columbia University School of Library Service, 1985).

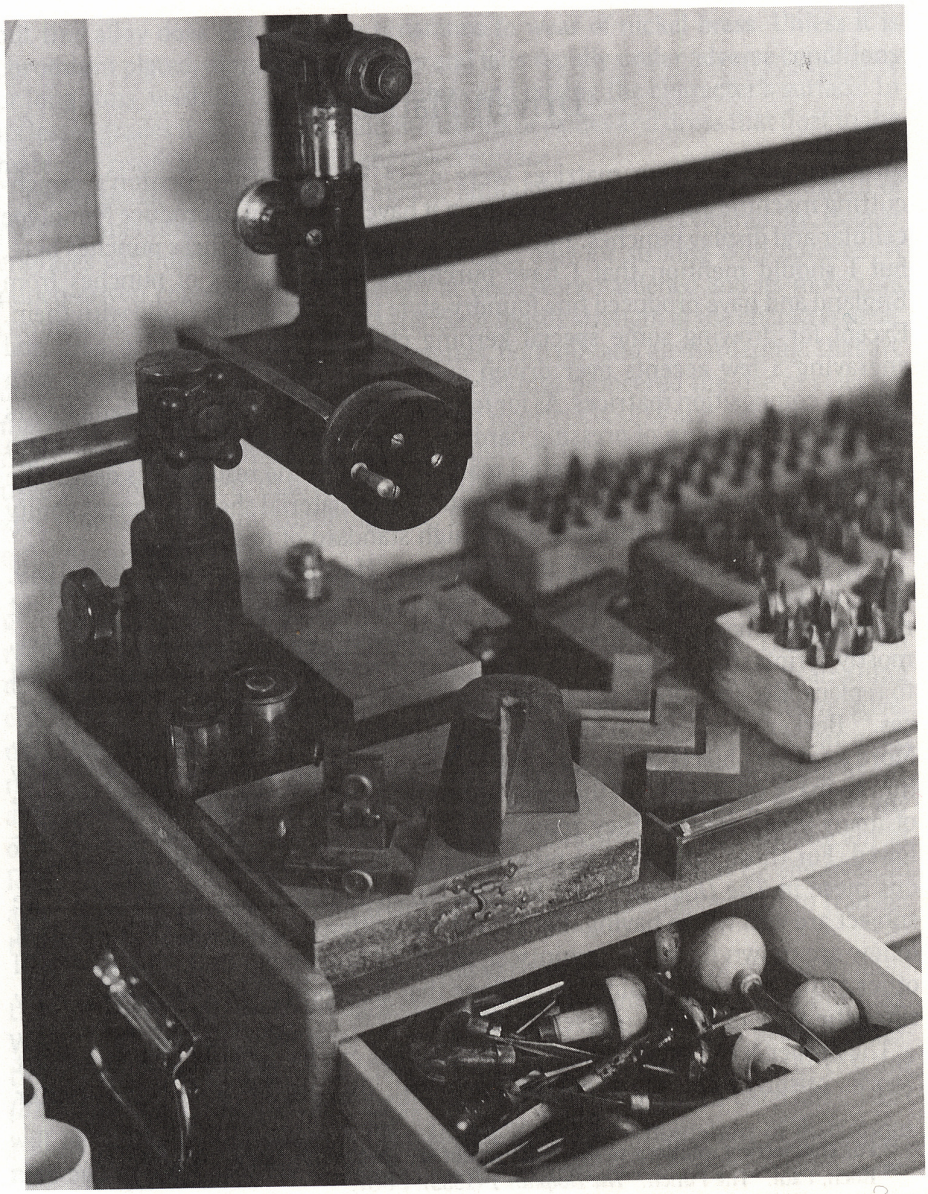


Figure 25. A punchcutter's equipment (Howell Foundry).

when being driven into the matrix planchet. Proper tempering assures a certain "give," which is most important: a brittle punch, incorrectly drawn or overly work-hardened, is very frustrating to work with. Many hours of labor can be lost in an instant if discipline is not maintained. Samples of prospective steel alloys should be tried, and—since one batch of an identical alloy can differ from the exact same kind from a different heat—the best alloy of a particular lot should be stockpiled.

Steel punches, hand or machine cut, should be stored carefully. Moisture, the deadly enemy of a punch, must be prevented from attacking the mirrorlike surface of the punch's character. The Guild possesses a few genuine specimens of production foundry punches, which we store well-oiled, wrapped in kraft paper. Old-fashioned steel cigar boxes make good punch vaults, and the cylindrical tins used by certain candy manufacturers can be made to look like punch vaults of ancient times.

The Guild Matrix Department does not "strike" punches; we use a driving fixture in conjunction with a small arbor press adapted for this purpose. The driving fixture allows more control and less distortion than merely hammering away on an anvil. In a pinch key stock may be used for an odd project, if only a single drive is needed. The matrix planchet must be sufficiently annealed and drawn for this procedure to be successful.

The amount of skill and patience required to produce a usable hand-cut punch is not offset by great returns, and the practice must be considered from a purely artistic standpoint, the only realistic advantage being that matrices so produced have little or no beard, and casts from them can be tightly fitted up. When faced with the prospect of cutting an entire font, lesser mortals must depend on the developments of somewhat later technologies.

In producing a matrix with an old punch, you must exercise the greatest care and restraint. Always use a driving jig. Begin by examining the punch closely. Rubbing the shank lightly with the finest emery paper or an ink eraser will reveal any defect or fracture. If such damage is apparent, the owner or guardian of the punch must be consulted before the process goes any further. With permission obtained, a bezel of brass, copper, or thin steel can be fabricated and applied before pressing the punch into the planchet. Seemingly hopelessly fractured punches can be epoxied into machined steel sleeves to produce excellent matrices. I also know of a case where frail punches of great historical value were eased into (forgive us!) aluminum (S-2 alloy) planchets and the resulting casts used for electro models.

Only time will return an old punch to its "berry-brown" patina. The salts and

oils from the craftsman's fingers soon permeate the metal, and to those more in a hurry, a pass or two from a propane torch flame (do not overheat!) will oxidize the punch's film of light oil to nearly its original look. Many well-made old punches still exhibit the annealing "blues" on their shanks. Such discolorations indicate good health. Fractures in the face of a punch render it useless, but you can deal with rust damage to some degree of success. The face should be carefully squared and trued on a fitter's stone (fine serpentine) with a 90-degree rubbing jig. If the surface is pitted, matrix dope can be applied as for casting from damaged matrices (see p. 54). A large punch can also be repaired with Permatex to fill in the larger voids, and after curing, the character can be worked over with gravers and burins before truing the character face.

When driving the punch, care should be taken to keep both the surface of the character of the punch and the surface of the planchet clean. A wipe of light oil will ease the start of the impression and make friction of the punch shaft in the ways of the jig less troublesome. The driving jig assembly has adjustments that enable the planchet to be positioned with accuracy under the punch, thereby easing the burden of fitting and justifying. Removal of the planchet to check depth of drive requires repositioning with accuracy. The planchet must be evenly annealed to aid with the progress of the punch. Punches with shoulders (Monotype display punches and certain large composition punches) drive down to .002″-.003″ over STL-2 depth (see appendix 1, p. 183); otherwise, especially if many matrices are to be driven, fabricate and use machined depth fences adjusted to the particular drive and allowing the same tolerances. Uniformity of rough depth in a matrix to be fitted is an advantage.

When computing the amount of drive necessary to fit a rough matrix, an overdrive of at least .002″-.003″ over the *lowest* area of the matrix face must be allowed for. Observe discretion in establishing the rate of drive—that is, the speed at which the punch is forced into the planchet. Ramming a punch by machine into an unyielding planchet causes severe punch fatigue and greater distortion than does a slow and carefully exerted driving pressure. ATF, Lanston, and Ludlow had resources enabling them to replace their punches accurately and continually. Such is not the case with the punches left to the present guardians of this craft: they cannot likely be made ever again, and ensuring their longevity is an important facet of our stewardship.

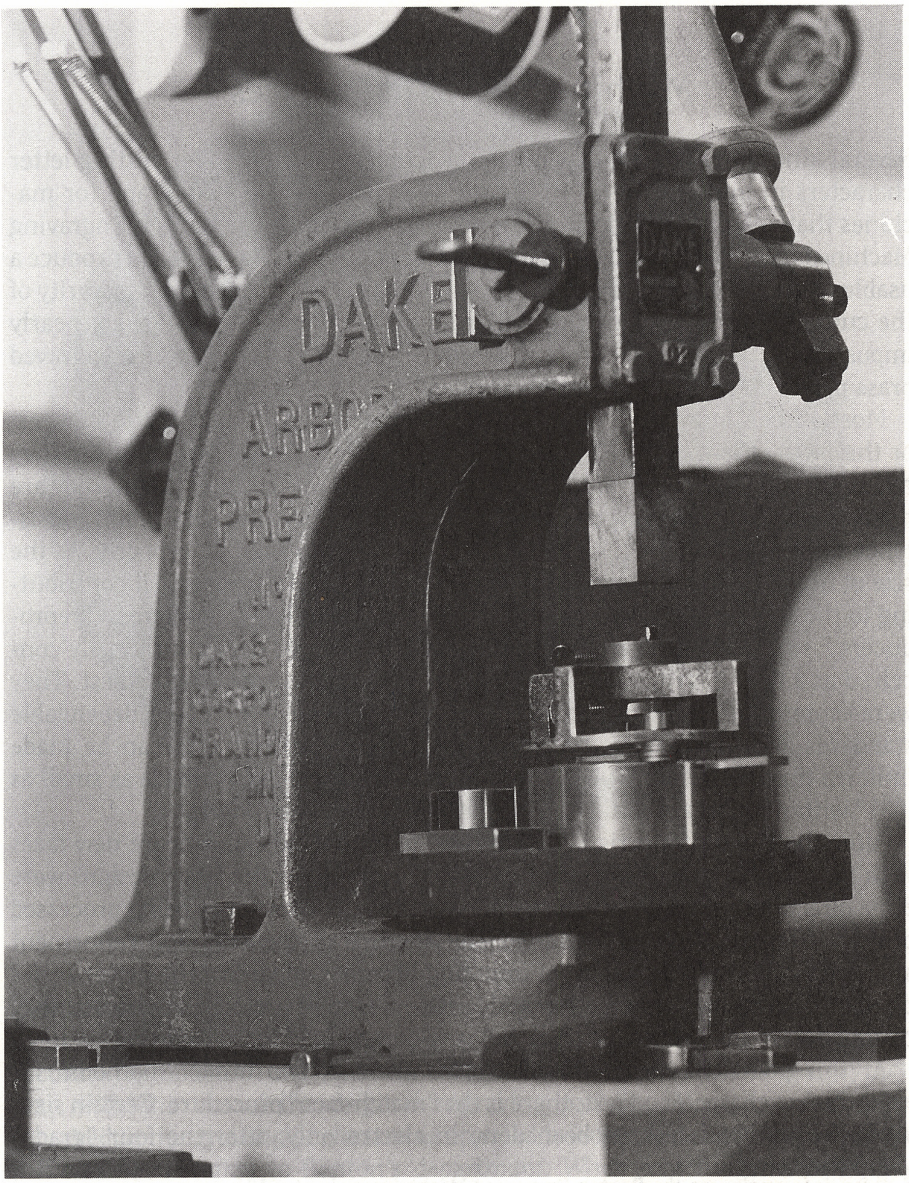


Figure 26. A punch driving press with jig (Howell Foundry).

Machine-Engraved Matrices

Several kinds of engraving devices and machines are suitable for cutting letter characters in matrix planchets. The most common is the pantograph (or machines that adopt its principle in various ways), of which the Benton Engraving Machine is both the best known and the finest.[32] Gorton engravers can produce a usable matrix, but one that throws an unwanted beard, because of the severity of the cutter's taper that is needed for strength. Smaller size cuttings are nearly impossible with these machines. A Gorton is better used to produce engraved brass patterns for other engraving devices.[33]

Most other engraving machines, such as Frederic W. Goudy's Little Pioneer, or the Swiss "Gem," require great skill to overcome their shortcomings. They have very definite size limitations; they produce enormous beards; and they are not precise enough for our demands. Their cutting tools cannot maintain consistency in tight corners, often break, and are difficult to sharpen properly. As the size of the cutter decreases, its resulting taper must be increased, all contributing to the rounding and distortion of the design being cut. The German "reproducers," such as the Deckel-Kampf and Benton's superb device (originally conceived as a type-cutting and later a punch-cutting machine), are the best. They were expressly designed for such tight, demanding work. Both have dependable standards and factor tables with cutting edge dimensions that can be made uniform time and again. The Benton machine's cutters can be made as small as .001″ with no increase in taper or sacrifice of integral strength.

After the death of Morris F. Benton in 1948, ATF did not prepare new faces with the same disciplines, and the etched zinc plates for the latest designs were done directly from reworked art, or velox prints, the latest ones being processed directly from the artwork positive. The absence of the care and refinement afforded by the Benton system of unitizing becomes apparent: the newer series do not relate well with each other and for the most part are not as refined as they could be.[34]

At this point mention should also be made of two other "methods" for reproducing characters. First, there is the "match-face" procedure. Certain sizes within a specific face have been done in electro only, after the four "grade"

[32] For information on the Benton Engraving Machine see chapter 10.

[33] See chapter 11.

[34] A discipline for making etched zinc plates is given on p. 134.

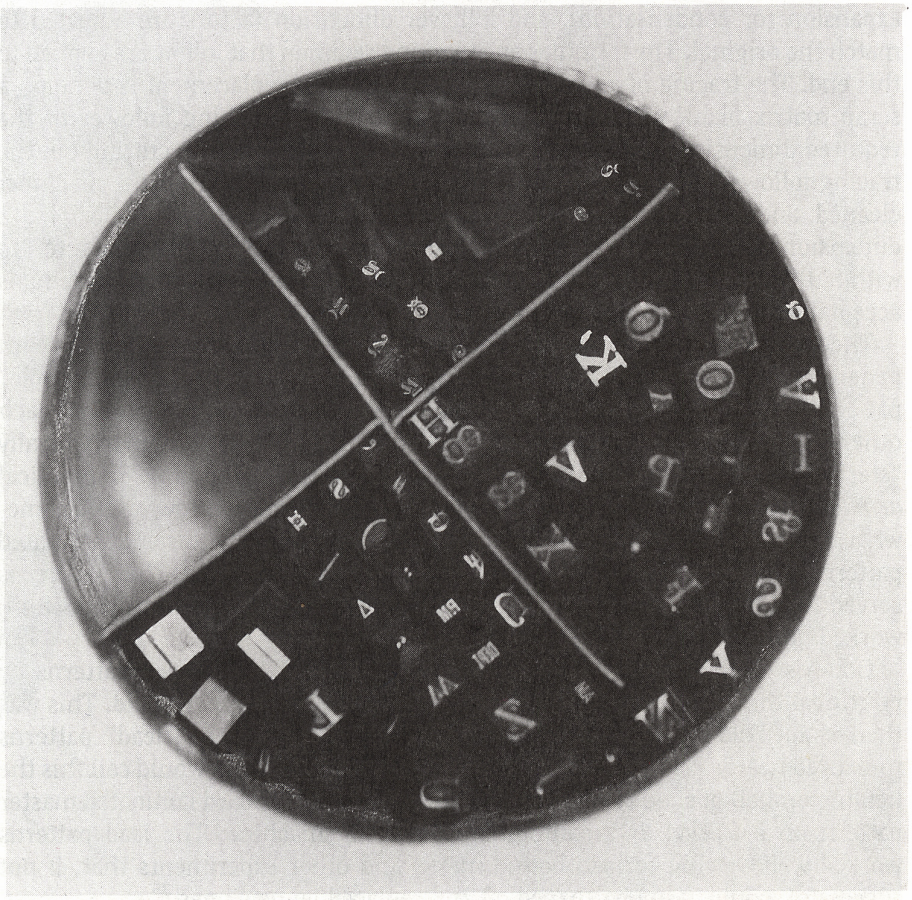


Figure 27. Punches cut by Hermann Becker (Howell Foundry).

characters (H,m,O,o) were cut. Perhaps they were given to the matrix department as "busy work" during slowdowns; but such a practice will not ensure an accurate reproduction of a character that has been in production for many years, even with the use of the original engraving patterns. Variations may have occurred in the growing of electros as opposed to how the design would engrave if it had been routed to Benton's department. When matching the originally issued electro, or when replacing a character for which no artwork exists in an ancient design, the engraver bows to the electro document, and the leverage,

expansion (or condensation), and follower dimension factors are adjusted to match the original. The formulas and working regimen that follow are applied to this end. The tracing of a new cutting or match-face replacement is done on a scrap matrix blank with the finishing tool and the finishing follower of the required dimensions. Lightly incised (only .001″ or so) with no cutting oil, the tracing follows the perimeter of the pattern. It is removed from the machine, cleaned, and measured under the microscope to compare it with the original's dimensions. Adjustments and further tracings must bring the character to within .0002″ tolerance of the original. Once it is determined that the tracing is acceptable, the matrix-cutting procedure is begun.

The second method is Goudy's technique of pattern fabrication. Endowed with generous amounts of tenacity and "work" patience (as opposed to "people" patience), Goudy was also a natural genius. Benton and Goudy endured each other warily. Goudy considered Morris Benton and his designs mechanically "sterile" (which was untrue); while Benton considered Goudy an impractical *artiste* (also untrue). Goudy had no access to nor inclination toward the somewhat complex regimens I have described; instead, he created usable laminated patterns of varnished card stock and Strathmore-type papers. These patterns served for his most important designs and, if not overly taxed in production, worked quite well.[35]

Goudy's final contribution to this protocol was to create new patterns by pouring a thin planchet or plate of type metal into a fixed open mold. This was then shaped down flat and the edges squared. His finished "lead" patterns measured nearly 4″ high, with a cap character height (Benton would call this the height parallel) of about 1 3/4″. This was cut from the cardboard laminated master pattern on a Deckel 2G1 pantograph engraving machine. The lead patterns worked well, having scribed bound marks and other experiments that, if not successful, could easily be shaped off and replaced by new ones.[36]

[35] I have made similar laminated patterns using sheet plastics of various kinds. If the design is cut with precision and accuracy, and the laminate is bonded and sealed securely, a project of this nature is feasible for practicing artisans with limited funds. Surely the most "expensive" factors in this equation are desire and perseverance, just as they are with character-cutting on quads, or punch-cutting itself.

[36] These patterns are Benton Engraver compatible, being approximately half the size (3.59″ height parallel) required and were useful for replacing engraved matrices for the Scripps O.S. italic for Claremont College. Our Benton Engraving Company had been concerned about certain characters that were not engraved cleanly (hardly Goudy's fault, as had he lived, he certainly would have recut them), and so an astonishingly successful collaboration of these two diverse men of genius has occurred, albeit forty-five years posthumously.

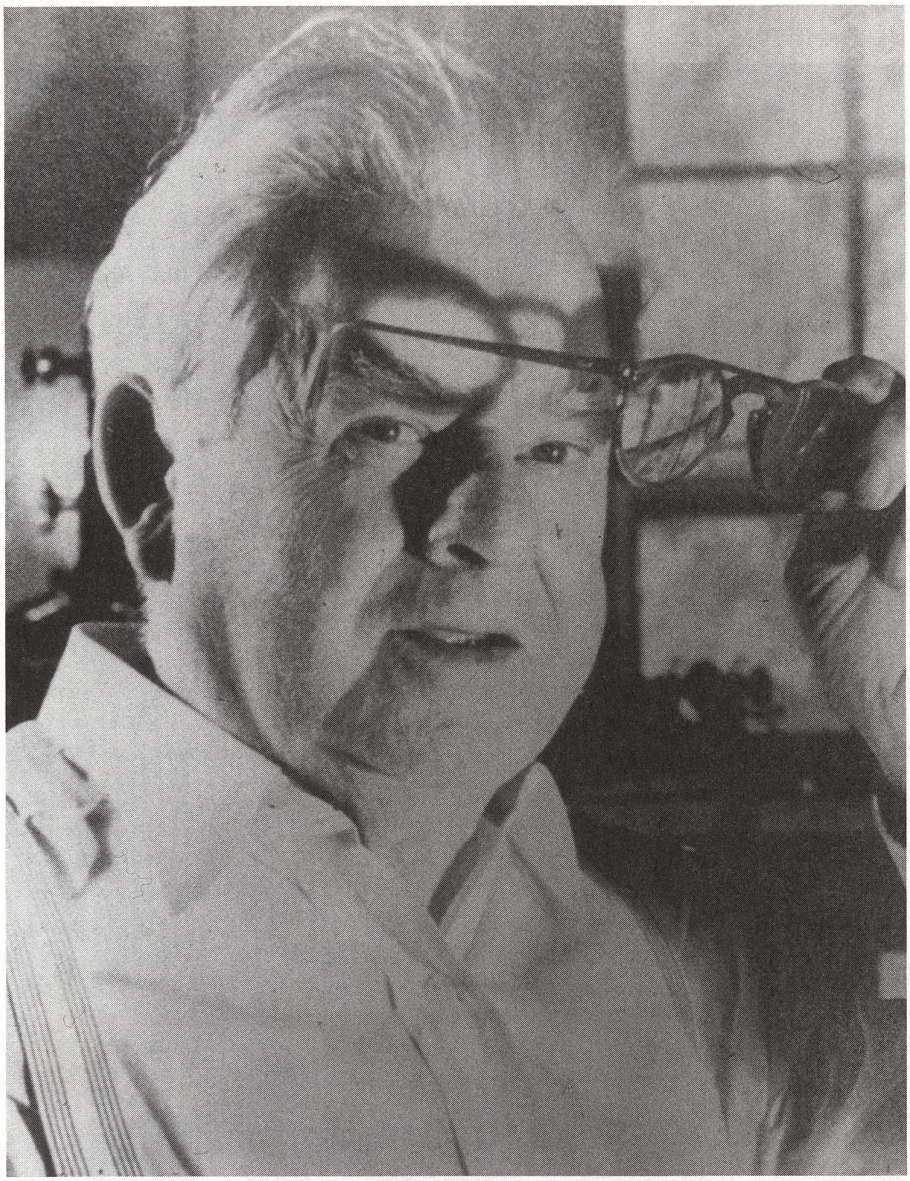


Figure 28. Frederic W. Goudy.

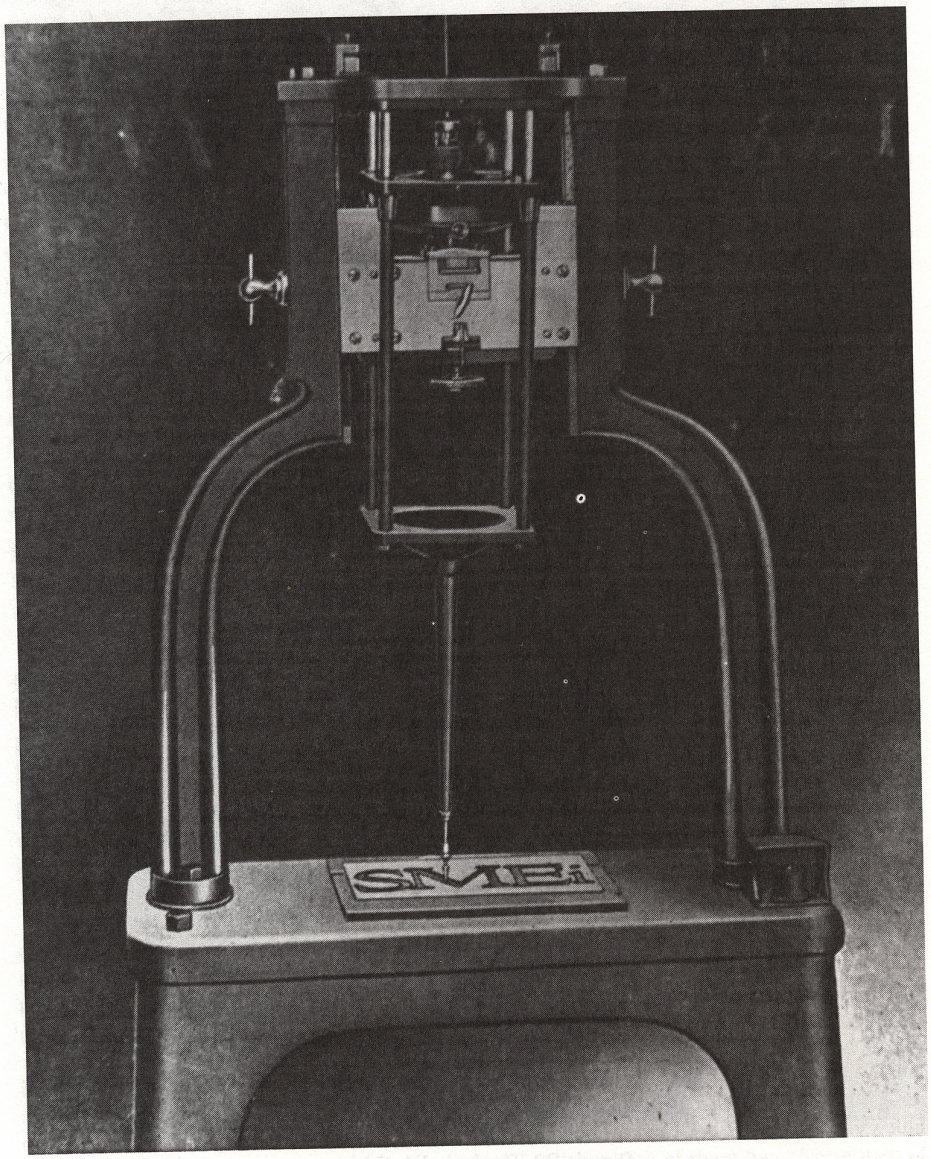


Figure 29. The Benton Engraving Machine.

Chapter 10

The Benton Engraving Machine

Historical Introduction

The following two chapters detail the history, protocol, and other working procedures for the Benton device. I am indebted to William Charles Gregan, last ATF master engraver, for sharing this phase of the craft with me, and passing on the standards and values of the Benton heritage.

The products of the old firm of Benton, Waldo & Co. (B&W) have often been described (quoting Benton himself) as something less than successful. In reality, the two men simply concluded that they could not compete with Barth's casters. I have examined B&W pivotal-cast type, matrices, and patterns, and have found them to be entirely well-engineered, delicate, and most accurate of finish (Benton was by nature a modest man). When the opportunity came, Benton allied himself with the new company; by selling himself to ATF, he found a place to fulfill the potential of his engineering concepts. The agreement struck with ATF included the following conditions: *(a)* to employ Benton's son Morris, who had graduated with an engineering degree, as head of Type Design; *(b)* to find a job for Waldo (he was made manager of the New York office); and *(c)* to recover all B&W devices leased to competitor firms, mainly Linotype and Monotype. All of these conditions were eventually accomplished.

Benton developed his engraving machine in the 1880s, the same period during which Barth perfected his automatic casting machine. Such was the perfection and engineering forethought embodied in the Benton engraver that the device has come down to us with little change or need for improvement. Originally conceived for the mechanical cutting of characters onto precast quads of type

metal (just as a letter cutter would do by hand but with greater uniformity and precision) for use as models to be electrotyped, the Benton engraver was later used to cut punches on steel for driving into matrix planchets. At this stage, a variant device was developed for the production of punches for both the Monotype cellular driven matrices and the brass Linotype matrices of Mergenthaler.



Figure 30. "Benton, Waldo & Co."—a page from a Milwaukee City Directory.

The accuracy of the Benton engraver is suggested by the following story: in the early 1900s Mergenthaler Linotype and the Lanston Monotype people promoted an example of the accuracy and superiority of their engraving machines by engraving the Lord's Prayer in a 12-point matrix. At ATF, a livid and raging Henry Bullen tried to persuade the elder Benton to retaliate. Benton silenced him, pointing out that the photograph showing that particular type appeared to be retouched. He also added that many years earlier a Lord's Prayer type had been done on an 8-point body in the ATF matrix department.[37] The final word on this came when Benton revealed that he had cut the Lord's Prayer in *script* on a 24-point body. (He had also cut it on a 4-point quad,[38] but a nickel electro failed to

[37] ATF still uses one of these original matrices for publicity castings.

[38] These are now in the author's collection.

reproduce the minute characters to Benton's satisfaction, so he always said 8-point was the smallest successful cutting done directly into the matrix.)[39]

When Robert Nelson's gamble began to pay off, Benton at first began to cut many new designs for the Type Design Department and certain of the ATF branches, notably Phinney's old Boston foundry. Access to these new designs was part of the condition of being allied with ATF foundries for those firms that were reluctant to participate.[40] Soon after the last of the most important holdouts were safely aboard, Benton began to cut fewer electro models and punches, and he concentrated instead on retooling his devices for the direct cutting of designs into blank matrix planchets. Figure 31 shows an entry from a now-lost B&W Day book which indicates the formidable (for the times) amount of revenue generated by Benton's punch-cutting devices. The higher figures seem to be lease agreements (pre-1892); the lower figures, sales of earlier machines. At this point the machines are still chronologically numbered. Other records show that nearly three dozen were produced and eventually sold and/or leased. Those machines that still exist are numbered in the forties upward but are not chronological, and all of them date prior to 1912. No machines were produced after 1924, although small refittings and upgrading continued on into the late 1930s.

In the early 1920s, Benton, with two assistants, undertook to supply the Japanese government (or a government contractor) two engraving machines, with all the attendant devices. It took nearly a year at sea to accomplish the delivery. An incomplete journal of this adventure was documented by Benton's foreman, John Bauer (this journal is now in the author's possession). The wry comments and observations recorded belong to the quaint and mildly intolerant prejudices of the era. It would be interesting to discover if these machines still exist.

Benton also built and enhanced a small number of pantograph engraving machines, fitting them with his quill and cutting tool assemblies, which enabled them to produce engravings with the same precision as the other machines. All have been scrapped save one, the "Ad-cut" machine,[41] which produces the largest matrices used in the Hand and Steam Casting Department. The cutting

[39] Author's interview with Mrs. Carolyn Benton Gregg of Racine, Wisconsin in August 1987.

[40] Some firms never did join up, and had to be absorbed through financial coercion. In producing these new faces, Benton was in direct competition with the hand punch-cutter John Cummings who did the Satanick and certain other series. Phinney used Cummings for cutting lost or incomplete suites of matrices, especially those of great historic nature such as Oxford, Caslon, etc.

[41] Completely re-engineered by Benton in 1918-19.

slips for this device contain settings of arm positions and decimal measurements of length and throw, rather than pica and point measurements. A Benton punch-cutter was employed up until the late 1950s to produce brass logos for certain New York City newspapers[42] but it failed to survive the 1960 purge.

The patterns originally used by the Benton engraver for cutting punches or type characters on blank type bodies had to be raised (i.e. in relief). Later, the raised offset patterns were discarded for right-reading incised ones, first cut by tracing the design on a flat square of lead and firmed up by hand engraving. The Benton Delineator was used for this purpose (no trace of this device has survived); it used a traced working drawing with a 25:1 ratio. After each use the thickness of the lead plates was reduced by shaving away the old surface, and a new one was prepared. When the plate was too thin to use further, it was discarded.

A pointed stylus follower would trace the incised lines of the pattern to the cutting tool, transferring the design to the matrix blank. Next a flat-surfaced follower would pass over the entire design surface between the incised lines to fill in and complete the cutting. Since there were no perimeter "fences" to prevent going beyond the incised lines, this early technique required considerable skill: one slip past the outline of the design and the tool was broken and the matrix most likely ruined. Later, zinc plates were incised and used, replacing the lead ones. The zinc plates could be kept for later recuttings of the design and could be stored more easily than the lead plates. If duplicate matrices could not be grown, a replacement cutting could provide a virtual duplicate (reproduction tolerances of specific designs were and still are .0002″). By 1905, patterns of electroengraved copper backed with lead were developed with a raised perimeter of the design, which could be followed.

Beginning in 1901, Benton embarked upon the formulation of his Engraving Factor Tables, a work of great skill and a most notable achievement. With the use of this data, every character cut, either in a new family or as an addition to an old and established face, will mesh within the design range, and obvious concessions to manufacturing problems are negated. To ensure uniformity and continuity, individual cutting slips for each design and specific size are recorded and referred to when reproducing a character. Properly trained, a day worker can produce as fine and accurate an engraving as Benton himself.

Special patterns within a suite are provided for use in cutting certain sizes of bodies requiring a truncation of descenders—and, rarely, ascenders—enabling them to fit within the vertical confines of each size (6-, 8-, and 10-point, and certain larger sizes may need them). Horizontal expansion and condensation are

[42] For example the "five-cent" cuts on the *Daily News*. I have a sample of one of these brass logos in my collection.

Feb. 13, 1889.

1- Benton Punch Engraving Machine No. 3 $4500.00

Mergenthaler Printing Co., Brooklyn, N. Y.

May 1, 1889.

1- Punch Engraving Machine No. 4, Rental Price 4900.00

Minneapolis Electro Matrix Co.,
Minneapolis, Minn.

June 28, 1889.

Minneapolis Electro Matrix Co.,
Minneapolis, Minn.

1- Punch Engraving Machine No. 6 2000.00

Sent to Ames Manufacturing Co., Chicopee, Mass.

Feb. 15, 1890.

Linotype Company, Ltd.,
Manchester, England.

1- Punch Engraving Machine No. 8 5000.00
1- " " " No. 9 3500.00

May 19, 1890.
Rogers Typographic Co.,
Cleveland, Ohio.

1- Benton Engraving Machine No. 10 5000.00

Figure 31. An entry in the Benton, Waldo & Co. Day Book (pre-1892).

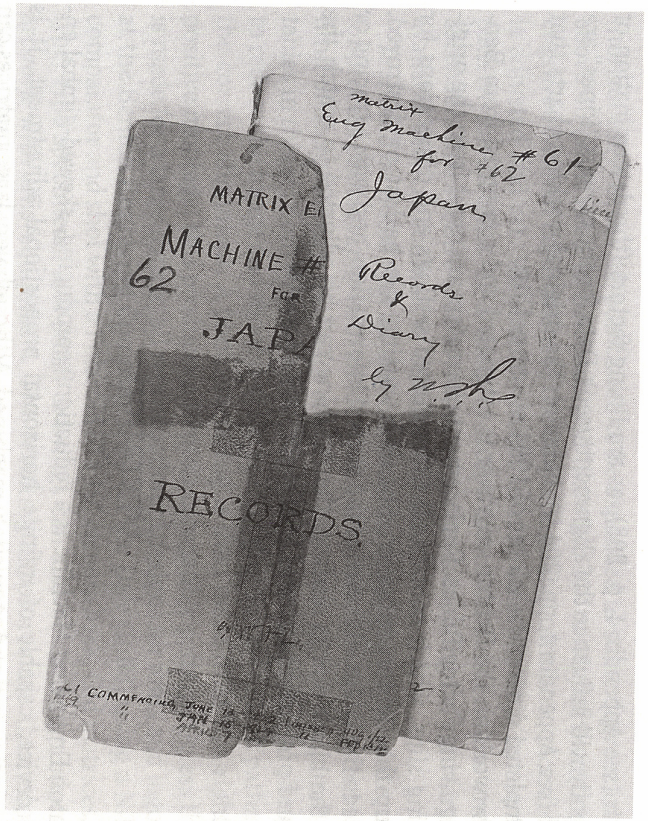


Figure 32. Diary of machine nos. 61 & 62 for Japan.

dealt with (see Appendix 4, p. 208), as are lining factors (the determination of size-on-body will influence the alignment used). Data for the various "Lines" are included (see Appendix 4, pp. 204-7), based on the original working charts that were completed during the winter of 1904 at Jersey City.

All new work on the Benton engraver is estimated and computed from Benton's Engraving Factor Tables. Replacement characters are recut from the original cutting slips, which contain all the required settings and dimensions for setting up the Benton engraver. Should a cutting slip be lost or destroyed, reference to the tables will provide the needed information, and with a tracing or two on the blank matrix surface, the machine can be adjusted to match the weight and proportions needed for the missing character.

Operation

The Benton Engraving Machine is a reduction-reproducing, skewed-gimbal engraving device, capable of infinite horizontal proportional adjustment. It is superbly engineered and exquisitely machined. Although very large matrices can be cut on most machines, the height extreme capability is determined by the limit of swing of the gimbal assembly on any given one, and most work over a 48-point body size is done on the largest-size machines. The biggest matrices for the Hand and Steam Department are done on the last surviving "Ad-cut" pantograph.

The matrix blank to be cut is fixed in a jig that is removable for inspection during the cutting operations and that can be returned to the machine with no compromise of accuracy of position: the "work" moves up and down, not the cutting tool, which is fixed in position in the cutting head assembly. Traced from the pattern, the design is transferred to the cutter via the gimbal assembly, which the operator adjusts with great precision according to the factors in the Engraving Tables. Computations are indicated for specific dimensions by the use of a fixed factor or norm, determined by Benton to be approximately 40-point. He had explained that this was the dimensional point of reference at which the human eye "fell away at recognition (below) or intensified at a point (above) it." Benton's device continues to compound until the extreme limit of the swing of its gimbals is reached. The 40-point dimension is coincidentally also the mid-range, more or less, of most common body sizes of type. All dimension sizes

(horizontally) below 40-point need to be expanded to some degree; and all sizes above 40-point need to be condensed likewise; 36- to 44-point cuttings can be engraved without adjustment to the 40-point gimbal constant, once the leverage is adjusted and set. We should, except in rare cases, be able to use the same pattern for all sizes of a design, except for certain descenders and (rarely) ascenders that require special truncated patterns enabling them to fit within the available vertical confines of certain body sizes.

It should be noted that all artwork must be crisp, black-and-white, and ready for process photography with an ideal ratio of no less than 4:1 (a ratio of 2:1 is the limit of acceptability). Ratios for specific proportions can be computed from the tables in this section. Process photography requires a commercial photographer to reduce the image and shoot it at the correct position on a blank pattern card of the correct alignment. A photoengraving is then made from this right-reading positive montage: this produces a Benton-compatible pattern. Unless the design is made for a large matrix, all reproduction of designs for fonts and logos is done at the Benton Engraving Company shop (at the Dale Guild) using a Nikon V-12 comparator and shot with a Polaroid 8″ x 10″ camera back. Old matrices, original type, type specimens, and small drawings can also be used to produce pattern artwork with this equipment. The resulting exposures are then copied on a Canon NP-120 copier and retouched if necessary before being sent away for process photography.

Ordinarily, if a cutting slip exists for a character, the device is simply set to the notated adjustments and a tracing is made and proved before cutting the replacement. For new work, the factors which will determine the line dimensions and interpretation of the working drawing to be made into pattern artwork are *(a)* printing area of character, *(b)* body size, and *(c)* location of printing area within body size. The Benton Engraving Machine can efficiently use the following kinds of patterns without serious compromise: *(a)* engraved brass (Gorton Machine), *(b)* photoengraved copper "process blocks" (obsolete), *(c)* hand-engraved (cut into lead or zinc plates; obsolete), *(d)* photoengraved zinc (right-reading positive film), and *(e)* laminated (card stock, metal, or plastic). These are all incised patterns or variants thereof; they create a positive reading character. Incised patterns require only a follower depth of .007″-.010 ″. Deeper graving or etching creates distortion of the design and is more difficult to clean up with the hand graver. Relief (raised) patterns are used for punch-cutting and for cutting characters directly onto a piece of blank type, the follower cutting away all the relief and leaving an offset negative (wrong-reading) character.

The vertical dimension (height) is determined by the amount of adjustment in

the Leverage Gauge located in the upper lefthand leg of the device. Hardened steel constants, first in pica measure, then in smaller increments of thousandths of an inch, are inserted into the ways of the gauge and act as a stop to the vertical movement of the gimbal assembly. Fine adjustments are made by tracing and measurement (or a test pattern of perimeter extremes is made of the necessary proportions). Two set-screws on each leg secure or release the adjustment made as needed.

Formula 1: L = .010″ (± 1 point [.0138″])[43]

One point in leverage dimension change will alter the height of the cutting by .010″. Thus, to increase the height dimension, *reduce* the leverage dimension. To reduce the height dimension, *increase* the leverage dimension. Leverage is always set *first*.

The horizontal dimension (width), as well as the "weight" of the character's internal proportion,[44] are determined by adjustment of the gimbal bearing stop-screws located at the top of the machine. Proportional changes are adjusted by altering the amount of constant ("stops") under the set-screws. It is important that what is changed on one side of the gimbal assembly must also be changed on the opposite side, otherwise serious distortion of the cutting will result.

To increase width, the 40-point constant stop is replaced by a 20-point stop and point-measure shims are built up to the needed minus-40-point dimension; this is referred to as an *expansion*: to reduce width, one *adds* point-measure shims to the 40-point constant stop to the needed plus-40-point dimension; this is referred to as a *condensation*. The 36- to 40-point sizes are cut at the "normal" 40-point stop. Smaller sizes (below 40-point) are *expanded;* larger sizes (over 40-point) are *condensed.* However, corrections, if seriously out of proportion, are not correctable, as the amount of scope of dimensional change is slight. If such a condition exists, the pattern must be done over, making adjustments to work with the correct proportions.

$$\text{Formula 2: } W = 40p \frac{(-) = \text{expansion}}{(+) = \text{condensation}}$$

To compute leverage for Common line constants, the following formula will bring the setup of the engraver to within a .004″-.005″ tolerance, and can be

[43] Shims below .0138″ are used for fine adjustment: tolerance .0002″ or less.
[44] Weight of character proportions are influenced by the width factors.

"tuned up" before cutting. Trace and measure (.0002"-.0003" tolerance optimum). When using other lining constants the dimensions produced will be somewhat greater but still workable. All new work is now relegated to St. Louis or B-depth factors using the Common line. The leverage factor is always twelve, as Benton designed and calibrated his machine using the universal pica/point measure.

$$\text{Formula 3: } L = \frac{12 \times HM}{HP}$$

The factor (12) is multiplied by the height of the matrix (HM), divided by the height of the pattern (HP).

The following formulas are needed to determine matrix blank dimensions prior to cutting. For old work, one simply measures the defective matrix and adds extra tolerances for fitting. For new work Benton devised a table for common line constants. He called this the "Key" for figuring matrix blank widths, and it is as follows:

6-point = 56.535	24-point = 14.665
8-point = 46.262	30-point = 11.954
10-point = 33.996	36-point = 9.708
12-point = 29.991	42-point = 8.176
14-point = 24.306	48-point = 7.061
16-point = 21.843	60-point = 5.546
18-point = 18.964	72-point = 4.568

Divide the width of the pattern character (WP) by the point size Key (K). The result equals width of character (WC):

$$\text{Formula 4: } WC = \frac{WP}{K \text{ (by point size)}}$$

Next add width of both side bearings plus a fitting allowance of at least 4 points (2 points each side). The result equals blank matrix width. For example, if the width of pattern Cap H equals 2.800" 36 point, take the Key factor for 36-point (9.708) and divide it into 2.800" which equals .288". Since we know that the 36-point Common line side bearing is 14 points x 2 (or 28 points) for the B-3 Depth standard,

we now add the .288″ + 28 points (SB) + @4 points fitting allowance equals .744″. This is the width of the matrix blank for this character.

The following formula shows how to find the height of a matrix:

$$\text{Formula 5: HM} = \frac{\text{WM} \times \text{HP}}{\text{WP}}$$

The height of a matrix (HM) equals the width of a matrix (WM) times the height of the pattern (HP) divided by the width of the pattern (WP).

$$\frac{\text{WP}}{\text{WM}} = \text{RATIO}$$

$$\text{For new work: } \frac{\text{HP}}{\text{R}} = \text{HM}$$

The width of a matrix (WM) equals the height of a matrix (HM) times the width of the pattern (WP) divided by the height of the pattern (HP):

$$\text{Formula 6: WM} = \frac{\text{HM} \times \text{WP}}{\text{HP}} \text{ for new work}$$

Benton standardized all possible variations in his factoring tables. These factors were ascertained using the following procedures: *(a)* the height of the character of the body size required, divided by the finished character height equals *factor;* and *(b)* the factor multiplied by the set-width of the character on the finished size plus the side bearing dimensions and an allowance for fitting. The Height of Character Chart was intended as a point of reference to check against tracing dimensions. Pattern ratios are given for each alignment standard, the dimensions of height taken randomly from known characters.

These ratios were extracted from what remained of Benton's notes. A typical entry in his hand can be seen in figure 33. The notation deals with the high speed steel "wires" used in the cutting tool, or "quill," of the Benton Engraving Machine. The chuck sizes were selected proportionately with the size of the work being cut and its ultimate depth. The chuck of the quill held an interchangeable collet of a specific size to hold each wire diameter as needed.

Benton's notes represent a formidable amount of experiment and calculation, especially in an era without computers. Many of the original compilations have

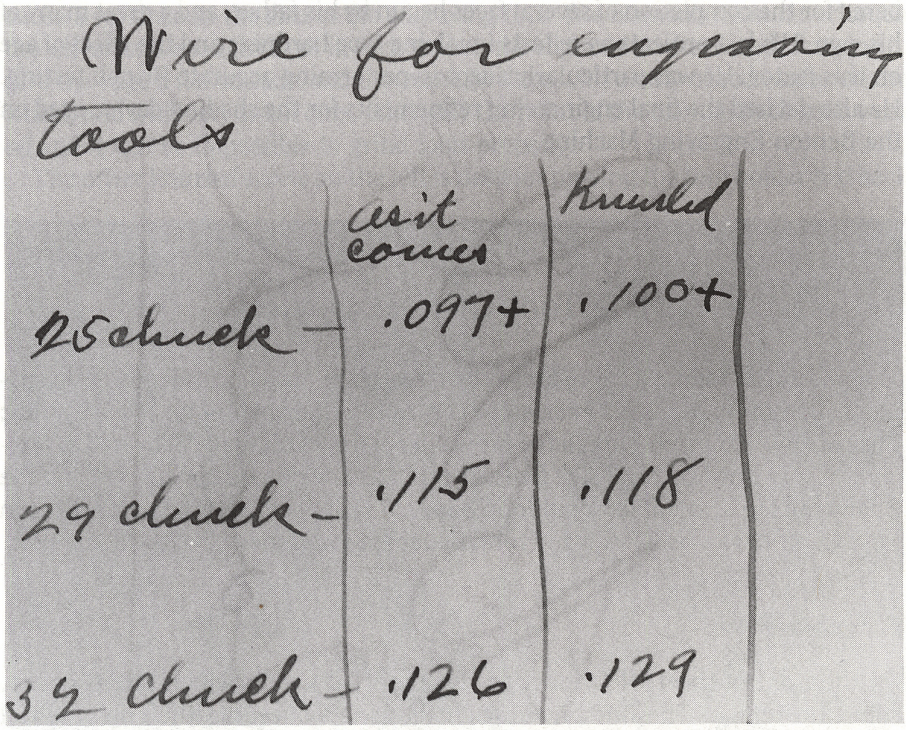


Figure 33. A typical note in Linn Boyd Benton's hand.

been lost. I have used what was left at ATF/Elizabeth, the collections at Columbia University, and the holdings of the Smithsonian Institution in Washington, D.C., and Suitland, Maryland. Much material was lost in the move from Jersey City, and the contents of Benton's "room" (curiously never referred to as an office proper, perhaps because, like Edison, Benton would sometimes sleep overnight in it) were not intelligently cared for. What remains is, however, impressive for its usefulness and accuracy. Just how such marvelous devices could spring so effortlessly from, and be developed by, a man without formal engineering training is intriguing. Benton kept most of his discoveries and information secret; and he trained no successors, although there were several apprentices and his son was certainly well versed in his theories.

Morris Fuller Benton was a reticent man whose outward manner seemed stern. He was in fact shy and modest when among peers. He is chiefly remem-

bered for the completion of several faces begun by his father, and a great many of his own. His last projects were tests involving type hardness and the effect of age on this factor. He was particularly adept in performing accurate Brinell testing. He also devised the final engineering refinements for the shading device used on the Benton Engraving Machine.

The Tool Grinder Device

The notes that follow were recorded by a secretary on loan to Benton's department. Benton had been persuaded to contribute information for a work study; this paper was the only completed project from him. Originally delivered *extempore,* it was typed on legal size foolscap and was later revised by his son and the Engraving Department foreman John Bauer. It is undated, but the names of Linn Boyd Benton, Morris Benton and John Bauer appear at the end of the document.

PART ONE

On the front of the Tool Grinder are two knurled knobs, which are in reality, adjusting screws. The one on the right is used for feeding the emery wheel toward the diamond, located under the brass shield. As the emery wears, it is brought forward to a position that will cause the emery wheel to *lightly* touch the diamond in passing and thereby automatically take up the wear on the emery wheel. This adjustment must be made while the emery wheel is revolving at full speed and the wheel must touch the diamond as lightly as possible in passing. The wheel is moved past the diamond by taking hold of the handle on the shaft-end and moving same back and forth with the right hand, whilst the left hand holds a brass tube with its inserted piece of sponge charged with soda water against the emery wheel.[45] The operator must learn to distinguish by sound and feel how the wheel is touching and endeavor to have the contact always the same. Any difference in this contact will

[45] Soda, or limewater, was thought to prevent rusting, and is responsible for the beautiful berry-brown patina on some of these devices. Varsol or refined mineral spirits of various grades are now used effectively as a cutting fluid. The Guild mounted its device on a piece of steel apron from a scrapped Barth caster, and fixed a titration pipette with a felt wick permanently touching the emery wheel (see figure 35).

cause a variance in the size of the engraving tool. The diamond must never touch the wheel hard enough to cut it, except when the edge of the wheel needs dressing to give the edge a flat surface; and this must be done with plenty of soda water on the wheel, and with very small cuts, otherwise the point of the diamond will soon wear off and it will be impossible to grind tools properly.

The other knurled screw on the left is used for moving the tool holder bed back

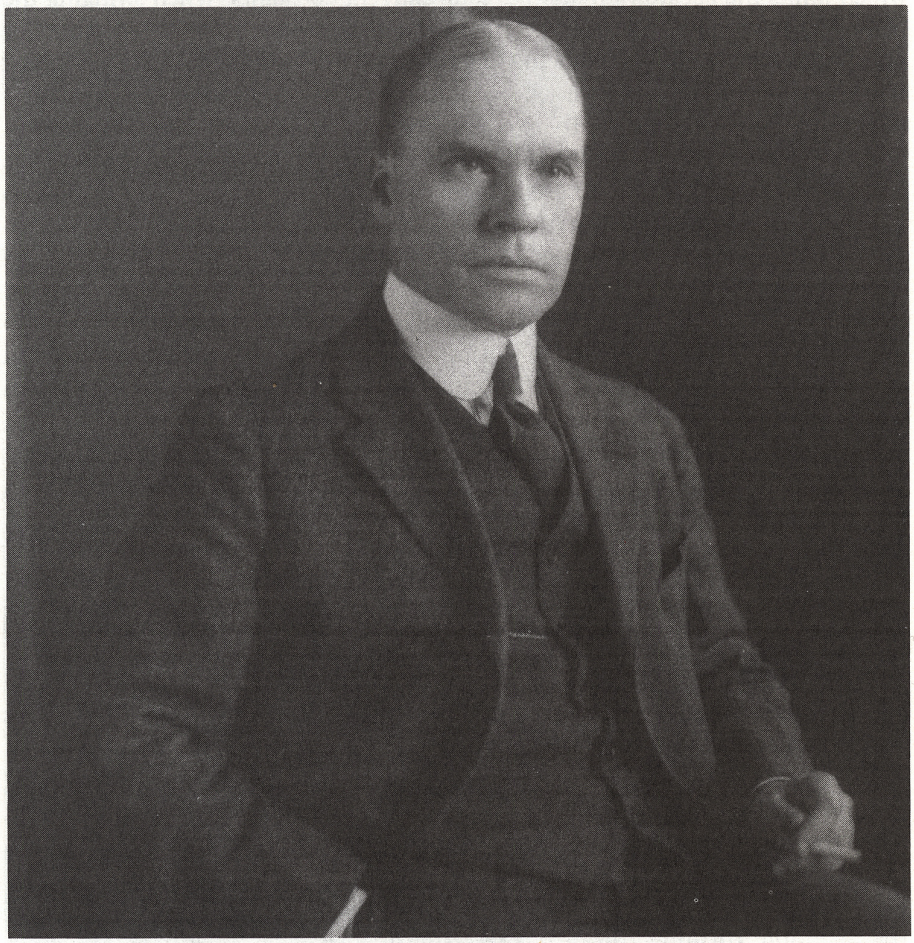


Figure 34. Morris Fuller Benton, *c.* 1900.

and forth. A stop under the back end of the bed arrests its backward position and is never changed once set. The forward motion is determined by small stops (called tool-stops) used for grinding the different sizes of the tool dimensions stamped on them. The tool holder bed is mounted on a swinging platform, and the travel of this platform is also determined by stops in both directions—the forward motion by one stop only, and the backward motion by a rotary stop having four bearing surfaces, which limits the backward motion to four different constants. When swinging the platform back against the surface of the rotary stop marked "F," it is in position for grinding the angle sides of the facing tool No. 3 and the finishing tool No. 5. When it is against the tool stop side marked "R," it is in position for grinding the angle sides of the No. 1 roughing tool, the No. 2 rough facing tool, and the No. 4 rough finishing tool. When against the stop marked "B," it is in position for grinding the angles forming the end of the beveling tool. When against the side marked "S," it is in position for setting the diamond.

The tool holder bed is provided in front with a rectangular slot into which are locked the different tool stops for making tools of different sizes. The smallest tool which can be made is .001″ and the largest, .030″. There is another stop marked ".039S," which is used in setting the diamond. The bed is also provided with a locking lever to the side, which is tightened after a tool stop has been inserted and fastened in place.

In order that the temper of the tools may not be destroyed, it is necessary that the wet sponge within the brass tube be held against the edge of the emery wheel immediately before grinding takes place, and in the case of forming a new tool on a blank piece of wire, where the grinding is excessive, the sponge should be held almost constantly against the wheel, until most of the excess stock is ground off. Using the water frequently, a little at a time also keeps the emery dust from getting into the ways and bearings of the machine.

When the grinding device has not been forced to do over-heavy work, in facing off the emery wheel, or has not been shoved roughly into the diamond, the point of the diamond will hold its position for several months (in constant use) before it is necessary to adjust it. The necessity for this is indicated by the tools all being ground smaller than the sizes indicated on their respective tool stops. Later on, when the emery wheel does not cut freely, and glazes over when dressed, it shows that the point of the diamond has become worn and it is necessary to take the diamond shaft out and reset the diamond in its bezel. This is done by removing the diamond, turning it over and resetting it in its cavity, with a fresh point projecting. The diamond must be bezelled tightly. The life of the diamond is about six years in constant use.

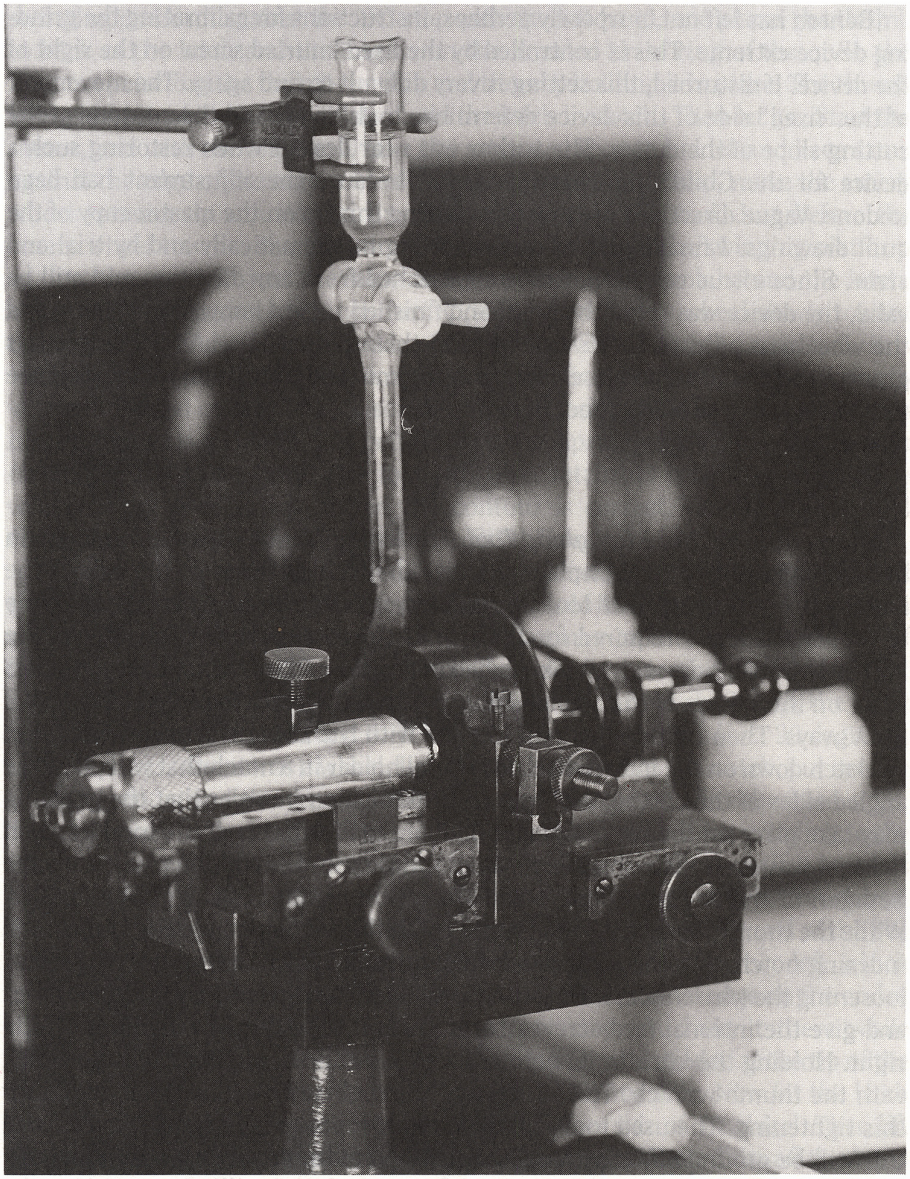


Figure 35. A restored tool grinding device (Benton Engraving Company).

[Benton has left out, purposely perhaps, instructions for calibrating the grinding device extreme. This is controlled by the fixed knurled screw on the right of the device. If disturbed, this setting is very difficult to find again. The movement of the "fixed" side of this device determines tool length and the contour of the cutting slope of the cutter. The author was near despair when restoring such a device for the Guild's matrix department, because the adjustment had been undone. Vague directions are given for setting this up on the master copy of the quill drawings. I finally arrived at the setting mathematically and by trial and error. Since a true equation can be approached from any direction and still be valid, the device was set with a quill and finished tool of known proportion and the wheel was adjusted in its axis to meet these dimensions. A trial cutter was ground and found to be close enough to permit a minute adjustment, and the next tool produced was perfect.]

PART TWO

Sharpening the No. 1 Roughing Tool. The tool holder bed must always remain locked while grinding takes place. Release the locking lever on the side of the bed. Move bed forward until tool stop will enter its slot freely. Insert the tool stop of proper thickness required for the size of the tool needed; then tighten the knurled screw head snugly. Lock the bed in position. Place the quill (tool holder) No. 1 on the V-ways of the bed, pushing it endwise against the stop at the end of the V-ways. Then tighten the quill in place with the knurled screw above it. Let the latch down on the index wheel of the tool holder in a notch that will place the angled sides of the cutting tool in a vertical position in order that the grinding may take place on the same surfaces (one of the four facets of the tool) as when the tool was previously sharpened. Take the thumb-wrench and place it on the hexagon of the draw-in-spindle, and loosen the wire chuck (collet) a "trifle." While the thumb-wrench is being turned with the left hand, hold the latch in the indexing notch with the right hand: this prevents the shaft from turning. After loosening the wire chuck, hold thumb-wrench while inserting a thin screwdriver and give the internal feed-screw a turn of about a tenth of a revolution to the right. Holding the latch in its notch, the wire should be tightened in the chuck with the thumb-wrench. Test to see that the tool turns freely in the quill after this tightening. The used tool should now project out at least .003" farther and this will be ground off by each subsequent operation on all four sides (facets).

Turn the rotary stop so that the side marked "R" will come against the swinging platform when the latter is pushed back to it. Pushing back the

swinging platform against the "R" stop with the left hand, one places the thumb in back of the latch and the fingers on the knurled brass ring of the quill, the fingers encircling the thumb-wrench and thereby holding it in place. The thumb being in back of the latch will also hold the latch in notch. Then let go. Start the motor, and with the left hand, take the saturated sponge holder and keep same against the edge of the emery wheel, while with the right hand, move the emery wheel (previously adjusted to the diamond) toward the tool. Just before the emery wheel touches the tool, drop the sponge and hold the swinging platform against the stop "R" just the same as before, with the thumb behind the latch, etc. While holding back against the "R" stop, move emery wheel slowly toward the tool and grind off the first side of the tool. [When shaping a new tool, it is virtually impossible to cut the facets in one operation. Back off the table screw to where the wheel can cut off a reasonable amount, and gradually increase the cuts until the taper is achieved. It is better to cut the tapers gradually on all four sides (facets) at the same time. The tool will then retain its integrity, and not be weakened by overheating. When the contour is correct, the unfinished tool resembles the silhouette of a miniature Eiffel Tower.]

As soon as it is ground, put soda water on the edge of the emery wheel and slowly swing the platform: at the same time, hold the emery wheel in such a position, near the end of the tool, as to grind a curve on the end of it (the top of the "tower"). Continue the forward movement of the swinging platform until it is arrested by the end stop. Now release the emery wheel shaft with the right hand and release the catch and turn the tool over two notches [i.e., 90 degrees], using the brass wrench as a wheel. Let the catch down into the notch, put sponge to wheel, and grind the second side of the tool. Repeat on the other two sides. Test the emery tool with the diamond. If it cannot be heard or felt grinding to the touch, move emery wheel very carefully toward the diamond until it touches properly, and grind over the four sides of the tool the same as before. Unlock bed. Take out tool stop and screw bed back against the back stop on the end of the bed and relock it. Next place latch in the alternate notches (there are two left, which are unused at the 90-degree angle) to locate and cut the chisel edge on the end of the tool. Move the platform against the front stop and hold it there while grinding off one side of the chisel. (The chisel is the cutting edge at the tip of the tool.) Put soda water on the emery wheel and grind one side. Now let the latch down, apply the sponge again, and grind off the other side of the chisel. Then lift the latch far enough to stay back out of the way for clearance. Take off the brass wrench, loosen holding screw on top of the tool holder, and carefully remove the quill from the device. The tool is now ready to measure under the microscope.

Sharpening the No. 2 Rough Facing and the No. 4 Rough Finishing Tools. These tools are ground in the precise same manner as the No. 1 Roughing Tool. The only change being made is the size of the tool stops used and inserted into the rectangular slot in the bed of the tool grinding device.

Sharpening the No. 3 Facing and the No. 5 Finishing Tools. These tools are ground in precisely the same manner as the No. 2 Rough Facing Tool and the No. 4 Rough Finishing Tool, except that the swinging platform is swung back against the side of the rotary stop marked "F." [When resharpening a cutter, if the tool has not been loosened too much, it will not turn in its collet and very little grinding will be necessary, providing of course that you are sharpening the same-size tool. If the tool is to be sharpened to a smaller dimension, this will work also. If, however, the tool to be sharpened is larger, *or* if it is loose and has moved, bringing its facets out of alignment, then a major regrinding is necessary.]

Sharpening the No. 6 Beveling Tool. Place the .001″ tool stop (marked .0630″) in position and tighten. Lock bed. Move swinging platform back against the side marked "F" of rotary stop and hold it in position while grinding off all four sides. Unlock bed. Remove tool stop. Screw bed back against back stop. Lock bed and move swinging platform back to side marked "B" of the rotary stop and hold that position while grinding all four surfaces of the cutting faces. The latch should enter the same notches when grinding these faces as when grinding the sides. After grinding, remove quill and without taking the tool out of the holder, stone the two angles forming the point with a whetstone, by hand, giving the cutting edges a little clearance. This tool will last for several months without regrinding, if used in brass matrices. Use the .003″ stop (marked .0638″) for making a beveling tool for 36-point and larger matrices.

Our custom in grinding tools is to sharpen all five tools in starting, and after cutting four matrices, sharpen the No. 3 Facing and the No. 5 Finishing Tools; cut four more matrices and then resharpen all five tools.

PART THREE

Quills. When the quills are not in the machine they should be kept in the box provided for them, where they will be protected from injury.

The tool holder or quill consists of a hardened chrome-steel shell, inside of which is a spindle running on two races (top and bottom) of ball bearings. Inside the spindle is a hexagon-headed piece that we call the draw-in spindle. This piece has a threaded hole in its center containing a screw for feeding forward the wire from which tools are formed by grinding, and a threaded hole on the end to

tighten the wire chuck (collet). On the spindle is an adjustable bearing which is moved by a nut. This nut is held in place by a set-screw. To adjust the ball bearings, remove the knurled brass ring cover. Place quill in grinding device and fasten in place. The tool may then have its slack taken up. Never adjust these bearings without first tightening a tool wire in the chuck. Turn the spindle until the set-screw is accessible and drop latch into notch. Loosen set-screw a "trifle," then give spindle a half turn and drop latch in notch. Hold latch in place and carefully turn nut with pin wrench. Now tighten set-screw in the nut and try spindle: it should turn freely. This is a very delicate adjustment and the greatest care and judgment should be exercised in making it. If the adjustment is made without the tool being first tightened in place, the spindle will be too tight to run freely, as the tightening of the tool makes it still tighter. If the tools are always tightened first, and with the same force, no trouble will be experienced. It is absolutely necessary, after tightening the draw-in spindle, to turn the spindle over by hand to be sure it is turning freely.

In the center of the outside shell is a small screw: remove it and screw in its place the grease gun and force in Vaseline until it is noticed coming out from under the brass shield at the quill's end. Remove gun and replace the screw. Lubricate all tool holders every other day in constant use, at least once a week if not. The Vaseline or mineral grease must be absolutely pure and free from grit and dirt.

Stoning the Tool. Move the sliding wedge on the stoning device to the proper position as indicated on it (by tool size). Place quill on device, with the newly sharpened tool on the V-ways and push endwise against the wedge and tighten holder in position. Drop latch in a notch that will locate the chisel edge at the tool end in a vertical position. Take the square arkansas whetstone and carefully draw the edge of the stone a short distance once or twice across the cutting edge of the tool. The V-way to the right guides the travel of the stone. Use only the middle portions of the stone to maintain constant accuracy. When the edges of the stone are worn, sharpen the stone by lapping it on a lead lap with fine powdered emery, taking care to preserve the 90-degree corners. Our custom is to stone out ("relieve") the centers of all tools larger than .003″, as they cut much more freely and with less drag (and scrolling). At the same time it is not necessary to stone out any but the No.3 Facing Tools. As to the device, the sliding wedge referred to above is marked off in numbered lines. Moving the wedge from one line to another affects the position of the quill by .0005″ increments. The position of the wedge for each size tool is first obtained by experiment and then tabulated. [End of Document.]

The Guild's Technique

Although the Guild will sometimes use the five-tool regimen as described above, usually only a three-tool, and often only a two-tool, regimen can be used: namely, a large roughing tool (optional); a medium tool, and a finishing tool, which are all ground on the "F" stop. If the matrices are small and their number few, the elaborate protocol need not be adhered to. Benton's own discipline was necessary to help maintain uniform quality in a busy matrix engraving department (it cut as many as eight thousand matrices per year!).

ATF currently uses carbide steel cutters and modifications to the old system, devised by the late George Seaman. His innovations included *(a)* the use of a larger motor pulley (nearly twice the diameter, to increase RPM) for the grinding device *and* the engraving machine itself, *(b)* the use of a diamond-dust impregnated grinding wheel, *(c)* the use of mineral spirits for the cutting fluid, and *(d)* the elimination of notching of all tools over .003″. What is gained is a finer "matte" finish to the interior casting surfaces of the engraving. The increase in RPM pulverizes the waste matrix metal and leaves no trace of scrolling, something that only an accomplished engraver could overcome with his steel wire tools and slower RPM. This practice eliminates the need to notch the larger dimensioned tools. The obvious benefit is increased ease and speed of production as well as less tool grinding as the carbide wears much slower.

Unfortunately, the carbide cutters are brittle and break easily if struck into the perimeter of the cut. The waste and grit by-products of the diamond wheel and carbide dust will eventually wear and destroy the surface meets and constants of the grinding device's hardened surfaces. Flushing the device with quantities of mineral spirits only seems to delay the process. For this reason, the Guild has returned to the use of high-speed steel wire stock for its cutters. The advantage gained by the use of carbide cutters, which outlast the steel ones four to one, cannot compensate for the loss of an irreplaceable device.

Followers

All followers are turned from tool steel wire or drill rod. They range from the 1-point (pointed) follower, for tracing and following scribed patterns (and the smallest of the flat-bottomed followers, which measure from .015″), up to the

large .250″ disc followers, into which a ball-end shank fits neatly, centering its machined aperture. The shank of all followers is tapered to fit the collet at the end of the Benton Engraving Machine's wand. This wand is spring-loaded and pushes upward easily to change followers. A drift pin especially machined for the purpose locates in an aperture at the side of the follower collet, and will release a follower that has firmed up inside the taper. The wand will follow the perimeter and interior surfaces of the pattern with a steady and even pressure.

The tool-to-follower proportionate ratio is nearly always 1:10. The actual dimension produced is always less than this ("slightly," by Benton standards). These dimensional constants are to be checked against the first tracings of any new design. To change a follower because of tool compatibility (that is to say: you have a perfect .0055″ tool and the cutting slip directions call for one within .001″ or .002″ of this), the following formula will determine a follower change that will keep to the proportions necessary to cut the design safely:[47]

$$\text{Formula 7: } \frac{T}{F} = UR\ (1.5) \pm \text{(larger or smaller)}$$

For example, if the cutting slip calls for a .0055″ tool, with a .1160″ follower and you have a .0045″ tool to use; divide .1160″ (follower) by .0055″ (tool size). This equals 21″ which is then divided by 100 to give a measurement of .21″. Subtract .21″ from the original follower (.1160″) to give a new follower dimension of .95″. This displacement must remain the same regardless of tool size. The goal is to keep the cutter within the perimeter of the pattern design but still allow enough cutting for the finishing tool to clean up.

Patterns are held fast in the raised ways of the bed by tapered brass shims, which are tapped lightly between the pattern edge and the two raised bosses or fences of the engraving machine's table. If the pattern is to remain overnight or longer on the bed, a holding bracket, or *finger,* is applied with screws to fix the pattern in place (in addition to the tapered brass shims). This safeguard prevents possible extremes of temperature and humidity from loosening the pattern, and thus ruining the setup. It is quite impossible to relocate a loose pattern once a cutting has progressed.

[47] The only limitation is when the size of the follower increases to such a proportion that it will not negotiate the thinnest ways of the pattern design.

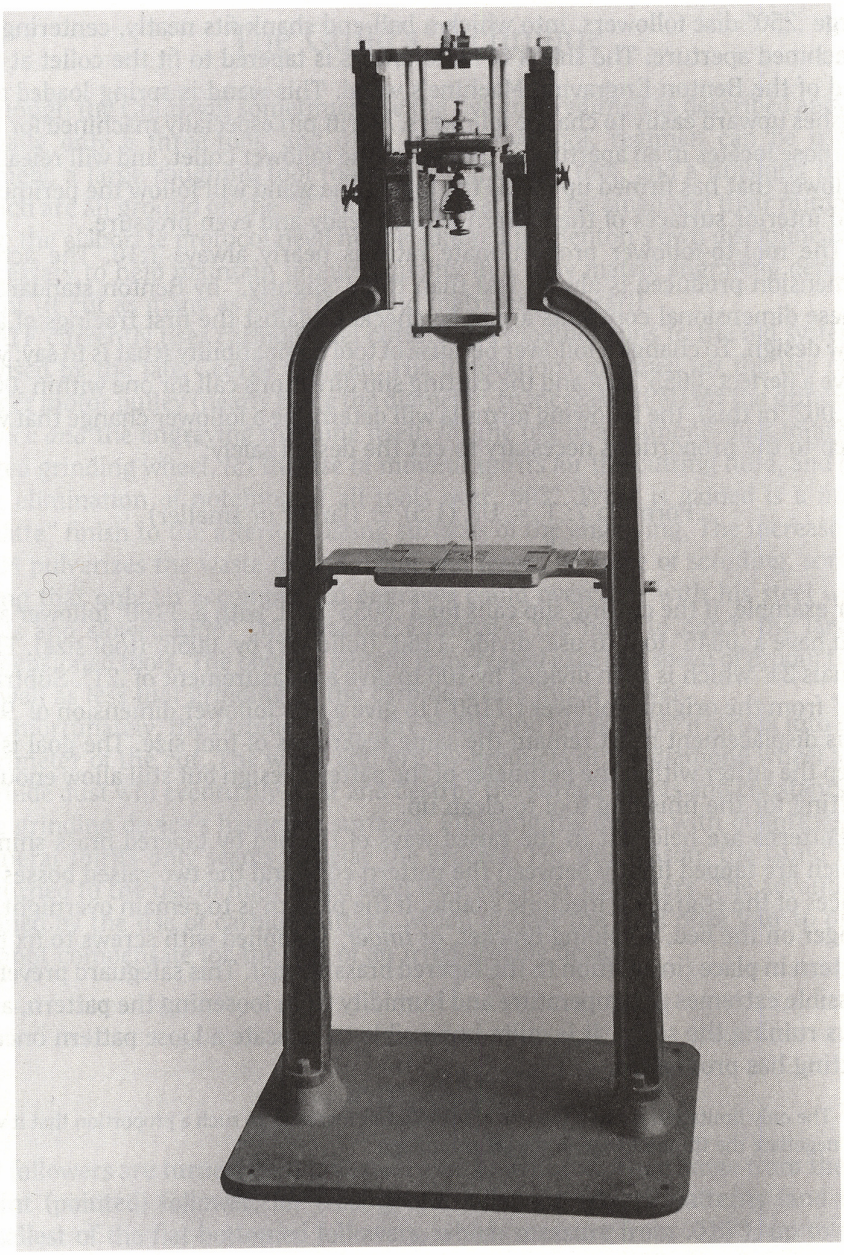


Figure 36. An original punch cutting device, *c.* 1884.

A Typical Cutting

You have obtained a defective matrix, a cutting slip, and a new matrix blank. In the case of new work, you consult the working drawing, matrix, and factoring tables, and prepare an appropriate matrix blank or blanks. You must now adjust the engraving machine to the settings set forth in the cutting slip. Most re-engraving is done from previously tabulated dimensions. New work entails working up the various adjustments by referring to the tables and, after proving by tracing, creating a new cutting slip for future reference. Adjust leverage first by loosening the right boss of the cutting assembly, located at the outside right of the engraving machine, and leaving it free. With your right hand holding the cutting assembly from movement downwards, loosen the left boss with your left hand and push the cutting assembly slightly upward to gain access to the leverage stops. To fix the cutting assembly temporarily, retighten the left boss. When the correct leverage stops for the new cutting are in place in the ways of the gauge, loosen the left boss again and allow the entire cutting assembly to travel down to meet firmly at the end of the leverage stops. Now tighten both holding bosses. It is most important to remember to keep your hand under the cutting assembly during this adjustment for safety, in case the leverage stops should fall out of the gauge. An unimpeded cutting assembly can fall the entire distance of the gimbal rods and jam tightly, causing possible damage to the device *and* the operator. Slight adjustments to the leverage may be necessary, after measuring the first tracings, especially for new work, according to the protocol of formula one (see p. 112).

You must now make the gimbal adjustments. The two cap screws atop the cutting assembly must comply with the dimensions required by the cutting slip. For new work, you must determine the correct expansion or condensation. Remember that the 40-point standard is used for a 36-point size design (there are very few exceptions to this rule). For cutting faces below the 36-point size, the 40-point stop is removed and the 20-point stop is substituted with any added shims necessary, up to a $39^{3}/_{4}$-point dimension. This will create the variable of *expansion.* For cutting characters in sizes above 36-point, simply *add* shims to the 40-point stop: this creates the variable of *condensation.* By consulting cutting slips, adjust for a new character if the pattern size is equal or at least similar to the old work. If you follow the old values, you will get at least an approximately accurate tracing that can be worked with. Ornaments and other "straight work" are usually cut with the normal stop (40 picas), sans expansion

or condensation.[48] Now scribe an alignment line across the new matrix blank, with allowance of extra dimension for the fitter to cut later. If you are recutting an old matrix, simply use it as the reference constant. Calculate new work from the tables and formulas. Remember that it is better to allow extra tolerance than to deposit copper in order to correct an insufficiency of stock.

Now secure the matrix blank to be cut in the holding jig. Tap a sliding wedge snugly, forcing the blank into the head stop of the jig. Before securing the blank, shim it from both sides to bring it to about the center of the channel of the jig. Hold the blank firm by two set-crews at the right side of this device. Now slide this assembly into the ways of the cutting head. Use the thumbscrew to lock the jig assembly in place. Directly under this assembly is located the depth wheel control, which has been calibrated by the operator. The wheel is marked with .001″-.0001″ increments. Again, make allowance for the fitter by adding .002″-.004″ for depth. Once determined, the depth wheel is backed away from its stop to clear the blank matrix and its holding jig.[49]

An easy way to calibrate and set the adjustable head stop is: *(a)* lock the finishing tool in place, *(b)* locate the extreme vertical perimeter of the secured pattern's character with the finishing follower in the wand, *(c)* gently run up the jig assembly (with the power *off!*) so that it just touches the surface of the matrix blank (a comparison with the scribed alignment line will indicate a correct setup; this adjustment will hold true for any remaining characters to be cut at these dimensions), and then *(d)* after proving your adjustments, remove the finishing follower and cutting tool, and resume the protocol. According to the values indicated on the cutting slip, locate and prepare cutting tools and followers. Securely fix the pattern on the bed of the machine. Ensure the cutting tools are all of the same length; variations are permissible, but must be adjusted for as the work progresses. The larger or roughing tools can be shorter than the finishing tool, but they should not be longer. If they are longer, an annoying regimen of depth-wheel adjustments must be adhered to; otherwise the engraving will be defective. Ideally, it is better to ensure that all tools are reasonably close to the same length, as provided for by the efficient use of the grinding device. All tools must be measured under the microscope.

[48] There are also matched pairs of stops, of proper dimension, for every common body size. These were meant to save time in setting up, but should always be checked by tracing and measurement. All new work should be tabulated and a new cutting slip created for future reference.

[49] When for any reason the jig is removed from the engraving machine, always be sure the depth wheel is completely turned down to clear the cutter: otherwise the quill's cutting tool will be broken off.

Put a drop of cutting oil on the cutting area of the blank matrix, and secure the jig in the cutting head. Now place the quill and fix it in the top of the machine. Fit the arbor with bosses that engage the ears of the quill. Apply a drop of oil on the shaft of the spindle of the power arm, and turn the motor on. Power is transmitted to the quill via the floating arbor much like an old-fashioned dentist's drill. If the quill has been lubricated with Vaseline, a plastic shield may be placed on the cutting assembly to deflect the spray of hot oil. After warming up the quill, proceed with the cutting protocol.

The required depth of an engraving cut *cannot* be made with one pass over the pattern. Rather, make three or four cuts (or more for deep drives) of increasing depth. For example, the depth required for an STL-2 (.0535″ finished) matrix depth is approximately .055″-.057″. We therefore divide this total dimension into three steps of @.015″-.020″ each, until the cutting tool bottoms at the depth stop we have calibrated and set. Frequent use of the depth gauge, especially when cutting the first matrix of a job, is recommended. If the amount of waste matrix metal builds up, remove the jig, clean the rough cutting, add more cutting oil, replace the jig, and resume cutting.

The counter is cut with the roughing tool. The estimate for height of counter for standard work is roughly determined by the finished depth of drive. Counter dimensions are usually indicated on the cutting slip. Height A is .017″; Stl-2 is @.027″; B-2 is .045″; etc. A piece of stiff clear plastic is positioned over the pattern and the roughing follower rides over this. Using stiff plastic contour forms as fences, work over (i.e., cut) the entire extreme or perimeter, taking care to remain *inside* the extremes of the character. Remove all areas cut above and within the counter areas. The height of the counter is determined by inserting a brass stop of the proper thickness between the depth wheel and its upward stop. Again, if the amount of metal to be cut is great, as with deeper drives, take the cuts in steps, as above, not all at once. An overburdened cutting tool will break easily.

If called for, secure medium cutting tools in the cutting head. Be sure to change followers if necessary; continue cutting. Check depth with depth gauge. The wrong follower with the wrong cutter will either cut an insufficient amount (in finishing) or ruin the engraving (with the roughing tool) by overcutting. By easing the cutting burden (by cutting in successive stages), the cutting tools will remain sharper and last longer. Again, you can suspend cutting at any time to clean the engraving, and refix the jig in the cutting head without any loss of accuracy. Scrolling can be kept to a minimum if you clean the engraving regularly, as the cutting proceeds. Secure the finishing tool and bring the cut to

finished (prefitting) depth. Sometimes you will want to use two finishing tools, the final one being slightly longer in depth dimension (+.0001″-.0002″) and so providing the finished surface. Once you have gained proficiency with the regimen, the rest of the matrices will work faster.

In order to ascertain where on the pattern the cutter has been working, roughly brush a stippled wash of grimed oil on the pattern with an old sable brush. You will then be able to see clearly the tracing movements of the wand on the character. This technique also provides a certain lubrication and eases the follower over the pattern surface. Bring the first finish cutting slowly and carefully around the perimeter or extreme of the character in a counterclockwise direction. Next cut the "ground," or interior surface, of the character with small parallel strokes to ensure a fine mattelike surface finish. Again, work in a counterclockwise direction, usually right to left. Be sure the final cut is made in a clean engraving, using Penetone and plenty of air to ensure cleanliness. The final cut goes clockwise, repeating the short strokes for the ground, and the perimeter is last. By renewing the grimed oil wash, and observing careful discipline, you will be able to cut the surface of the engraving completely and uniformly. If an inspection of the cutting reveals flaws or uncut areas, the protocol described above must be repeated. If flawed (by bumping the follower against the fence of the pattern, for instance), an extra .0005″-.001″ can be adjusted with the depth wheel and the cutting for finish can be repeated. After inspection, remove the approved engraving from the jig and send it to the fitter.

When shutting down the Benton Engraving Machine, be sure all areas of the cutting head assembly are clean and free of debris. Oil the gimbal rods lightly. The wand should rest on a piece of clear plastic stock. Cover the entire machine to protect it from dust and dirt in the air. Loosen the drive belt from the power arm to release tension and prolong its life. Store the quills in their boxes, except for the one left in the machine at all times.

Special Cuttings

I have developed the following procedure to cut special ligatures, especially diphthongs in faces that did not originally contain them, and small logotypes.

Trace each character directly from the pattern by rubbing it with the edge of a soft-lead pencil on a piece of thin card stock or rag-content artist's paper. Locate

and indicate each character's original center line. When all the characters have been traced and indicated, take dividers and calculate (and indicate) a new center line for the logotype or ligature. Tape the template to the bed of the machine at the *new* center line. Place each pattern in sequence with its center line matching its counterpart on the template, and proceed to cut each succeeding character. Each cutting must be the same as its fellow's, so take care the tools used do not break. If they break, the depth and other dimensions may not be uniform with the new tools. Always check that the new center line is centered on the machine. One ruined character will spoil the cutting. With patience, the technique works quite well.

Morris Benton perfected the shading device used for such faces as Engravers Roman Shaded, Lithograph Shaded, etc. This equipment locks up on the back of the cutting bed between two fixed bosses and requires two men to attach it safely. The device uses notched wheels that produce a follower grid and is reversible (depending upon the shading line direction of the design), using cutting tools that are .001″-.0025″ in dimension (the larger the character, the bigger the cutting tool diameter). Specific details are given on the cutting slips for each face. New work is, as usual, trial and error.

Copper matrices can be cut, but a lighter cutting oil such as Kerosene might be beneficial. If burning occurs, you are taking too large a cut. Rolling copper through a mill will help toughen it. Cutting in steel must be done very slowly. The carbide cutters are superior for this work. Cutting increments of .010″ or less are the rule. Be sure the effort is worth the trouble. Only high-yield production matrices or those used in zinc-casting service warrant such labor.

I have not dealt with either the cutting of punches or the direct engraving of characters on blank type quads. Much of the data and equipment concerning the technique for these procedures has not been preserved; however, the author has successfully cut some simple designs on blank steel punches and cast quads, the success of which encourage further experimentation.

When cutting the "fill-in" of a character with a fine (i.e., narrow) follower, a .080″ or .090″ cup follower may be used (under the narrow follower). This will protect the surface of the pattern from being gouged and prevent bumping the perimeter "fence" during this part of the protocol. A steady, careful control of the wand is necessary so that the thinner follower will not tip out of the larger one. Always remember to finish the perimeter (sans larger follower) in a clockwise direction for the last pass. Thin followers (below .030″) are commonly used with finishing tools for 12-point and smaller sizes.

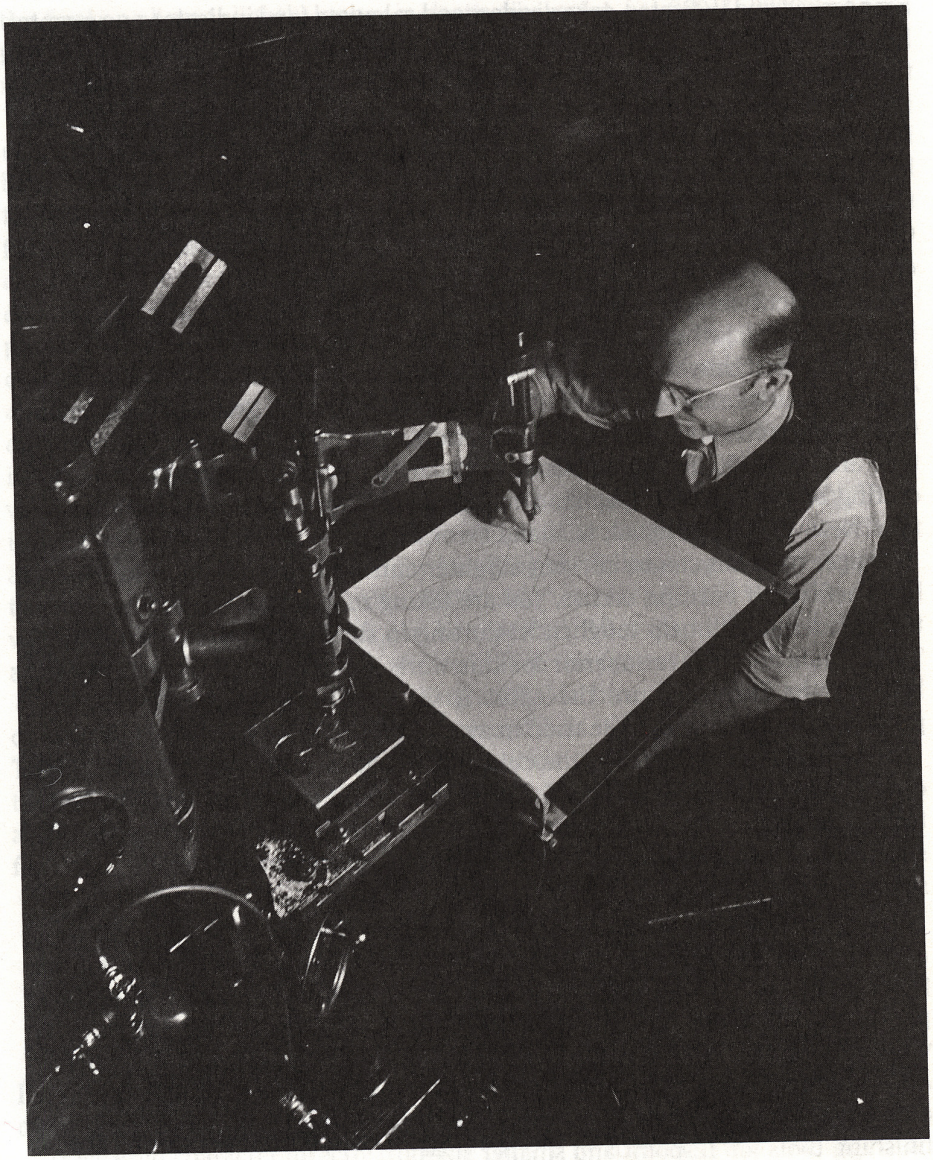


Figure 37. Cutting a brass pattern at ATF, *c.* 1945.

Chapter 11

Engraved Patterns

The Gorton Engraver

At ATF, electroengraved copper patterns were not done in-house; when they became unavailable through obsolescence, they were replaced with modern acid-etched zinc plates done in the matrix department. During the war years (1941-46), strategic materials shortages prompted the use of engraved brass plates done on a customized Gorton #3-U engraver. Plates measured 5″ x 9½″ x .097″ (7-point) thick. They were cut on both sides to save stock, sometimes carrying two or more designs per set. This technique was discontinued in 1948. The 1946 ATF film, *Type Speaks*, illustrates the procedures. A comprehensive regimen for this method follows:

1. Insert chuck in collet
2. Adjust tool ¼″ in the chuck
3. Set head at 50 degrees
4. Grind face of cutter to point
5. Set head for 30-80 degrees
6. Set feed handle so that chuck clears wheel
7. Grind size surface to approximate size wanted
8. Set to 90 degrees and insert pin into No.4 on plate
9. Grind cutter halfway to No.4 for clearance
10. Set head for 20 degrees and let cutter ride across wheel; grind front clearance
11. Set head for 80 degrees
12. Grind cutting lip and back clearance
13. Raise chuck from collet
14. Insert in Engraving Machine

15. Place brass plate in jig
16. Take cut in brass plate
17. Bring to measuring microscope
18. Measure width of cut for tool size: tool size x 2.76″ gives approximate follower dimension
19. Secure brass plate in jig
20. Begin by cutting perimeter of design
21. Fill in all areas of design slowly with short arcs; brush chips and replenish cutting oil (Kerosene)
22. Finished plate may require graving by hand in tight areas
23. Rub interior surface with fine pumice

Note the maximum depth of cutting is .010″ and the maximum cutter width for finishing is .025″.

Etched Zinc Plates

The working drawings for ATF's types remained virtually unchanged during the entire period. Many examples preserved in the Smithsonian Institution's 1970 ATF bequest date from *c.* 1905-49. Although quite a number of designs in the pattern archives of ATF have been lost by the various holding company purges of past decades (those of the Barnhart Brothers & Spindler foundry are lost as well), most of the 1905-40 lead-backed copper patterns still exist and are now catalogued. The modern zinc plates for the most recent designs were cut from large sheets, made photosensitive, exposed to right-reading positives, top-coated (all resist areas not to be etched), and finally splash-etched in the acid bath. The operation is performed in a plastic tank with a hinged lid and an aeration system that controls the amount of turbulence. The plates to be etched are held in a Lucite bracket that suspends them facedown over the etching solution. The specifications for the etching bath are: *(a)* 4½ gallons of distilled water, *(b)* 32 ounces of HNO_3 (reagent grade— 78 percent minimum concentrate), and *(c)* 3 tablespoons of $KA1(SO_4)$. The duration of the etch is six to seven minutes with agitation, and the water to acid ratio is 18:1. The optimum depth of the etch is .007″, with the maximum depth being .010″.

The bath should be renewed each day to maintain etching quality, as it tends to atrophy once contaminated with work; for large amounts of work over several

days, larger quantities of bath may be made ahead of time and stored, so that the daily regimen can go forward without delay. Afterwards the plates are rinsed and dried. Any imperfections such as swirls or pimples that would impede a follower are shaped down with gravers, and the corners of the etched design are likewise trued and squared up. Rubbing down the design surface with wetted fine pumice completes the plate. Under no circumstances should magnesium be used for patterns. Fluctuation of temperature and humidity levels in storage will cause an oxidation influorescence, which eats away at the sharp edges of the etching, ruining the plate. Working drawings at the Guild are usually transferred at the proper scale to preprinted pattern cards on which are indicated the correct alignment and other dimensions. These cards have been made for all alignments; they are the best substitute for the now-lost Benton unitizing protocols.

The Guild now uses a Deckel (2G1) pantograph engraver to duplicate the ATF brass plate engraved pattern outlined above. This was the same device Goudy used for his pattern cutting at Marlborough.



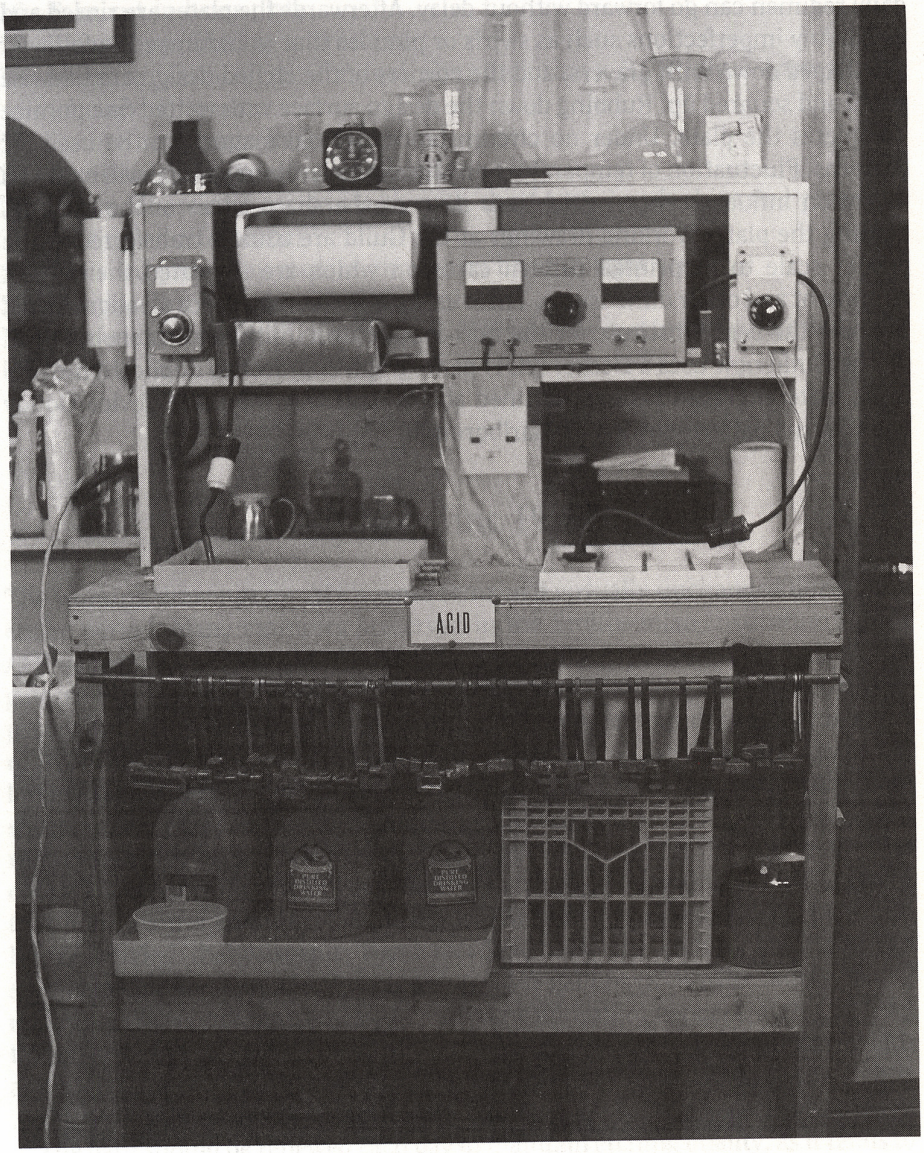


Figure 38. The electro baths.

Chapter 12

Electros

The electrotype matrix discipline for reproducing typefaces either from cast type or engraved models was one of the most zealously guarded mysteries of the old foundries. The protocol and formulas that follow are unique; to my knowledge they are published here for the first time. The legacy of many craftsmen, each contributing the best techniques of his respective foundry, ensured that work produced under these guidelines was the finest humanly possible. Although we have undoubtedly lost some minor points of detail, matrices grown and fabricated using these recipes are very nearly the equal of those priceless originals now preserved in museums and private collections. The basic principles of electrodeposition are well known.[50] In the matrix department, we are concerned primarily with copper and nickel baths. Anyone can grow a copper deposit; the art of the craft is to accomplish this skillfully and to create a matrix that will give good service for many years.

A production electro matrix has a nickel casting surface (.008″-.010″ in thickness), is solidly backed with a good deposit of copper, and is finished with a fine coating of chromium or nickel plating.[51] Ordinary matrices can be grown in copper, backed with copper, or more commonly "half-backed" with 50:50 tin-lead solder (light service matrices and display "flats" are usually done this way). The body of the electro is always laminated brass. Copper was used originally and

[50] An excellent monograph on the history and ancient techniques of electro-making can be obtained from Roy Rice by contacting him at the Recalcitrant Press, 3848 Fox Glen Court, Atlanta, GA 30319.

[51] If there is a choice between chrome and nickel finishing, the following must be born in mind: nickel is almost as strong as chromium, is less costly, and is infinitely less toxic. A recipe for the chromium bath is given on p. 144, should the need arise. If the amount of work is small, or the artisan is concerned with the attendant health dangers, borrow the axiom of Cennini from his treatise for the plating of gold by mercuric vapors: "Pray, let *others* do it."

works well, although unless hand-rubbed, it does not machine and finish as easily. A range of milled and sawn brass bars—usually half-hard, free machining "alpha" brass—provides the materials for the routed top plates and bottoms, which are frankly riveted together. The Guild has also experimented with tapped holes and brass machine screws to secure these laminates, and found them quite satisfactory. A matrix made with such fasteners can withstand the removal of greater amounts of surface, to alter depth of drive, than is usual with flattened rivets.

Zinc-bodied matrices were popular in Europe and England. Electros are grown on a rough postlike form (solid copper or nickel); the dendritic accretions are filed off, after which they are secured in a form or mold that is filled with molten zinc. After rough fitting, the type is eased out—if it has not already fallen out—and the new matrix is fitted up. I have watched a craftsman in rural Spain produce such matrices by using large tin cans plunged into the dirt floor of a stable. Used automotive batteries and hand files were his only other equipment. Since his matrices were beautifully finished (and reasonably accurately fitted!), one might also add skill and perseverance to the list of his equipment.

The Copper Bath

The earliest source of electrical current for such baths was essentially the archetypical Galvanic Pile. Some call it a Voltaic Pile, remembering Galvani's defeat in the great theoretical confrontation. A gravure montage in the MacKellar Smiths and Jordan Keepsake of 1896 shows a primitive direct current generator of the time and pitch-lined lead tanks in their electro department.

The problem with these early generators was their unreliability and their failure to control amperage. The current produced was unstable at times, a condition that could cause problems with the rate and quality of deposited copper. At ATF, until the early 1940s, a pile battery was used for a backup power source, even with the availability of a generator. Indeed, the older craftsmen preferred it, being conservative in nature and mindful of past disasters. When growing deposits over a weekend, it was not considered safe to run the generator. Furthermore, if the inside temperature fell below 32°F—and it did on occasion—ice crystals would form, slowing and disturbing the flow of copper molecules to the cathode, and so ruining the work in progress. As to the method of

setting up a pile generator, no records nor recipe has survived at ATF/Elizabeth. At the Guild, we experimented with a simple battery, as found in school textbooks; it worked satisfactorily.

For the production needs of a working matrix department, a modern DC power supply[52] as used in test cell laboratory work will provide a controlled, "unrippled" current source. Seamless plastic tanks and quartz heaters ensure optimum depositing conditions. Solid copper rods carrying the anode and cathode circuit are fixed securely across the tank. It is also wise to cover the tank with a lid. Cast plastic lids made for the tank are usually just as expensive as the tank itself, so many shops simply cut a piece of acrylic window glazing for their tanks.

Agitation is important in the copper bath. It is beneficial in creating an improved flow of molecules and a steady, even deposit. The easiest way to accomplish this is to install a Sethco[53] circulating pump, having it run constantly during the plating period. The Guild operates a 50-gallon copper bath (as well as a small, 7-gallon one), which holds up to one hundred electro type forms at a time, rather like a farmer's rotation crop: new forms immersed at one end and completed ones extracted from the other end. Forms in various stages of finishing hang in between. Unlike nickel, copper growth can be reinitiated at any time, after examination and rewaxing if need be. When the demand on the tank is great, the agitation pump is usually kept running continuously.

When the pump is no longer in use, thoroughly rinse and flush clean water through the entire pump housing and hoses. If this simple procedure is not done, a copper sulfate crystal deposit will form in the pump chamber as the water in the electrolyte evaporates and will ruin the pump. Since a pump rebuilding is nearly as costly as buying another used pump in good condition (if you can find one!) this procedure is a crucial one. Leaks in the pump housing and at the joints of the hoses can also be memorable experiences, especially when in the middle of a plating sequence. Loss of integrity, or seal, in the system can often lead to a disastrous siphoning off of the entire electrolyte solution on the floor of the shop. Monitor the bath frequently to avoid such problems as a runaway quartz heater, which could boil away the water in the electrolyte, or a shorted breaker cutting the power supply, which could ruin newly immersed work. Temperature fluctuations, if not extreme, are not serious. Low temperature inhibits accumulations of deposit; high temperature creates uncontrolled dendritic growths, which resemble staghorn coral.

The ingredients of the copper bath are *(a)* distilled water, *(b)* $CuSo_4$ (33 ounces

[52] This can be obtained from Kocour, 4800 South St. Louis Avenue, Chicago, IL 60632.
[53] Sethco, 1 Bennington Avenue, Freeport, NY 11520.

per gallon of water by weight), *(c)* sulfuric acid (10 ounces per gallon of water by weight), and *(d)* fish glue (1/2-1 ounce total). The following procedure is based on a tank size of 50 gallons (18″ x 18″ x 36″) for which there should be 48 gallons of distilled water on hand (although not all of it will be used):

1. Put enough distilled water to come within about 3″ of the tank top
2. Add $CuSo_4$ (33 ounces per gallon: keep count!)
3. Let it stand for two or three hours; stir with wooden paddle
4. Skim detritus
5. Dissolve fish glue in hot water; add about 1/2 ounce to start
6. Add sulfuric acid last (10 ounces per gallon of water)
7. Let stand twenty-four hours; stir; skim again
8. Engage agitating pump; filter through foot of return hose
9. Estimate amount of additional electrolyte needed and make small amounts to bring level up to 1″ from the tank top

When electrolyte is "fixed," only distilled water is added to maintain the operating level, as only the water evaporates; cover the mixture with acetate sheet to limit dust and foreign matter entry.

The continuous agitation and fish glue make for a finer deposit of copper. Molasses and other sugars are not ideal for the buffering organics: they create too much detritus when breaking down. The fish glue may be difficult to obtain. Formerly used to bond veneers permanently to porous furniture woods, it has the appearance of colored glass shards. It was called *pescatori glutenum* by the old chemists and pharmacists. Pearl glue, used by luthiers, has the appearance of tapioca; it works nearly as well. Periodic filtering after a long continuous use is good for the bath. Filtering is accomplished by fixing a tubular chamber with a screened end to the foot or end of the pump return hose in the tank. The filtering is done through a paper-lined cartridge of activated charcoal. If you do not have the convenience of a circulating pump, you can siphon the electrolyte through a large funnel and filter paper held in jugs or other vessels, and return it to the tank afterward.

A virgin bath should be left to circulate for a day or so, and any detritus removed by skimming often. It is wise to buy the best and purest grade of copper sulfate available. As for the sulfuric acid, a reagent grade is satisfactory. Running a blank strip of brass stock in the form of a hanger before putting in your regular work will help stabilize the bath. A test strip of known thickness can be waxed down at the surface level; it is handy to determine the rate of copper deposit and its quality before offering work to the new bath. The notation of elapsed time and the thickness of copper deposited can be measured at a specific level; this

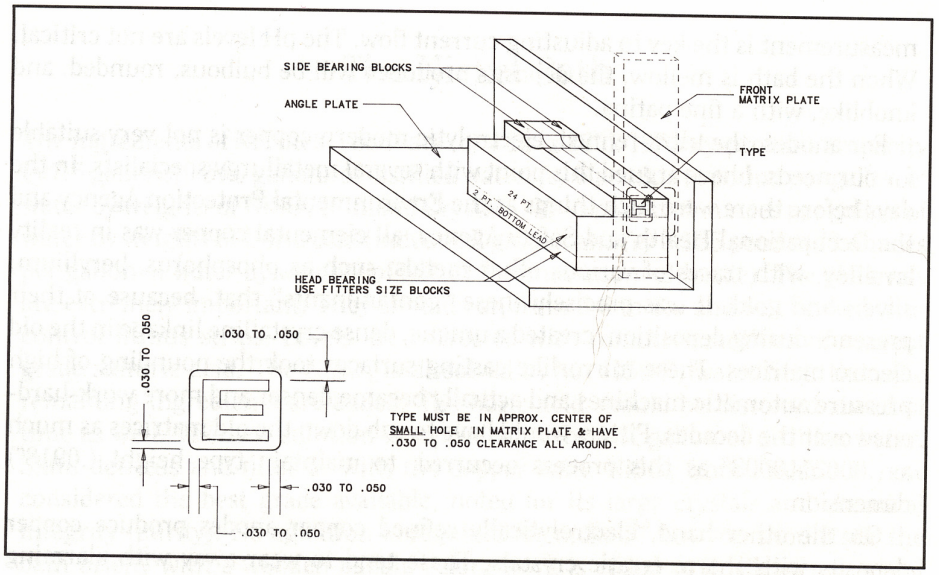


Figure 39. Drawing of assembly used to test blocking.

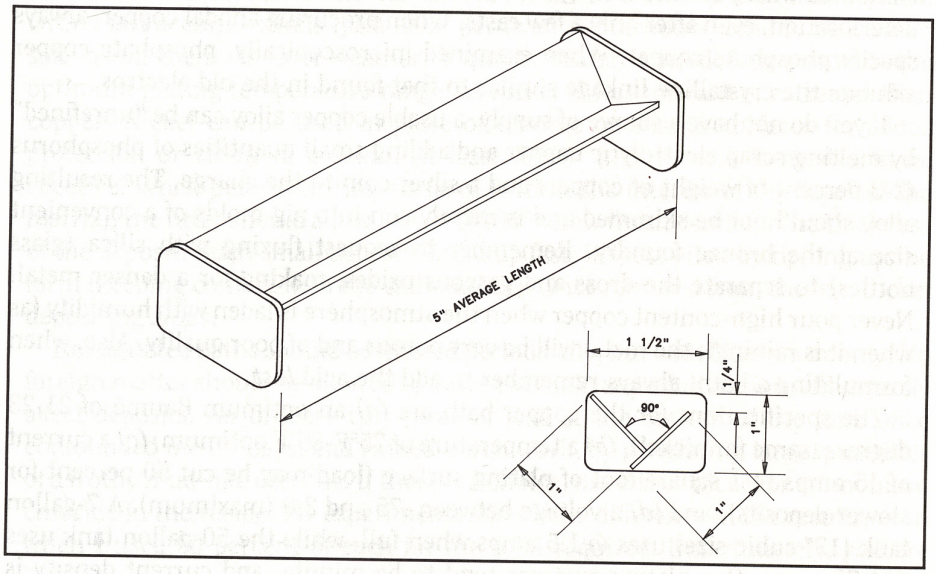


Figure 40. Stand for holding type.

measurement is the key to adjusting current flow. The pH levels are not critical. When the bath is mellow, the deposits produced will be bulbous, rounded, and knoblike, with a fine patina.

For anodes, the ultra-refined, electrolytic modern copper is not very suitable for our needs. I have argued this point with several metallurgy specialists. In the days before there were such things as the Environmental Protection Agency and the Occupational Health and Safety Agency, all elemental copper was in reality an alloy, with traces of various other metals, such as phosphorus, beryllium, silver, and gold. It was precisely these "contaminants" that, because of their presence during deposition, created a unique, dense crystalline linkage in the old electro matrices. These mirrorlike casting surfaces took the pounding of high pressure automatic machines and actually became denser and more work-hardened over the decades. Fitters would have to rub down the old matrices as much as .0002″-.0003″ as this process occurred, to maintain type height (.0918″) dimension.

On the other hand, electrolytically refined copper anodes produce copper deposits with sharp, erratic crystals. These tend to wear away with alarming rapidity, leaving gaping, eroded areas on the casting surface of the matrix. When combined with poor depositing conditions, such electro matrices show marked deterioration, even after only a few casts. When procuring anodal copper, always specify phosphate copper. When examined microscopically, phosphate copper exhibits the crystalline linkage similar to that found in the old electros.

If you do not have a source of supply, a usable copper alloy can be "unrefined" by melting scrap electrolytic copper and adding small quantities of phosphorus (2-3 percent of weight of copper) and a silver coin to the charge. The resulting alloy should not be skimmed and is merely run into pig molds of a convenient size at the bronze foundry. Remember to request fluxing with silica (glass bottles) to separate the dross and gaseous oxides, making for a denser metal. Never pour high-content copper when the atmosphere is laden with humidity (as when it is raining); the metal will be very porous and of poor quality. Also, when formulating a bath, always remember to add the acid *last*.

The specifications for the copper bath are *(a)* an optimum Baumé of 21-23 degrees (same for nickel), *(b)* a temperature of 75°F-85°F optimum, *(c)* a current of 15 amps to 1 square foot of plating surface (load may be cut 50 percent for slower deposits), and *(d)* a voltage between .75 and 2.0 (maximum). A 7-gallon tank (12″ cubic size) uses @1.5 amps when full, while the 50-gallon tank uses @4.75 amps. Our plating surfaces tend to be minute, and current density is usually low.

The Nickel Bath

The ingredients of the nickel bath are *(a)* a 12″ x 12″ x 12″ poly-pro tank (capacity @7.5 gallons), *(b)* 6 gallons of distilled water, *(c)* 6 pounds (1 pound per gallon of water by weight) of $NiSO_4$ (Finland Crystal), *(d)* 1/2 pound (4 ounces per gallon of water by weight) of Boric acid (industrial grade), and *(e)* 1.125 pounds (3 ounces per gallon of water by weight) of NH_4Cl (orammonium chloride). The pH levels are extremely important. They should run from 5.6 to 6.0 and be checked with control litmus strips. Levels are corrected with minute quantities of reagent grade sulfuric acid. The $NiSO_4$ is dissolved in hot (150°F) water first; then the remaining ingredients are added. The boric acid should be dissolved ahead of time as well. The new solution is topped with the last gallon of distilled water. Skim detritus and filter as with the copper bath. $NiSO_4$ from Finland is now considered the best grade available, noted for its large crystals and chemical integrity (purity). No agitation is required for nickel,[54] but you should stir the bath briefly with a wooden paddle before work is added to it. Clean raw metal surfaces with denatured alcohol and a clean sable brush. The thin brass test strip should show a deposit thickness of .002″-.003″ in a twenty-four hour period. Overly fast accumulations (past .005″ per twenty-four hours) tend to be weak or soft; avoid them. In cool weather, a quartz heater is needed to maintain the optimum plating temperature range, as nickel is less tolerant of extremes than copper. Nickel can be used in place of chrome on matrix surfaces for added protection or repair of erosion. At least .0005″ in thickness is needed to be effective. When plating casting surfaces (within the interior of the "eye" of the matrix), the fitter should allow .0003″-.0004″ below finish depth for the thickness of the deposit. Such small deposits build up fast; inspect often by tipping up the form (keeping contact with the cathode bar). Once removed from the bar, nickel depositing *stops*.

Nonagitated baths should be filtered periodically, but with filter paper only. No foreign matter should be allowed to enter the tank; any adulteration will severely affect deposits. An unseen, tiny piece of lead at the bottom of the tank once confounded me for days, and ruined much work, by generating large quantities of a frothy mud-like detritus. If there is a choice, use either nickel or ammonium chloride in the recipe. My experiments show little difference in the results, even when I used 50 percent of each for the total required. Unfortunately, you are

[54] Although agitation is not essential, it does make for a better deposit.

usually compelled to purchase vast amounts of such chemicals from suppliers. A call from a friend at the supply house usually informs us of broken containers, etc., and so we can usually purchase only what we need. In many areas this practice may not be strictly legal, as most of these substances are controlled by law and must be accounted for.

The Chrome Bath

The ingredients of the chrome bath are *(a)* 15 gallons of water, *(b)* 51 pounds 9 ounces (100 kilograms) of Chrome flake, *(c)* 7½ ounces (by weight) of sulfuric acid, and *(d)* a Baumé of 22-25 degrees at room temperature (23.5 degress is the optimum). The bath produces a slow (by comparison with hard chromium "flash" baths) deposit of .0002″-.00025″ in thirty minutes at 110°F. Amperage is set according to the amount of surface to be plated. Matrices are held in "masked" (plastic-resistant) stainless or aluminum galleys, the matrices being held with scrap bars of brass and lead via set-screws threaded into the edges of the galley. A plate of brass cut to fit within the confines of the galley is an electrolytic trap that deteriorates, leaving the backs of the matrices to be plated from being eaten away during the plating process. The work as usual faces the anodes, which in this case are made of lead. All plating deposit metal is ionized from the electrolytic solution. Always begin with a warmup period in which a test form is plated for fifteen minutes to stabilize the bath. Plating time for our matrices takes no longer than thirty minutes, no matter what the area of the plating surface measures. A 12″ x 12″ x 12″ tank with a capacity of @7.5 gallons will handle adequately any amount of work for the matrix department.

This bath *must* be vented. Its fumes are deadly, and cause great damage to any surrounding metal surfaces, let alone to worker's lungs. Handling of the electrolyte is risky; rubber gloves, a respirator, and a plastic apron are necessities. Spilled on the skin, the electrolyte must be dealt with swiftly, with vigorous scrubbing, as it is readily absorbed into the body. The only maintenance needed once the bath is operating is to maintain the level by adding distilled water periodically to replace evaporation. The bath never goes "bad" unless foreign matter contaminates it, and it should last a decade or so with proper care. When not running, the anodes must be removed and the chrome detritus brushed away under running water and stored in a pail underwater. One day companies owning

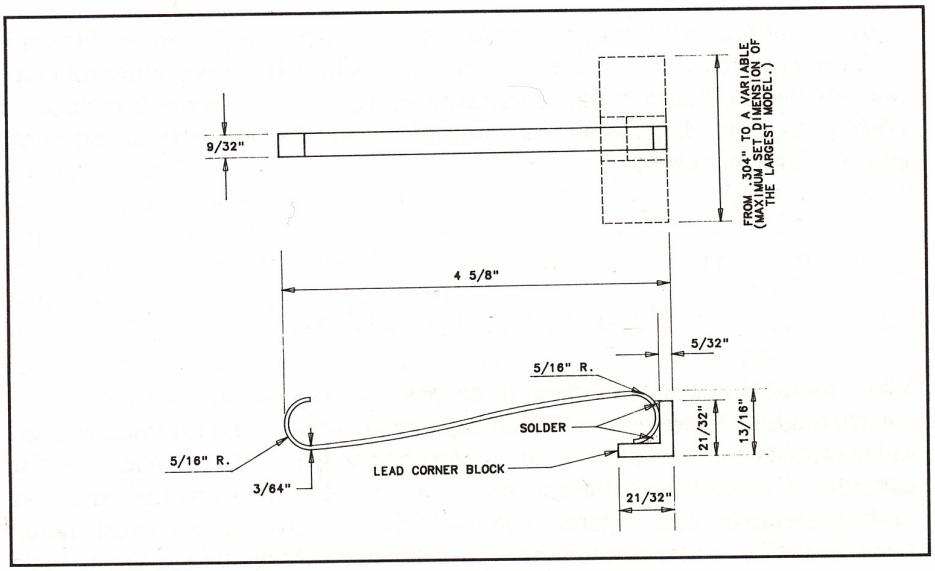


Figure 41. Drawing of a typical type hanger.

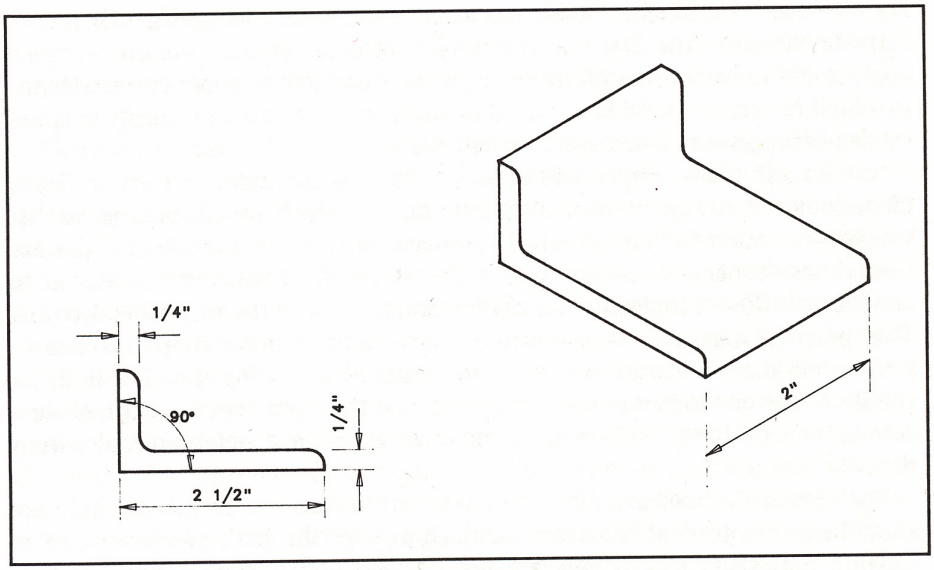


Figure 42. Sketch of a joiner.

or operating such baths will have to be registered with the government (or law enforcement departments), like registered felons (much of the pollution in our world is tied to indiscriminate carelessness). The Guild does not use chrome. When properly used, nickel answers most of the needs of the matrix department, and is infinitely more safe.

Disciplines for all Baths

When immersing forms, be sure no air has been trapped in the cavity of the electro module. There are three solid copper bars fixed across the bath: the two outer cathode bars and the central one for the anode(s). All work placed on the cathode bars *must* face the anode. The prepared electro modules must be protected from air contact (and oxidation of the plating surfaces) by suspending them in distilled water until immersion in the bath. Once hung in the bath, do not break contact for two or three hours (for copper); for nickel, never break contact for the entire plating time. Copper may be removed for inspection anytime after a sufficient deposit has accumulated. Rub hangers gently on the cathode bars after the first hour or so (do not break contact!) to ensure good contact. Minute quantities of sulfuric acid may be added to copper or nickel baths to adjust pH readings. Additives used by commercial platers, primarily to speed up depositing, are not necessary for our work.

Anodes, especially copper, will develop a detritus coating that must be rinsed off periodically. Always place an alternate anode on the bar while plating, so that you can maintain the circuit when removing one of them. Nickel anodes are sometimes suspended cinched within rough muslin bags, a practice said to equalize the flow of molecules for plating and to capture the inevitable detritus. This practice may also slow down the deposition somewhat. Remember to remove all anodes when the bath is not engaged in plating. Be sure that the shanks of the anode hangers are waxed up past the surface of the bath, since a secondary depositing can form here and can steal plating metal molecules from the intended plating area.

The recipes outlined are reasonably safe with ordinary precautions, and they should not create dangerous or caustic fumes. If the bath you are using *is* causing fumes, its proportions are not correct, and it should be discarded. Precautions should also be taken when disposing of spent bath materials. Obey

local safety codes. There are simple techniques for the safe disposal and neutralizing of electrolytes.

Current flow in the electro bath runs from the negative (anode) to the positive (cathode). Even when the load is split, as with the two cathode bars, the current stays at virtually the same level. Industrial platers recommend current density levels for plating large surfaces. Their settings are measured per square foot of surface. Our needs require very low amperages as we are concerned with small plating areas. Start with between .5-1 amp, especially with a newly formulated bath, and use a test strip (wax-resist all areas except a measurable area for plating). Vary the amperage slightly after short periods, observing and measuring the amount deposited at these settings. When small amounts of work are plated, a "sink-bar" of deposited metal can be immersed along with the work so as to stabilize the circuit. This practice will ensure slower depositing and denser, more controlled "flowers." Amperage may be increased to the point where the bath will function efficiently, but not beyond that at which dendritic or "runaway" deposits will form. Be careful not to exceed voltage levels, as removal of modules decreases total plating surface; adjust the power cell rheostat accordingly. The power cell has one rheostat and two level gauges: amperage and voltage. Maximum voltage should be no more than 4.75-5.00 volts. Larger baths must carry additional voltage in proportion to work load and amount of electrolyte (actually the amount of free metal molecules in suspension, moving toward the work area). Power cells should be protected with fused output circuits, which will shut down the bath if the rheostat is set beyond the load level of the fuse.

There is a tendency for briskly deposited electros to form exaggerated flowers of ions at the perimeter of the routed area and only slowly within the interior of the cavity. This phenomenon of plating physics can be kept to a minimum by monitoring both the current flow and bath temperature. There is also a danger of growing over voids in the flower, which may later collapse under the stresses of the pounding required to cast type when the matrix is in service. Until manipulative skill is developed, it is sometimes wiser to remove the model from the bath, pare back the wax, and cut or grind down the incomplete flower. Just adding additional wax resist at this point will help; then re-immerse and continue plating. Be careful to remove any particles of metal debris imbedded in the wax, or cover them with additional wax, since little satellite growths will form on them. The work will dry out after a short while, oxidizing the plating area. A drop of reagent grade nitric acid on the plating surface will restore the work (shake some sodium chloride on it while it is working, and do not breathe the fumes!). Keep it underwater until ready to immerse.

The wax used for resist is made from coarse beeswax with Venus turpentine added, 20 parts wax to 1 part turpentine. The material can be recovered and recycled; it develops a warm, darkish hue. It is slightly sticky, and it brushes on well. A double boiler of metal or glass, or a steel beaker heated gently with an enclosed electric hot plate, will maintain a working liquidity. For safety, do *not* use an open fire to melt this material—wax fires are dangerous.[55]

Creating the forms containing the type models for electro-depositing is a task requiring patience and dexterity. The type must be prepared and stored with care, and it must be as perfect as possible. The type model should fit within the routed opening without contacting the shoulders of the type character. In order to bond the electro to the plate effectively, a dado is struck around the entire perimeter at the middle of the cavity with a sharp punch. A special block or anvil to assist with this operation is illustrated in figure 43. This dado "keys" the electro in position and prevents it from being loosened or punched out from abuse. All plates to be grown into, whether for flats or foundry laminates, should be dadoed and cut for an allowance of 2 or 3 points *over* the trim size to allow for proper positioning by the worker and later by the fitter when finishing. After waxing in the module, the plating surface is cleaned with a sable brush and denatured alcohol. The models are then stored underwater until ready to be immersed in the bath.

Type models may need to have their shoulders shaped down to increase drive depth, or to change to a deeper drive if needed. However, types whose drives need be made shallower are simply set to the new depth (plus .002″-.003″ over), using the appropriate constants; and the work proceeds as usual. An electro so produced will be raised past the matrix plate surface, and it is therefore rubbed down after the model is removed during cleanup. If the amount of this difference is great, nickel cannot be used, as the initial nickel deposit is only @.005″-.008″ in thickness, and will be entirely removed in some areas. These matrices should be done in solid copper and then plated .0003″ or so with chromium for casting surface integrity.

In determining and fixing the amount of projection of the type model into the routed cavity (for drive depth), add .002″-.0025″ over finished depth dimension.

[55] If in the course of waxing up a model assembly, you inadvertently get wax resist into the electro cavity, it must be removed completely with a brush and Penetone or the depositing will be faulty. Additionally, burnishing the face of the type model with the frayed edge of a cardboard reglet or paper-match base soaked in denatured alcohol will prepare it for immersion. Clean as usual with alcohol to remove any Penetone residue, and store underwater.

This is to be rubbed down by the fitter (see chapter 14).[56] With display flat blanks whose large surface is tedious and time-consuming to bring down to dimension, a simple procedure is used. On a flat steel surface, two steel stops are laid parallel. The thickness of these stops is the depth dimension plus only .0005″-.001″ over. The blank rests upon these stops with the model projecting through to the steel surface. Gentle pressure and a clean surface, so as not to injure the face of the type, fix the model in position. The discipline takes practice, but when mastered, makes for less time fitting and a better product.

Production flats are done at the Guild using a special jig with set-screws to hold the model in precise position. The jigs are specially fabricated from cored pieces of large body type, cast and machined to proper dimensions for justification and alignment. While not always perfect, such matrices require a minimum of fitting to bring them into acceptable dimensions. Body sizes from 4- to 24-point are done in this manner. Larger type is done as with foundry plates.

If a nickel electro is desired, the first immersion is in the nickel bath, to deposit a thickness of .005″-.008″ in the cavity. Depending upon bath conditions and size of the electro, this is usually for twenty-four to forty-eight hours duration. The forms are removed from the nickel bath, rinsed off, inspected briefly, and immersed in the copper bath. When the copper deposit completely fills the cavity, remove the work, break it down, and grind or cut off the flower close to the surface of the plate. A form may be removed from the copper bath before it is completely filled and the void filled with molten 50:50 lead solder. This usually is sufficient for matrices destined for light service, and the technique is popular with amateurs. Flowers can be cut off with a model-maker's razor saw (Zona brand), although a nickel deposit will dull this tool faster than an all-copper flower will. A surface grinder with a special holder is used for large electros or great quantities of work where consistency is an efficiency factor. Rough ground plates, either display or foundry, are now sent on to the fitter.

Always be sure that the work is firmly attached to its hanger, either by soldering or threaded screws. For this very reason, tapped holes are sometimes found in old foundry matrices at their base. If your work is not secure, poor deposition and adhesion will result. Depositing copper to correct fitting mistakes, or to change a matrix to a different mold by way of increasing the head-and side-bearing surfaces, or to repair the edge of a worn electro, is a handy use

[56] It should be noted that flaws in the model are reproduced in the electro exactly as they exist. With no recourse to good models, a poor model needs to be trimmed up by hand engraving. This is an expensive, sometimes frustrating task, with much referral to type specimens, the microscope, and the V-12 comparator. Progress is checked with smoke proofs.

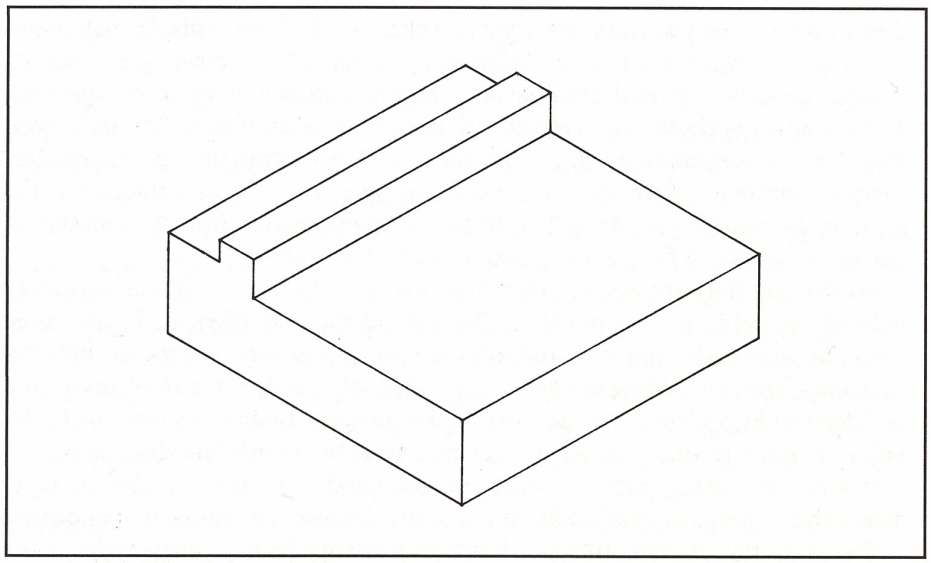


Figure 43. Matrix anvil—not to scale. 5″ square; cast iron or cam bronze.

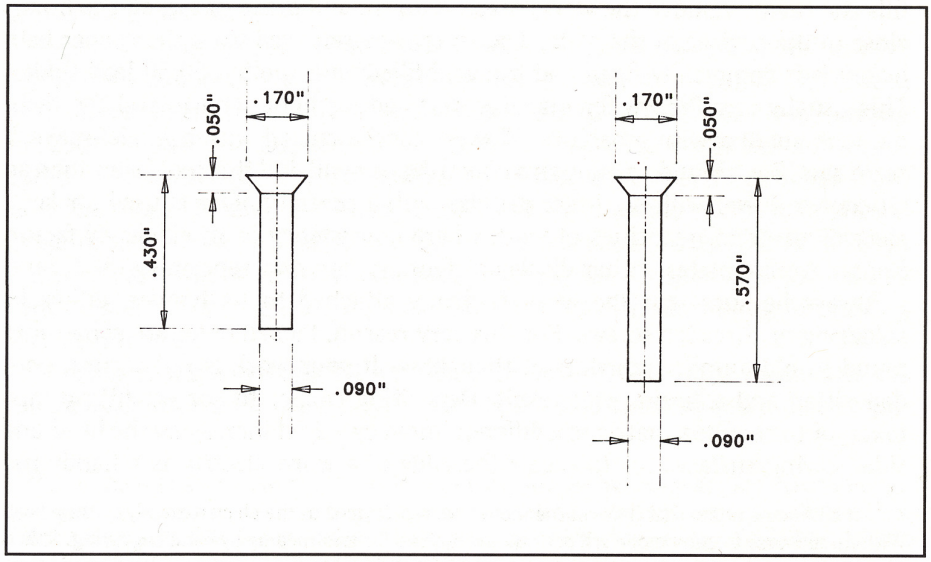


Figure 44. Brass rivets used in making electro matrices.
Note: countersink must be made to correspond to bevel on rivet. Hole should not be countersunk to full size of rivet, as rivet must stand up about .010″ so as to allow for solid blow for spreading rivet.

of the type craftsman's bath technique. Wax resist covers the entire matrix, especially the "eye", except for the area to be deposited, and the immediate corners of this area are trimmed of wax to ensure a solid corner when finishing. Clean with reagent nitric acid and salt to be sure the plating surface is clean and receptive. Deposits that peel off cleanly reveal poor preparation of the work.

The optimum deposits of nickel and copper for electros resemble soft-looking, rounded globules of matte-patinated bright metal. The copper is a pinkish, light liver-color; the nickel is pearly-silver. When monitoring a bath, working adjustments must be expected from day to day. It is a good practice to move the rheostat adjustment slightly every day on a long plating run. This ensures circuit continuity and accuracy of current flow values. Settings too high will result in coral-like growths and grainy deposits. It is better to plate copper slowly, and plate nickel "hotter," making denser, harder deposits. Cathode bars need rubbing with emery cloth occasionally to remove the periodic oxide buildup that reduces circuit efficiency.

If finished (kerned) type models are used, it is important to "lead up" a soldered shoulder under the kerned projections of lower-case f's and j's, etc., and most especially scripts and italic designs. Work made without correcting this condition will produce electros that will not release properly. A fitter with skill may be able to pare down the wall of the void and so release the model, but it is not worth the trouble. *Never* attempt to melt out type metal stuck in a copper or nickel-copper electro matrix. Cooking such matrices ends their useful service life in short order.

Electro-deposited matrices are also the logical answer to the problem of casting from engraved matrices on casting machines that have no provision for trimming the substantial beards created by such matrices. The elimination of tedious hand work involving rubbing heavily bearded casts is worth the effort and expense of a suite of electros for popular or aesthetically worthy designs.



Figure 45. Copper electro-plated surfaces.

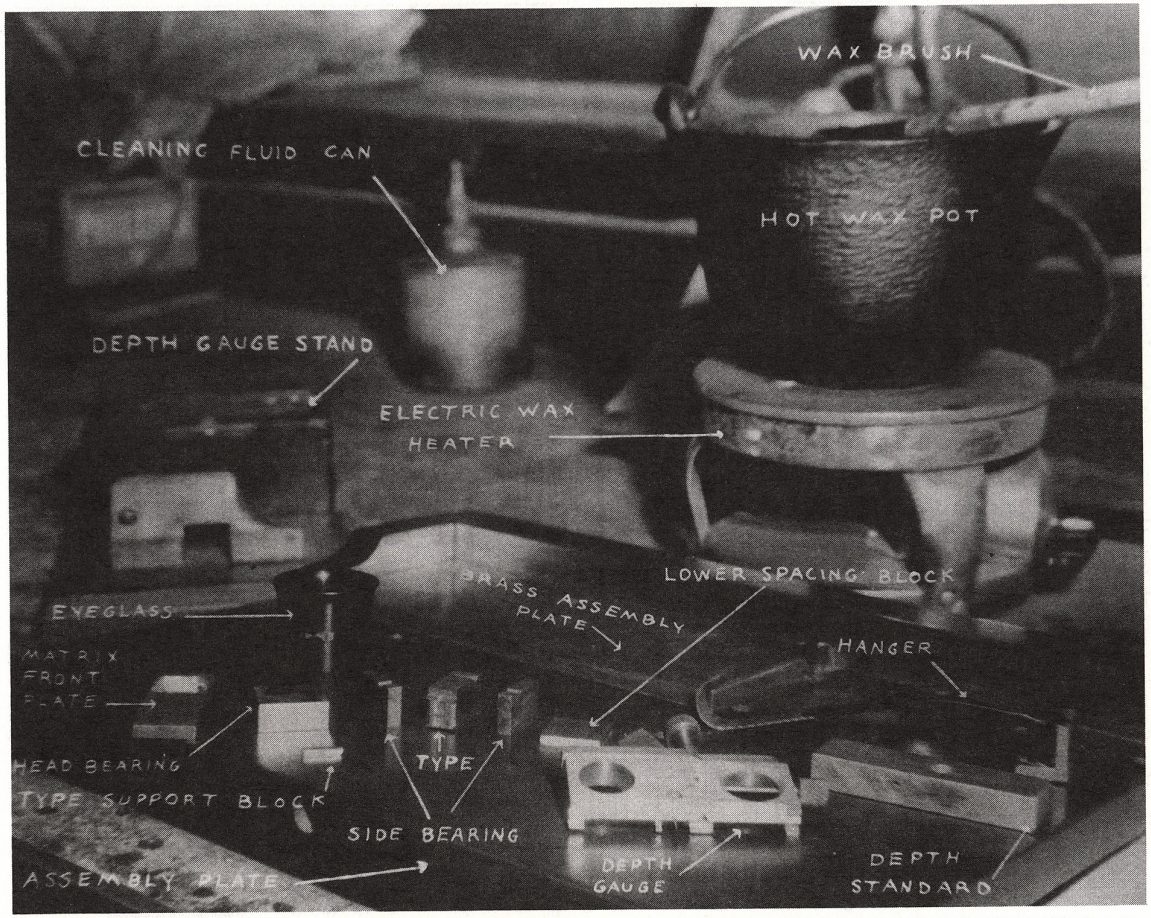


Figure 46. The electro setup.



Figure 46. The electro setup.

Chapter 13

Making Matrices from Type

The following protocol is reproduced, lightly edited and with section titles added, from a work study by the matrix-electro department at ATF/Elizabeth. It was written by A. H. Tyler and is dated 7 April 1945. Electros are no longer produced at the Elizabeth plant, because of neglect and attrition. Former ATF employee Frank L. Walsh, now foreman of the Guild matrix department, has kindly revised and added to the original document. His comments appear in square brackets within the text.

TYPE MODELS

The type prepared for use in this process is in all respects like a perishable jewel and should be treated as such. The face has been flattened [squared] and trued up, the shoulders have been engraved off [with a shaper], and the typeface has been carefully checked so as to be perfect. The face of the type must never be touched with the fingers or by any tools other than those indicated in the instructions. Type metal bruises and scratches easily, and anything but the softest cloths may injure it. Grease from the fingers or oil or dirt once deposited on the face is hard to remove and may result in a poor plating job.

Keep the type models in a safe place, preferably away from the work area until ready to be used. When working with prepared type be sure to observe all precautions noted in the instructions. Do not handle finished type unless it is absolutely necessary, and always handle by grasping it on the body. Any damage to the typeface, no matter how slight, will be reproduced in the matrix and the type produced from it. The quality of the matrix is directly dependent on the condition of the type at the time it goes into the bath. Used properly, the finished type will produce a perfect matrix.

The work requires patience and skill, which can only be improved by practice. Cleanliness is absolutely essential in all parts of the work. One particle of dust in the wrong place can throw the entire type assembly out of line. To work down to a .0001″ the worker must be able to see exactly what is being done. This work is best done with a north light and plenty of it. The worker is a craftsman, and light is one of his most important tools. Examine the prepared type carefully through the loupe to be sure it has not been damaged. The face must be absolutely clean, flat and free from nicks, scratches, or dents. Place carefully in the type stand.

FACING UP PREPARED TYPE

Depending on the condition of the type model, .0002″ or so can be deftly stoned off the type using a *flat* [trued] piece of serpentine stone. This is done under running tap water with a special type joiner. Do not remove too much surface! It is extremely difficult to pare the shoulders of the type's character to bring it back to its proper weight. The serpentine stone is cleaned of its minute accumulations of type metal with Penetone and a flat piece of pumice [lava rock, kept especially for this purpose].

SETUP

Select the proper side-bearing blocks. Using the body size of the type as a reference, determine the set width of the quads to be used as side-bearings. [Check dimensions with fitter's size blocks or a point micrometer.] Cut the brass front plate from stock. [Top plate.] Width is the width of type model and the two side-bearing blocks, plus 2 points [or .025″] for finishing. Obtain length and finishing dimensions from chart (see Appendix 1, p. 183). Be sure the nicks on the side-bearing blocks are on the same side as those on the type model: this will give you the correct width of the type and block assembly. File burrs off all corners of front plate. Hold plate between thumb and fingers, and run a mill smooth file along the edge at an angle of about 40 degrees to the plate surface, taking off about 1/64″ on the edge of one side. Just burr the other side, because it will be cut off in the fitting machine.

Square up one face and one side on the stone. Use an emery [or sand] stone and joiner. To stone the face of the plate, hold at the ends with the thumb and first finger of the left hand, and put the thumb of the right hand on top of the plate at its center. Left hand pushes and guides; right hand exerts pressure. To square, hold up finished face of plate against the face of the joiner with two fingers of the

right hand and push on the plate, not the joiner. The left hand pushes the joiner across the stone. Absolute squareness is not necessary; this step is for rough lining only. Plus or minus one-tenth of a degree is satisfactory.

Set fitting machine to cut front plate to size. Set the machine to total width of type and the two side-bearing blocks. The machine's dial [knob] is graduated in sixteenths of a point. It is assumed that the machine's cutters, microscope, and dials are adjusted [synchronized] accordingly. Put front plate in place on the fitting machine. Put the burred side against the large paddle. Be sure front plate is square on table and its side square to the large paddle.

Clamp the front plate for cutting to size. Put a lead block under the clamp if the front plate is thinner than the large paddle. Square up clamp (and the lead block, if used) and keep the clamp about 1/8 away from the edge to be cut. Tighten the clamp screw lightly. Check setting of the front plate. It must be tight against the large paddle. Tighten the clamp screw down hard by hand. Check the tightness by trying to move the front plate by hand.

CUTTING AND ROUTING

Start the cutters revolving and push the table by hand to 1″ from the cutters. Engage feed-screw, and hand-feed the front plate slowly as you cut it to size. Feed only as fast as the cutters will cut clean—faster on thin brass plates, slower on thick ones. Stop motor, disengage cross feed, and pull the table out to you by hand. Be sure the motor is stopped or cutters may recut if running. Loosen the clamp and remove the front plate. [Remove type and side bearings and place in a type stand, if they were used for setting the large paddle.] Burr the front plate with the file. Take off about 1/64″ on the corners to get a surface that will not burr up when stoning.

Mark the front plate for routing. Use fitter's size blocks and scribe lines on the front plate approximately 2 points [or .030″] outside the area of the surface of the face all around. These lines show where the point of the cutter should cut. On 24-point or smaller, the whole type area should be considered as the "face," and the lines drawn 2 points [or .030″] outside this area. On 30-point or larger, fit the routed hole to the typeface, so as not to unnecessarily weaken the front plate or make [an aperture] too big to plate up.

Set routing machine and rout out the area marked. Allow 2-4 points [.030″-.050″] clear on all four sides of the type at the bottom of the hole. The sides of the plate should not be less than 3 points [or .035″] wide at the smallest dimension. The dimensions of the area around the typeface should be as even as possible, to

assist in control and ease of growth of the plating metal. Narrow, deep areas may not fill properly [or cover over without filling]. Wide areas may fill up more slowly, holding up completion of the plating and requiring considerable rewaxing during plating. On front plates 12 points or thicker, rout out a second cut to allow for easier growth of plating. Use a flat-bottom cutter [end mill] and cut about halfway down [the bevel], being sure to stay within the area of the first cut. Leave the top righthand corner uncut to allow room for the drilling of the hole for the pin of the shoe of the automatic casting machine.

Clear out the routed hole so that all of the typeface has 2-4 points [or .030″-.050″] minimum clearance. File or cut out extra area where the type does not have clearance. Be sure to retain as much bevel as possible, so that plating metal will deposit properly. Do not cut outside the line of the large hole. Remove burr from routed hole. Use file on the face of the plate. Use three-cornered knife in the hole. Keep the knife at the same angle as the bevel. Scrape the burr from around the hole, keeping the knife flat to the bottom of the plate.

Make a test setup to try the correctness of the routing of the plate. Put a fitter's size block the same thickness as the head-bearing block on an angle plate. Hold the angle plate in the left hand with the side up and to the left, the bottom resting on the fingers of the left hand and looking toward the right. Put the size block in the corner of the plate and about in the middle of it. Put prepared side-bearing blocks and type in place on the fitter's size block, the side-bearing block with its nick up placed in the corner formed by the fitter's size block against the left side of the angle plate; then put the type in, next to the side-bearing block and on top of the size block with the nick up. Be careful not to touch the face of the type. Put the other side-bearing block in, next to the type with its nick up. Adjust the assembly so the shoulder of the type is even with the ends of all the blocking. This makes it easier to see what the results of the routing are. Hold the assembly together on the angle plate with the left thumb. Try the routed plate to check the correctness of the routing. Put the front plate over the type [with the narrow end of the routed bevel against the blocks]. Push the front plate into the corner and square it up with the angle plate, bringing it down against the blocking around the type. Visually determine whether the brass plate clears the typeface by the required 2-4 points [or .030″-.050″].

If the front plate does not clear the type properly, remove it carefully from the assembly and rout or file or cut more metal around the hole to get the clearance needed. Repeat checking until the front plate clears the typeface as required. When it is determined, take the assembly apart carefully and put the prepared type and blocks away in a galley or other safe container, being sure to keep them

MATRIX MAKING: Material used for setting up forms for Electro Matrices (to be used in setting up forms only)				
Body	6- to 12-point inclusive	14- to 24-point inclusive	30- to 24-point inclusive	48- to 72-point inclusive
Depth Standard	B1	B2	B3	B4
Side Bearing each side (quad)	10-point or .1384"	14-point or .1937"	16-point or .2214"	18-point or .2490"
Head Bearing (lead slug)	26-point or .3597"	26-point or .3597"	26-point or .3597"	26-point or .3597"
Lower spacing Block (lead slug)	6-point or .0830"	6-point or .0830"	6-point or .0830"	6-point or .0830"
Thickness of Front Plate	7-point or .0968"	10-point or .1384"	12-point or .1660"	15-point or .2075"
Thickness of Back Plate	15-point or .2075"	14-point or .1937"	17½-point or .2421"	15-point or .2075"
Length of Brass	1½"	2"	2¼"	2½"
1-point = .013835. Side Bearings will be 24-point x 14-point x body height. From chart: 14-point required set width. From type: 24-point required body size.				

Figure 47. Matrix-making specifications.

together. [Many assemblies done at the same time can create a confusion of pieces: be extremely careful and do not mix them up. A mistake can ruin not one assembly but at least two!]

CHISELING AND SQUARING

Place the front plate on the anvil block, up against its shoulder. The block is set with its shoulder facing the worker. Chisel a semicontinuous line of struck nicks all the way around the interior of the routed bevel to give the deposited metal a dado to grow into. These nicks should be about halfway between the top and bottom of the plate. Use a chisel that fits the space, but no wider than 3/16″. A wider chisel will require so much force to drive it into the plate that it will bend or buckle the thin walls on the side of the plate. Hold the chisel as nearly horizontal as possible. Hit it sharply [with control] to get a cut 1-1½ points [or .015″-.020″] deep.

Straighten and square up the front plate to eliminate distortion caused by the routing and chiseling. All sides must be square, straight, and flat. Rub the plate on the stone to achieve this, but remove only enough stock as is necessary, especially on the face of the plate. If necessary to remove a lot of stock, push the plate across and back crosswise and across and back lengthwise. Be sure to remove all marks of the crosswise stoning before checking. The stone is about 14″ x 24″ [Norton Co. Corundum Vitrified Bond, 14″ x 24″ x 2½″]. One stroke lengthwise [up and down] and back will be enough to take before checking the plate. If the plate is too far out of flat to stone down easily, tap it flat with a small hammer on the anvil block. Next rub both edge surfaces on the stone to remove the bulge made by chiseling. Use the joiner. Then stone to perfect flatness. Be sure to burr hole thoroughly with the three-cornered knife after stoning: around the small perimeter of the bevel, on the top of the bevel, and around the surface perimeter of the plate. Check with turning gauge and straightedge. Faces [planes] must be parallel to within .0005″ and must be flat lengthwise and across when checked with the straightedge. Cut the head- bearing block. Get the correct thickness of the head-bearing block from the chart (see Appendix 1, p. 183). The width of the block is the same as the front plate. Use lead slug material. The block should be as high as the shoulder of the type [body height]. Cut the lower spacing block. It should be the same width as the plate. Use lead slug material. The lower spacing block is usually 6-point for convenience, but it must be large enough to fill the space between the type body and the lower edge of the bevel. This block must also be as high as the shoulder of the type. Remove the

burr from the face of the head and lower spacing blocks. Rub lightly across the stone. [Always use lead on a separate stone. Never stone lead on a stone used for brass.]

Square up the face and the side of the head-bearing, and lower spacing blocks that are going to be used next to the type shoulder. Use the joiner and stone. Hold the blocks on the joiner and push the joiner across the stone in the same way you stone the front plate. Remove any possible burrs from the side-bearing blocks. Rub the blocks lengthwise on their faces along a 14″ "Hand Second cut" file lightly. Be sure all the edges are free of burrs. Hand-scrape the sides to be plated on all bearing blocks with the three-cornered knife. Obtain a clean surface but remove as little as possible. Edges must be burred with the knife as flat to the piece as possible. Do not touch the scraped side with the fingers from here on. Get type hanger for supporting type in the bath. Be sure it is clean and square on the block end. Clean and square it up on the stone used for lead, if necessary. The hanger block should be a little smaller in width than the width of the head-bearing of the type block assembly.

WAXING

Melt wax in pot and gather for use the wax brush, rubbing cardboard, assembly plate, dull-knife, type supporting lead, depth gauge, depth standard, and pointed orange-stick. Have the type and its blocking in a type stand safe and ready to use. Clean work thoroughly. Do not allow any dust or debris to remain on any working surface. Wash down with Penetone, wipe dry, and blow off with air. Set depth gauge to depth standard and lock it. Set depth-gauge indicator to the highest increment to give yourself working leeway.

Select lead for supporting type. Use the largest lead support that will lie free under the routed area in the plate, rubbing it gently on the steel surface plate to clean and flatten it. A stroke 3″ back and forth once may be enough. Place supporting lead on steel assembly plate and put the front plate over it and check the setting of the supporting lead with the depth gauge. The smaller perimeter of the bevel in the plate should be *up*. Be sure everything is lying flat on the assembly plate when checking. Typeface must be .003″-.005″ deeper than that of the depth standard. [If the setting of the typeface is not lower by at least .003″ than the depth-standard reading that the depth gauge has been set to, change the lead and repeat. This setting cannot be checked or adjusted again after proceeding. It must be correct and accurate here or the type will not be in correct position within the matrix. An error will not appear until after the plate has been through the bath.]

Clean out the corner of the assembly plate with air. Be sure the bottom is clean and flat. Clean the supporting lead and put in place approximately where the hole in the plate will be. Wipe supporting lead on cardboard and clean with air before putting it in place. Wipe matrix plate [front plate] with hand, and air and put in place in corner over supporting lead. Do not hit lead with brass plate. Brass must be clean. Place in corner, small perimeter of bezel *up,* side against left side of assembly plate. Locate supporting lead in center of hole. Move into position by moving brass plate. Put head-bearing blocks in place. Clean the same way as the supporting lead. Clean scraped surfaces on cardboard. Clean with air. No dust or dirt allowed. Put in one side-bearing block same as above. Make sure nick is toward you. Put prepared type in place. Check for any damage to typeface with loupe. Put in assembly facedown. The nick should be toward you, and away from the head of the brass plate. The type should be carefully slid against the head and first side-bearing blocks. Rest it on the supporting lead lightly so as not to bruise the face. Do not move it once it is in place. Place the second side-bearing next to the type, and clean as above.

Clean assembly with air—use only 5-8 psi for this—and adjust accordingly with the air pressure regulator. Put hanger in position. Slide it along the plate into place against the lower spacing block and center it. Slide it in with the left hand in such a position that it can continue to hold the assembly together while the right hand performs the next operation. Check that the assembly is solid against the assembly plate. [More than one assembly can be made at the same time, but the more that are made, the more careful the worker must be in cleanliness, in accuracy, and in holding the parts together.] Wax all exposed areas of the assembly except the face and the head end. [The old wax-resist formula was 1 ounce rosin and 1 ounce Venus turpentine to 1 pound coarse beeswax.] Cover all areas of the assembly you can reach in the assembly plate except the exposed face of the head-bearing. Do not let excess wax run all over; it must be cleaned off for the next assembly. Let it just run fully into the joint between the assembly and the assembly plate. Hold the assembly together until the wax cools.

Remove the waxed assembly from the plate just as soon as it sets. Hold the form [as the waxed assembly is now called] and cut the wax between the form and the assembly plate with the dull-knife so as not to injure either form or assembly plate. Lift the form gently with the hanger. The wax must be cut so as it almost comes free by itself. A rip or tear may dislocate the pieces of the assembly. Wax the balance of the form. Turn form over by lifting off the assembly plate carefully and shift it to the left hand. Wax the side first, then the bottom, and finally the

front plate. The wax must be kept out of the routed area in the plate. Get a heavy coating on all the corners. Everything must be covered with wax-resist where plating is not desired. On plates for larger type where secondary routing with an end mill has been used, wax must be run down in the unrouted corner to prevent nickel plating at this point, as it must later be drilled for the pin of the shoe of the automatic casting machine.

When the initial coating of wax is applied, set the form down on its end and let the wax set thoroughly. [Go on to the next assembly.] Keep the wax out of the bevelled aperture. Inspect the form; then put on two additional coats of wax, allowing them to set between applications. All joints must be flush and sealed tightly.

Rub the inside of the hanger hook with emery cloth for better electrical connection. Wash the typeface and beveled opening thoroughly. Use a prepared wash of trisodium phosphate and sodium carbonate. Use 8 ounces of each per gallon of distilled water. Fill the cavity full of this solution and agitate with a soft sable brush [1/4″ or 1/2″ wide].This solution will remove every kind of contamination except mineral oil [petroleum]. Use Penetone for this. Be careful because Penetone will dissolve the wax-resist. Unless the cavity is absolutely clean the plating deposit will not adhere. Also, the solution should not be allowed to stand overlong in the cavity, as it will make the face too hard to extract from and more difficult to deposit a smooth surface [it can etch the plating surface]. As soon as the cavity of the form is clean, immerse it in a glass container [Pyrex baking dish] of distilled water. The cavity must not be allowed to dry out. Contact with air will oxidize and ruin the plating surface in a short time. Rinse the forms under the tap and examine them in good light. No air bubble can be allowed in the cavity.

PLATING AND RIVETING

Put forms in the bath, by lowering them carefully and be sure there is good electrical contact between the hanger and the cathode bar. The bath should be already on and running with a sink hanger to stabilize the ion flow and current levels. With nickel, too high an initial current will produce a rough, grainy deposit. Bring up the current after fifteen minutes of immersion. Plate with nickel until the recesses on smaller sized type forms have .010″ or so deposited; larger type [say 30-point body and over] at least .020″ plus of deposit, other sizes in proportion. Nickel baths should be run as close to 110°F as possible. [The variable is the melting point of the wax-resist.] Do not break contact with the hanger and the cathode bar for the entire duration of plating in the nickel bath.

When the nickel appears thick enough, remove the form from the bath, rinse under the tap, and inspect in good light. Defects in deposition will be apparent and should be noted, for changes with the next form to be immersed. Dry and wax the form. [The area around the perimeter of the nickel flower up to the edge of the aperture; be careful not to allow wax inside the cavity.] Clean cavity, if drying has occurred, apply reagent grade nitric acid and salt, rinse thoroughly, store under distilled water or immerse in the copper bath.

The copper bath should be running already before immersion. During plating check to be sure copper is filling all areas and not growing over any voids. Wax areas to retard growth in unwanted places. Areas may be waxed temporarily to stop plating and can be plated again following complete removal of the wax-resist. [Copper forms may be removed from the bath at any time after the first four hours or so. Kept wet, the plating surfaces can be reimmersed with no variance in deposition quality.] Continue plating until cavity is filled sufficiently.

COPPER/NICKEL BATH TECHNIQUE

A form may be immersed in the copper bath briefly *before* it goes into the nickel bath. Plate only enough copper ions to give something for the nickel to adhere to (a few microns only). Do not let the copper build up. This very finely grained deposit will assist in starting the nickel deposit correctly. About one minute in the copper bath is enough time. Keep the cavity wet and immerse in the nickel bath as usual. The minute traces of copper will wear away, leaving a smooth nickel surface when in service. [Scouring with fine pumice will also remove all traces of copper if the matrix is to be chrome plated.]

Remove wax from form and outside surfaces of the assembly. Do not attempt to remove the type model from the electro. Using the dull-knife, work over a container to catch wax, saving it to reuse again. Type should not be twisted or pried when disassembling the form. Fingers or small pliers can be used to gently pull the type out of the electro deposit in the plate. Larger type can be put into a bench vise. Carefully tap the plate off the secured piece of type. Be careful to pull straight. A twist can break off the type in the electro. The plate may be warmed briefly on the hot plate, keeping the temperature below the melting eutectic of the type metal. This will aid in removing particularly stubborn type models.

Inspect the face within the electro deposit. It must be perfect. If it is not perfect, throw it away. One cannot repair the face, and type cast from such an electro will bear the imperfection. Remove all wax-resist from the front plate. Wash in Penetone and blow dry. File or grind the excess copper from the *sides* of

the front plate. This will form a secure place to clamp when grinding down in the jig on the surface grinder. Remove from the grinder and rub flat on the stone [this is the *back* of the top plate, *not* its top]. Do not remove more metal than is necessary to get the surface flat. Check with the straightedge.

Mark for rivets and center punch marks. Determine thickness of the back plate, cutting it about .015″-.002″ wider than the front plate and be sure it is at least the same in length. Stone and burr the back plate, ensuring that it is flat and smooth on the side which joins the front plate. Drill holes for rivets in the front and back plates. Do the front plate first, burr it, and use it for a jig for drilling the back plate. Hold these plates together, being sure that the back plate overlaps on both sides of the top plate. Drill one hole at the head of the matrix; insert a rivet in the hole; drill the opposite end and do likewise. The rest of the holes are now drilled.

Remove these two rivets, and countersink for the rivet heads in both plates. [If many matrices are in progress, a punch of the particular character is made on both plates to aid in proper identification. Also remember which side is "UP" when countersinking for the rivet heads: the wrong side countersunk will prevent the proper assembly of the matrix.] Burr both plates on side opposite the countersunk holes, so they may meet well.

Fit the plates together. Be sure adjoining plates are flat and clean. Clean with Penetone and air dry. [A shallow depression can be filled in with 50:50 lead solder to make a firm joint. When putting the rivets in, be sure that the rivet heads project at least .010″ above the surface of the front plate. If they are even with or below, the plates will not rivet tightly together. Place assembly on anvil and rivet together. Many light blows of the hammer are better than a few heavy ones. Rivets should be set firmly, but do not buckle the matrix. The rivets should still project slightly on both sides when finished. File off rivets flush with plates. Use a 14″ bastard file. Check depth with gauge. Matrix depth should be .003″-.005″ deeper than the depth standard and flat. Matrix is now sent to the fitter.

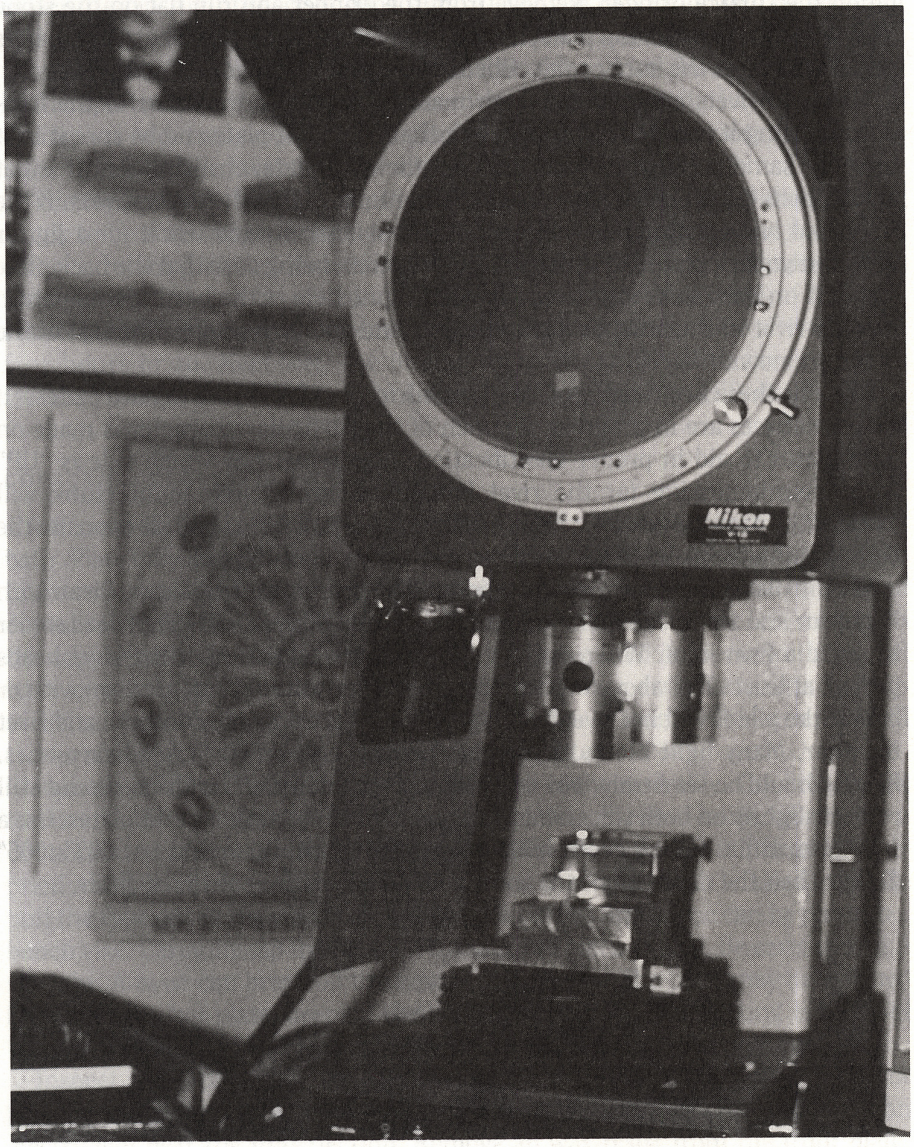


Figure 48. The celebrated Nikon V-12 profile comparator.

Chapter 14

Design Guidelines

The fitter is the craftsman who is responsible for maintaining continuity for the working type foundry and the continued integration of new designs, assimilating them into the fabric of type manufacture.

Fitters and Fitting

Fitters are lonely, usually tiresome, and for the most part irascible people—perhaps their work makes them so. It is demanding, taxing of the nerves, and never fully appreciated. The matrix must be perfect, because no amount of "shoemaking" will make it so, if it is not. Usable type cannot be made with defective matrices. Perfection being taken for granted, the fitter never hears about the work, unless it is wrong: "When I do well, nobody notices: when I make a mistake, everyone knows." Even praise is seldom considered without suspicion. The fitter vies with the liner for authority, and if they are incompatible, hell will ensue.

The following notes were provided by Frank L. Walsh, last of the ATF master fitters trained in the grand oeuvre:

> They will tell you that there are no tolerances in fitting, but this is not true. For instance, fitters are responsible for maintaining correct and accurate matrix drive depths. In this they also are indirectly responsible for type height. Type height is the sum of mold height and the matrix depth of drive (.9184″ ±). Any deviation from this dimension ±.0004″ is to be rejected. Now type height can vary as much as .001″ either way if the casting machine is improperly run or if the mold is worn out. As time passes, a matrix may also "pound in" while in service, and all these factors can severely affect the accuracy of cast type.

The fitting machine is the primary tool of the fitter. It is used to cut a matrix precisely to its proper dimensions. Microtome-like cuts can be made with it on the flat surfaces of the matrix body. The adjustable set wheels are calibrated in points and in half, quarter, eighth and sixteenth of a point increments. The work is viewed and set against the hairlines of the microscope which is also calibrated to the cutting stops, or "paddles," of the table of the machine. There is a 1 point clearance between the cutting head and its two revolving knives and the table. The fitter makes adjustments to his mind's eye, truing his calibration to what his eye perceives as "perfect." This ensures a steady, accurate machining of many matrices through the various steps of the dimensional cutting protocol. A fitter must maintain this device consistently; he must be able to remove, sharpen, and re-install cutters quickly, and interpret what is needed to maintain the quality standard of the work in hand.

A burr is usually thrown when making a cut, so the edges of the work must be broken by hand-filing the edges of the work piece. This chamfering ensures a flat and true contact of the work with the machine's surfaces. Square cuttings are absolutely essential: their absence is inexcusable. A fitter will tell you that the work must be perfect, but the true definition of this term is lost in human error. When recutting old work, one simply reproduces what has been done before. If a mistake is discovered, the accepted dimension must be fit to match regardless. (One is not to change history!) For new work the byword is to fit to "look" right. The orientation of the design on the body, its relationship to its fellow characters, its slope, set-width, etc., are all variables which are influenced in turn by the fitter's perception of the work. Eye perfection is *not* mechanical perfection. This subtle interpretive skill is what makes the difference between a great fitter and a mediocre one. Type designers have sometimes come to grief because of the interpretation or "attentions" perpetrated by the fitter. Another consideration with any new work is "productability." The designer and the fitter must both bow to the strictures of the mechanical casting machine. Commercial conservatism in this respect has been faulted many times by those with artistic leanings, but at the very least the design must be cast efficiently to be successful. The fitter must be skilled with the use of file, burin, graver, and the lap. He uses one or two large emery stones (surface stones) and at least two laps of varying fineness. These tools are his personal property, and it is unwise to incur his wrath by attempting to use them.

There is a curious story of a fitter who had a supposed remarkable ability to increase the drives of "short," underheight electros. For many years he practiced this skill with much secrecy, for in those days the matrix department was set apart and shut away from the other areas of the foundry. This was presumably for security reasons, although any electro pirate could obtain fonts of new designs by merely buying them over the counter. In reality it was a "knowledge is power"

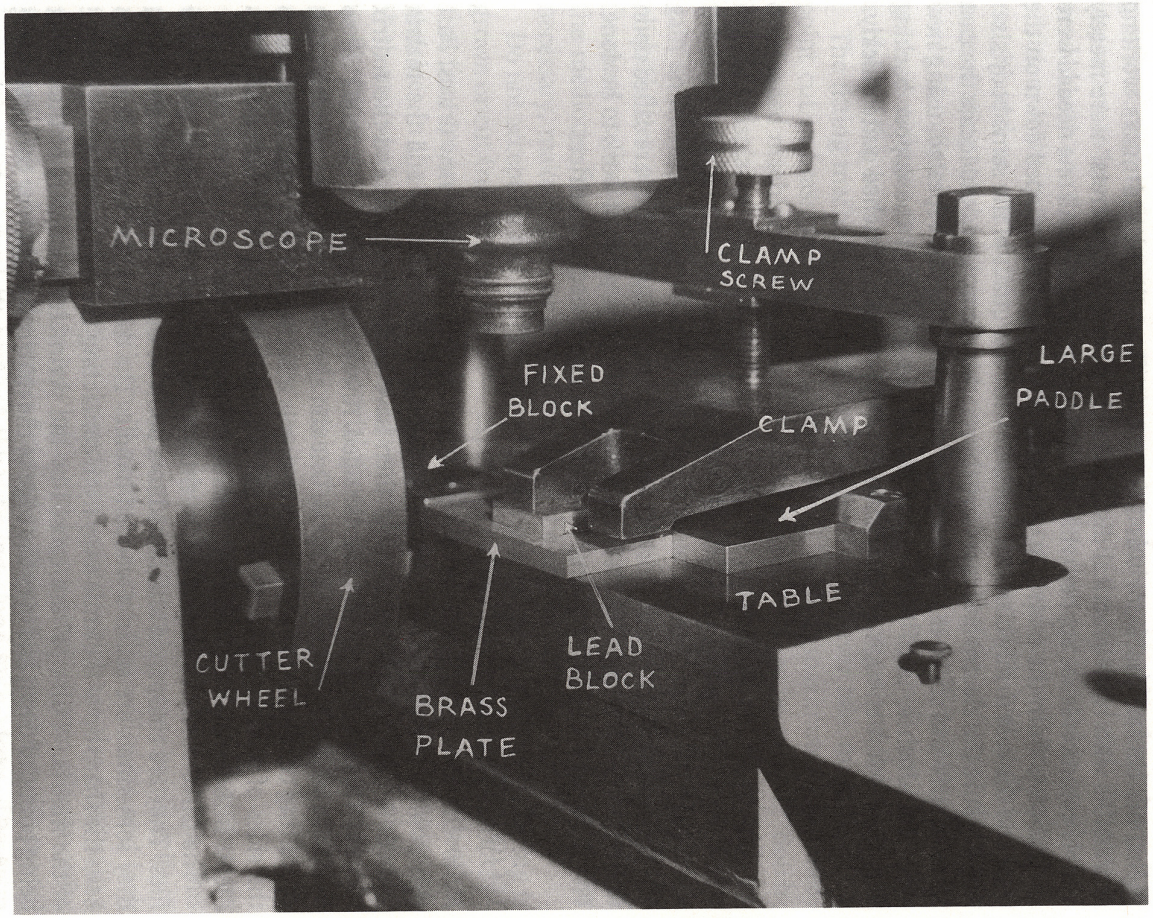


Figure 49. Detail of a fitting machine.

ploy of the sweatshop hierarchy. So when this fitter drew closer to his retirement, his chosen successor was keenly interested in the old man's working secrets. As with most practical disciplines, however, the "secrets" were merely simple common sense applied with inventive improvisation. All one needed were several casts from the matrix in question. Shoulders were shaped down on the type and the cast firmly clamped together with two quads of the same body size. Making sure the electro and cast were thoroughly clean, he would locate the cast in its matrix and strike it a blow with a hammer. This was repeated, using new types as punches, until the desired depth was gained. If the copper backing deposit was soft enough, a gain of .0008"-.001" could be reached quite quickly.

Electro Matrices

Fitters are usually the same workers who make electros, and they are called upon to fill in for others or to lend a hand if there is a great press of work to be done. The most critical job is making the front plates for electro matrices.

TECHNIQUES

Never cut down electro matrices more than .008" to adjust for new drives. Past this point the rivets holding the laminates will be shorn off and the matrix ruined. A new bottom plate would then have to be fabricated and the matrix redone, if the front plate was not damaged. Always rub the last .001"-.002" or so down of a matrix front plate by hand. One can always remove more material, but depositing copper to make up a dimension is a bother. Most repairs are done to the sides of matrices because of mistakes in side-bearing dimensions or alignment. If the mistake is severe, it is usually easier to start over.

The three-cornered knives of the fitter are best made from small triangular files. They are sharpened and honed to a point at the end. Frequently restoned, they sometimes are set in a wooden handle. The most important concern is to keep the sharp tip of the knife away from contacting the casting surface of the eye of the matrix. "Pull-ups" are caused by the perimeter shoulders of the matrix being pounded down and over the edge of the matrix eye, thereby compromising the draft needed for efficient removal of the cast from the matrix. A set of three or four of these knives with different degrees of angle is useful for cutting out these

pull-ups. A fitter must also trim the sharp edges of counters in newly engraved matrices, prior to fitting them. Fitting machine knives should be kept sharp. It is important to learn how to fix them in position in the cutting head. Patience is needed with an offset wrench, because the set-screws are located in an obscure position. If the cutters are not set evenly, the cut produced will be uneven and rough; and as one cutter will be doing all the work, it will dull too fast, necessitating a resharpening too soon. As mentioned before, a 1/2 point clearance has to be maintained between the cutter and the table (use a 72-point thin copper space as a finger-gauge). When properly set both cutters will just "kiss" the surface of the work after the paddle adjustment has been set and the work cut.

The fitting machine is a precision milling device. Never take more than a 2 point cut in brass and copper, in steel only a 1/2 point maximum. A jammed, overloaded machine will fracture the cutting head boss, so be careful. "Botching" is a displacement of matrix metal caused by striking the matrix roughly on the anvil with a chisel or punch, thereby "raising" the surface of the matrix to gain an increase of dimension. It is a technique frowned upon by the accomplished fitter, and although it will get you out of trouble relatively quickly, its frequent use indicates the lack of skill, training, and general poor work habits of the mediocre fitter. If possible, avoid the botch, do accurate work, and when necessary, make repairs or alterations with the copper bath.

Do not accept for fact that the electro or engraved character you are fitting is grown or cut true and square, or— especially in the case of italics and scripts— that they are on their proper degree of grade and slant. Always check with other matrices in the suite that is in service, using the hairlines in the microscope. With new work, the working drawings must be consulted (and the designer as well). Often a new face may need trial proofs of various characters in order to ascertain the best orientation of certain characters. For these designs extra set must be allowed for, so the fitter can maneuver the matrix for perfect grade, alignment, and letter-set.

A close matrix is used to fit italics and scripts. The italic is fit against an imaginary parallel, eyed from the near lower corner of the close matrix. This parallelogram is a maintained constant, aligned to the microscope hairline; if not aligned, the uncorrected cutting will produce a cast that will print and look "wrong" when set with its fellow characters. Scripts, which are also fitted with a parallel, are not fitted tight to set. Instead they are fitted with an allowance for "joining." This is because the type is finished on the casting machine with special knives or (more often) by hand at the dressing stand with plows. The extra allowance for "sweeps" (before or after; sometimes both on a character) is

Special Casting—15 on 16 Point Cloister Lightface for John Henry Nash July 18, 1930

HHAHBHCHDHEHFHGHHHIHJHKHLHMHNHOHPHQHRHSHTHUHVHWHXHYHZHQuHH Hm

OBOCODOGOJOOOPOQQUOQuO FAR AWAY FROM WAVY AVENUE LIVES A TYPE FOUNDER

IN THESE BERKSHIRE HILLS HUNDREDTH COMSTOCK ELEGANCE TAYLOR DAZZLE REJECT

LESSON FAVOR ALTAR PAPER GOOD JOHN OXEN HHQummH HmHmHmHmHmHmHmHm

Figure 50. A sample "Nonsense" proof used to fit a design.

figured and provided for, so the character may join its fellows in an unbroken sweep. When growing from a type model or being cut from a pattern, this must be planned for, as no amount of pivoting will bring the character close enough to the set-width edge for dressing. Without such preparation, poorly engineered script faces are hopeless junk, which only confound compositors.

MATRICES AND TOOLS

There are four kinds of service matrices:

1. Liner's matrix: usually a "cross" form, the earlier ones were circular in form. Em set in width. Purpose: to check alignment and side-bearing of casting machine. Cast on machine.
2. Fitter's matrix: as above but also for depth of drive. Purpose: used to check and calibrate fitter's equipment, fitting machine, fitter's hand-molds, etc., and in conjunction with a fitter's standards. Rarely if ever cast on the machine.
3. Close matrix: cut by engraver in rectangular extremes of perimeter of body and a particular alignment line (i.e, Common, Cap, Art, etc.). 2- or 3-em set-widths (rarely 4-em). Never cast.
4. Height standard matrix: these vary in their cast shape (usually a cross) and are used by the casting machine service machinist to check mold height of each machine. Always cut in steel.

A fitter's complement of files must include two or three sizes of the following kinds: *(a)* single cut smooth, *(b)* mill smooth, *(c)* mill bastard, and *(d)* a good open cut fine bastard, as used by the dresser. The latter one is quite rare, being handmade, and is difficult to find nowadays. Fitters would pass on their special tools to their successors (if they liked them), thus preserving the in-house traditions. When using the file, the fitter does not draw the file against an immovable work piece held in the hand or vise. Successful hand filing with accuracy requires that the work piece be drawn against a "floating" file surface held in the opposite hand. This will ensure a precise cut and reduces the amount of riffling and scrolling (teeth grooves) produced on the work piece. To clean a simple file (not a cross-cut one), merely press a short length of 6-point slug parallel to the teeth of the file. The lead will bite down into the file and push ahead of it all the accumulation of debris trapped in the file. A final note: never argue with the fitter.

Old Designs

Old designs for the most part are regrown in electro either from sorts of the original type or from casts from the original matrices. Electros grown from badly worn type cannot presume to be an exact reproduction of the original design. Wear, damage, and the fitter's skill (or lack of it) are all factors that affect the finished product. Every compromise, no matter how slight, brings the work that much further away from the design's original integrity. Worn type presents a problem of typeface preparation beyond that which is ordinarily encountered. Some techniques (including phosphatic electrolysis) intended to remove accumulations of ink, dirt, and oxidated metal render the type model useless. Only a clean unblemished metal surface will release freely when the typeface is disengaged from the electro deposit. One possibility is to use three-cornered knives and gravers to lay bare the metal once again (this can be a tedious job). The weight of the design must not be altered, so only .0001″-.0002″ may successfully be removed by the fitter with his joiner and trued block of serpentine. Remove more than this and the cast must be literally re-engraved, while being monitored under the measuring microscope, and a series of smoke proofs made to check progress.

Smoke Proofs

To make a smoke proof, the model, punch, or piece of type is held in a hand clamp and is passed through the upper flame of a beeswax, or a "plumber's," candle. (The area of the upper flame is where the tongue of fire's outer perimeters meet, or just above it.) Fine soot will deposit on the surface of the metal. The warm type or punch is then fixed in a proofing jig, paper is applied to the upper or platen of the device, and is imposed. Some craftsmen prefer thin tissue. If more work is indicated, Chinese white is applied with a fine sable brush and the graving and cutting are brought forward. Always be sure there is a cushion on the platen so that the model will not be damaged. All measurements are checked under the microscope. The weight of a character is just as important as its set-width and height. If there are to be any variations, it is better to share these proportions evenly and equally between the three dimensions.

In lieu of formal artwork (most of which has not survived anyway), a handy

tool is the Profile Projector or Comparator, coupled with an 8″ x 10″ Polaroid camera back system, which produces the most astonishingly quick and accurate proofs for copying. A piece of type, an ancient matrix, or even an original specimen sheet can provide the raw material to bring an old "lost" design back from oblivion. Relieved of the need and expense of a dark room, the Guild has perfected the technique and has successfully duplicated both "new" and old characters that phase quite suitably with existing ones.

New Work

We have used all the techniques at our disposal to recreate many designs from the past, but what of new work? New work can be somewhat less demanding, but certain other problems arise. The design (no matter how striking or subtle) must conform to the physical limitations inherent in mechanical casting. The most important decision may well be what machine to cast it on. Another factor is just how much of the design will be cast? This tells us how much effort to spend on matrix fabrication. Even *roughs* for amateur casting can require a substantial investment if the hundred plus characters required for a suite of just one size is reckoned with. The most popular sizes done at present in our matrix department have all been in the 12- to 24-point size range. A surprise has been the number of "exotic" sizes that keep turning up, such as 20-point and especially 16-point. (The artistically endowed seem to favor 16-point as a text size.) Drives are also a problem. Most new work at ATF was done on B depths, all others being considered obsolete. Unfortunately, few people have access to B-drive molds. The Guild favors the old St. Louis depths for foundry casting, and will cut or grow matrices ("flats") for Monotype Display and Thompson (.050″-.065″).

Another problem is knowing what to expend one's energies upon. A few years ago, a patron of the Guild embarked on a project to bring one of Tolkien's alphabets to letterpress. After some trial work and a few characters had been cut, the project was shelved for lack of funds. One must ask quite frankly: who would possibly use such a design? Costs for a suite of foundry matrices can go as high as $5000. Most projects must have the expectation of some kind of monetary return, or at least a "break-even" goal. With this kind of levelheadedness, we must be content with the reproduction of old designs or perhaps the embellishment of existing ones, as with certain customized characters, such as swashes.

Afterword

A final question: *why?* Remember the stored formes in certain Netherlands printing offices? They have stood on galley exactly as they were composed nearly four hundred years ago! The realization of how the many varied changes in our world have occurred even within the brief span of the existence of our Guild is overwhelming. For the Guild, it seems that the problems of those faroff days, which at the time loomed so importantly over us and our craft, are as nothing, and indeed seem almost desirable in comparison to what we face now. We have not merely arrived at the end of an era, little prepared for, but something of the grandeur of ancient times is about to be lost. William Morris was right: one may reproduce but never duplicate! A craft that wields such influence of the mind, such realization of things of great beauty, and such a permanent record of the accomplishments of man is most rare indeed. What we have chosen to attempt to save is not merely some dusty typographic art techniques. Examine the slipshod currency in your wallet, or the "weak kiss" of offset and laser graphics: they just do not measure up. Non-letterpress printing gazes back at us with the lackluster eyes of a dialysis patient. Something was traded away for its very existence.

There is room for both extremes to coexist. Dampened hand-made paper, firmly struck with well-cast type formes and properly inked with stuff worthy of the name, creates an imperishable, three-dimensional document of the glories of the hand and mind of man. Our craft *must not* become extinct: it is not a species of some obscure lifeform limping quietly toward a long and permanent defeat. Letterpress embodies the very essence of our civilization.

Appendix 1

Standards

In 1738 the French type founder Fournier gave the name of Prototype to the pattern or standard of measurement into which he divided the sizes of bodied type. This was the first effective effort to establish a uniform standard of body sizes. His Prototype contains two inches of 144 points; it is the plan and measurement upon which the American point system is based.

In the Fournier system, 1000 points = 35 centimeters. Due to the general use of picas as a printer's measure the United States Type Founders' Association adopted the following as standard in 1886: *(a)* 83 picas = 35 cm, *(b)* 996 points = 35 cm, *(c)* 1 pica = .4217 cm, *(d)* 1 point = .35145 mm. In 1916 the equation of .35145 millimeters = 1 *English* point was proposed; this equation was not accepted at the time, however, since England did not then have a standardized point system; but these equations are now the standard in both the United States and England.

The *general* equivalent of a point is approximately $^1/_{72}$″, or approximately .0138″: but this figure cannot be taken for computing an accurate point system.

ON MILLIMETER TO INCH VARIATIONS

The computations of millimeters into inches has varied. In 1866 the United States Bureau of Standards adopted the metric system as legal and ascertained that 1 mm = .03937″, which in turn was derived from the equation of 1 mm = .03936982″. In 1933 the American Standards Association adopted 25.4 millimeters = 1″ as a standard, one which is now recognized as the standard equivalent throughout the world.

COMPUTATIONS IN THE OLD POINT SYSTEM

Considering first our old point system equivalent of 1 point = .35145mm, we get the following computation (using the legal Standard of 1886, i.e. 1 mm = .03937″): 1 English point = .35145 x .03937 equals .0138365865″. Using the

equation of 1 mm = .03936982″ the result is 1 English point equals .35145 x .03936982″ = .013836523239″. Finally, using the American Standards Association equation of 25.4 mm = 1″; 1 English point = .035145 ÷ 25.4 = .01383661417″. The three different point-to-inch equations compute to six decimal places, showing one English point = to .013837″—the standard until the derivation of the American Point Standard.

COMPUTATIONS IN THE NEW POINT SYSTEM

In computing the American Point Standard, we take the standard adopted in 1886 by the United States Type Founders Association of 83 picas (996 points) = 35 cm; and the 1933 American Standards Association adopted standard of 25.4 mm = 1″. This means 1 American Standard point = 35 ÷ 996 = .035140562 cm or .351405620 mm. Ergo, 1 American Standard point = .35140562 ÷ 25.4 = .0138348666″. In comparing the computations of the United States Type Founders Association point with the English point, which was apparently approximate, we get a difference of .00004438 mm (1 English point = .35145 mm, while 1 American Standard point = .35140562 mm). The difference is caused because our previous point standard of .013837″ differs from the American Point Standard of .013835″ when reduced to six decimal places. This figure correlates with that of Theodore L. De Vinne[57]; but other sources usually state that 1 point = .013834″. From our calculations, we find that in reducing the answer of the American Point Standard to six places, we get .013835″, which is more accurate.

ON AMERICAN STANDARD TYPE HEIGHT

In 1866 the United States Type Founders Association asserted that 83 picas = 15 Type Heights. Using our deduction that 1 pica (or 12 points) = .1660183848″, we arrive at the following equation:

$$\text{Type Height} = 83 \times \frac{.1660183848}{15} = .918635062560''$$

From this we observe that Type Height = .9186″ when reduced to four places. The present accepted American Point Standard of .9180 for Type Height differs by .0006″ from the original formula. The tolerances allowable in making type for

[57] De Vinne, Theodore. *The Practice of Typography* (New York, 1902).

Type Height (American Point Standard) .9180″ is ± .0005 for all sizes except 72-point bodies over 60-point set (± .0008) and 120- or 144-point bodies (± .001).

ON FOREIGN TYPE HEIGHTS

In a Berthold Specimen Book of 1900 Didot Type Height[58] is given as 62⅔ points = .927508543954″; Type Height = 23.56mm = 9275529592″ (DTH = .928″).

The following countries use the American Point Standard Height of .9180″: Africa, Australia, Canada, England ("Anglo-American"), Mexico, and Central and South America. There are various nonstandardized Type Heights throughout the world:

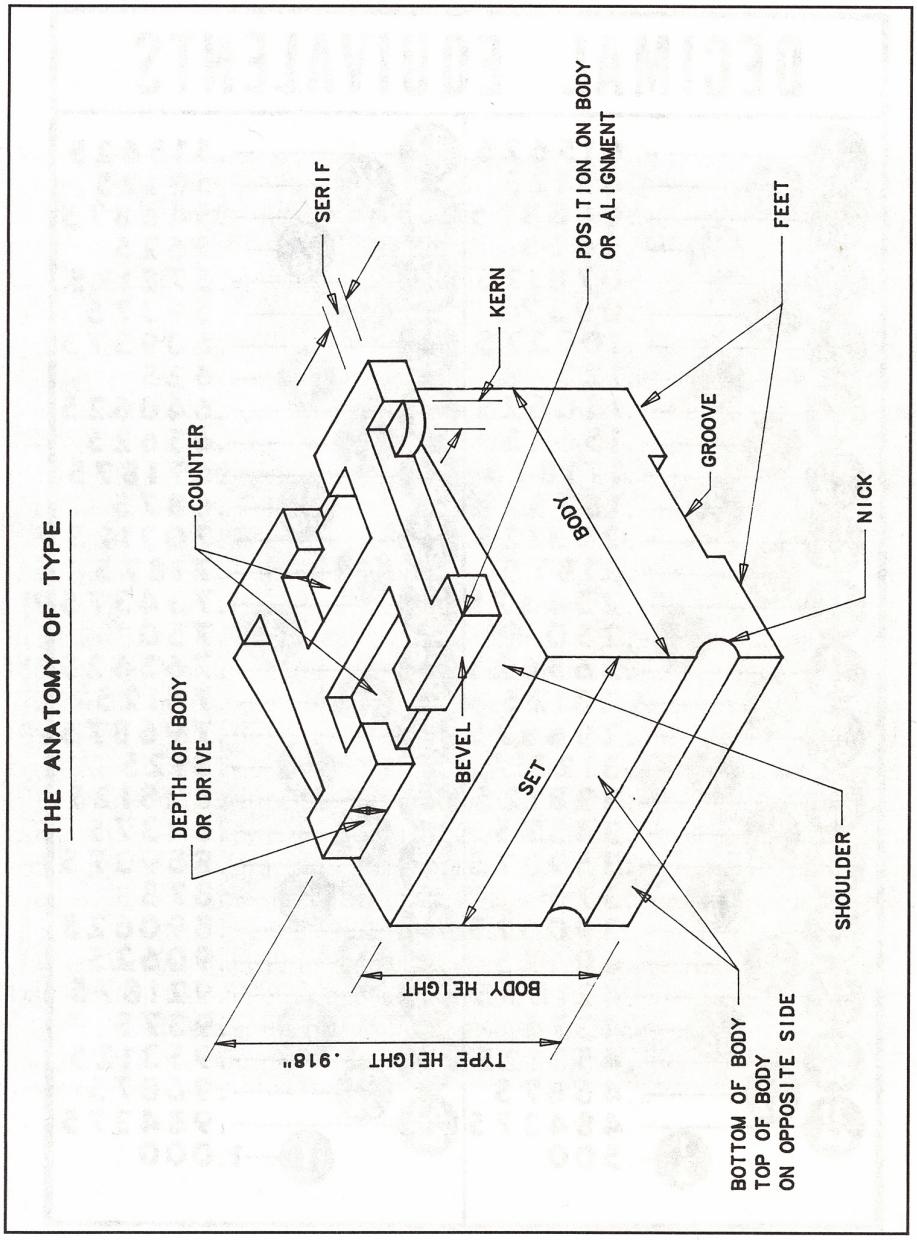
Bulgaria = .936″
Denmark = .982″; 986″; .987″
Dutch = .978″
France = .928″ (Didot)
Germany = .928″ (Didot)
Holland = .978″
Italy = .987″
Russia = .989″
Sweden = .928″ (Didot)

THE 144-POINT BOX GAUGE

Take set casts and place the indicated quantity of type on a flat, clean surface. Determine the amount of difference from 144-point (if any), and add point dimension standards to bring them up to 144-point. For example, to make a 67-point standard difference, add a 36-point, a 24-point, and a 7-point standard. Gently push them into the bottom of the gauge; they should firmly enter and hold. Adjust set-width of casts until they fit as above. Standards required for this discipline are one each of 1-, 3-, 4-, 5-, 6-, 7-, 8-, 12-, 18-, 24-, 30-, and 36-point.[59]

[58] It should be noted that when casting Didot matrices on American bodies, or from ancient matrices whose characters produce kerning both top and bottom, always go to the next larger body size (i.e. 12D on 14 point; 14D on 16 point; 16D on 18 point; 18D on 20 point; etc.). This is the rule, unless tedious hand finishing is acceptable, or the quantity very small.

[59] The 1-point standard is required only for the 35¾-point set width.


THE ANATOMY OF TYPE
SERIF
KERN
POSITION ON BODY
OR ALIGNMENT
FEET
COUNTER
GROOVE
BODY
NICK
DEPTH OF BODY
OR DRIVE
BEVEL
SET
SHOULDER
BODY HEIGHT
TYPE HEIGHT .918"
BOTTOM OF BODY
TOP OF BODY
ON OPPOSITE SIDE

DECIMAL EQUIVALENTS

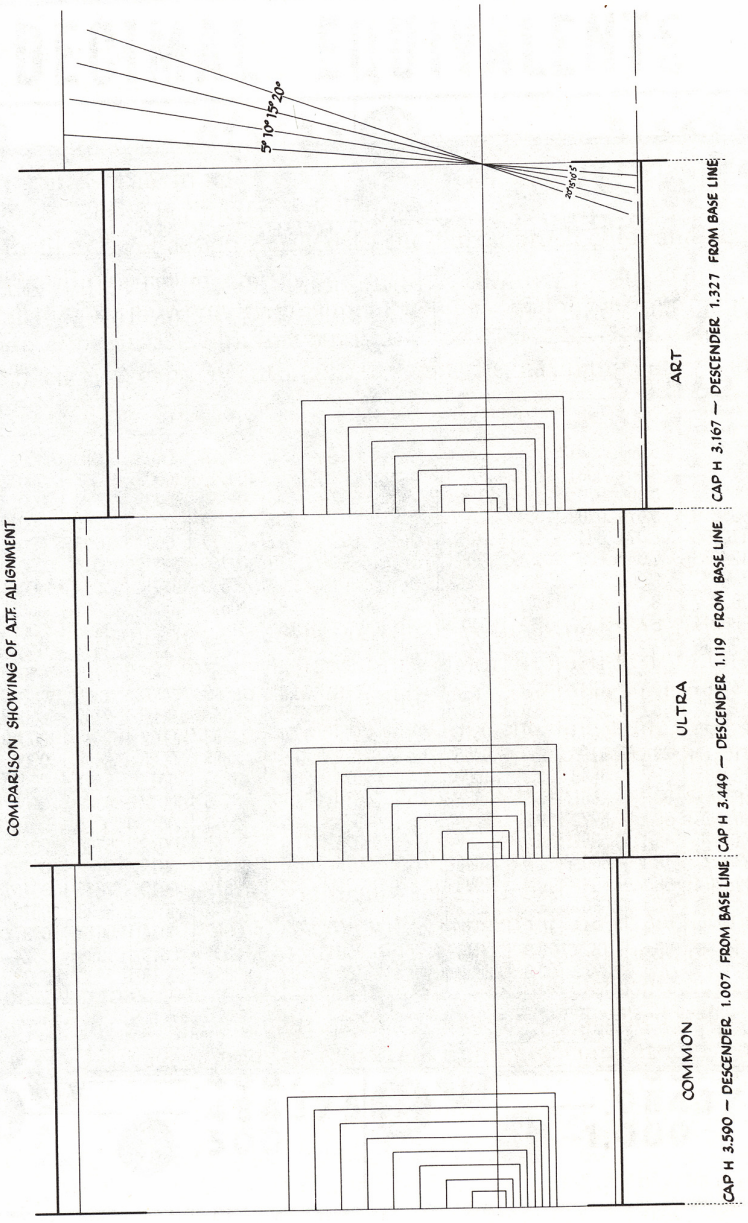
1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.250	3/4	.750
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.500	1	1.000

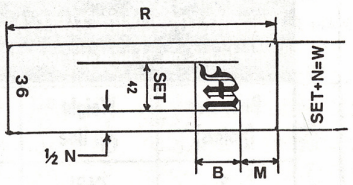
PUNCH AND MATRIX TABLE

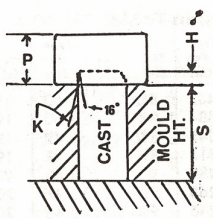
MAY, 1902 — AMERICAN TYPE FOUNDERS COMPANY

DIMENSIONS OF STANDARDS FOR COMMON LINE						DIMENSIONS FOR CUTTING PUNCHES AND MATRICES TO LINE ON TOP AND BOTTOM*							
Bodies		From Top of Body to Line		From Bottom of Body to Line		From Top of Body to Top of Cap "H"		From Top of Cap "H" to Line		Drop of Cap "H" Below Line	Height of Cap "H" in Cast Type	Estimated Shrinkage	Height of Cap "H" in Matrix
Points	Inches	Points	Inches	Points	Inches	Points	Inches	Points	Inches	Inches	Inches	Inches	Inches
5	.069185	4.06	.05618	.94	.013	.5	.00692	3.56	.04926	.0003	.0495	.0001	.0496
5½	.0761035	4.56	.0631	.94	.013	.5	.00692	4.06	.05618	.0003	.0565	.00011	.0566
6	.083022	5.06	.070	.94	.013	.5	.00692	4.56	.06309	.0003	.0634	.00013	.0635
7	.096859	5.07	.0702	1.93	.0267	.5	.00692	4.57	.06324	.0003	.0635	.00013	.0637
8	.110696	6.07	.084	1.93	.0267	.5	.00692	5.57	.07707	.0004	.0775	.00015	.0776
9	.124533	7.08	.098	1.92	.0265	.5	.00692	6.58	.09105	.0004	.0914	.00018	.0916
10	.13837	8.09	.112	1.91	.0264	.5	.00692	7.59	.10502	.0004	.1054	.00021	.1056
11	.152207	8.1	.1121	2.9	.0401	.5	.00692	7.6	.10516	.0005	.1057	.00021	.1059
12	.166044	9.1	.1259	2.9	.0401	.5	.00692	8.6	.119	.0005	.1195	.00024	.1197
14	.193718	11.1	.1536	2.9	.0401	.5	.00692	10.6	.14667	.0007	.1474	.0003	.1477
16	.221392	13.1	.1813	2.9	.0401	.5	.00692	12.6	.17435	.0007	.1751	.00035	.1754
18	.249066	14.1	.1951	3.9	.054	.5	.00692	13.6	.18818	.0007	.1889	.00038	.1893
20	.27674	16.1	.2227	3.9	.054	.5	.00692	15.6	.21586	.0008	.2167	.00043	.2171
24	.332088	19.1	.2643	4.9	.0678	1.5	.02075	17.6	.24353	.0008	.2443	.00049	.2448
30	.41511	23.1	.3196	6.9	.0955	1.5	.02075	21.6	.29888	.0008	.2997	.0006	.3003
36	.498132	28.1	.3888	7.9	.1093	1.5	.02075	26.6	.36806	.001	.3691	.00074	.3698
42	.581154	33.1	.4581	8.9	.1231	1.5	.02075	31.6	.43725	.001	.4382	.00087	.4391
48	.664176	38.1	.5272	9.9	.1370	1.5	.02075	36.6	.50643	.001	.5074	.00101	.5084
54	.747198	43.1	.5964	10.9	.1508	1.5	.02075	41.6	.57562	.0012	.5768	.00115	.578
60	.83022	48.1	.66556	11.9	.16466	1.5	.02075	46.6	.6448	.0012	.646	.00129	.6473
72	.996264	58.1	.804	13.9	.1923	1.5	.02075	56.6	.78317	.0012	.7844	.00157	.7859
84	1.162308	69.1	.9561	14.9	.2062	2.5	.03459	66.6	.92154	.0013	.9228	.00184	.9247
96	1.328352	79.1	1.0945	16.9	.23385	2.5	.03459	76.6	1.0599	.0014	1.0613	.00212	1.0634
108	1.494396	89.1	1.2329	18.9	.2615	2.5	.03459	86.6	1.1983	.0015	1.1998	.0024	1.2022
120	1.66044	99.1	1.3712	20.9	.2892	2.5	.03459	96.6	1.33665	.0016	1.3383	.0027	1.341

* NOTE.—The heights given for Cap "H," in the "Dimensions for Cutting Punches and Matrices to Line on Top and Bottom" table are only for those which are straight on both top and bottom. Where the design calls for curves or points, they must be cut longer to appear the same length.


COMPARISON SHOWING OF A.T.F. ALIGNMENT
5° 10° 15° 20°
ART
CAP H 3.167 — DESCENDER 1.327 FROM BASE LINE
ULTRA
CAP H 3.449 — DESCENDER 1.119 FROM BASE LINE
COMMON
CAP H 3.590 — DESCENDER 1.007 FROM BASE LINE





14

fW

MOULD•	B BODY	H DRIVE	K BEVEL	M HEAD BEARING	N TOTAL SIDE BEARING	P ° THICKNESS	R LENGTH
STL-HA	6pt	.0309	.009	.19144	.2184	.2975	1–3/8 inch
STL-HA	8	.0309	.009	.19158	.2184	.2975	1–3/8
STL-HA	10	.0309	.009	.19252	.2184	.2975	1–3/8
STL-HA	12	.0309	.009	.19290	.2184	.2975	1–3/8
STL 2	14	.0535	.014	.23385	.2329	.3252	1–3/4
STL 2	18	.0535	.014	.23360	.2329	.3252	1–3/4
STL 2	24	.0535	.014	.23491	.2329	.3252	1–3/4
STL 2	30	.0535	.014	.23428	.2329	.3252	1–3/4
STL 3	36	.0844	.020	.30642	.3331	.3944	2–1/4
STL 3	42	.0844	.020	.30531	.3331	.3944	2–1/4
STL 3	48	.0844	.020	.30685	.3331	.3944	2–1/2
STL 3	60	.0844	.020	.30654	.3331	.3944	2–1/2
STL 3	72	.0844	.020	.30660	.3331	.3944	2–1/2
B-1	6-12pt	.0420	.012	.3321	.2214	.2975	1–1/2
B-2	14-24	.0758	.017	.3321	.3321	.3252	2
B-3	30-42	.0968	.023	.3321	.3874	.3944	2–1/4
B-4	48-72	.1241	.027	.3321	.4428	.3944	2–1/2
B-4	84-108	.1241	.027	.3321	.4428	.4220	3–1/8
B-4	120+up •	.1251	.027	.3321	.4428	.4220	3–1/8

MOULD•	B BODY	AUTOMATIC MOULDS			PIVOTAL ('H&S') MOULDS STD		
		S	H+S	ESTIMATED SHRINKAGE	S	H+S	ESTIMATED SHRINKAGE
STL-HA	4-12pt	.8903	.9212	.0032	.8889	.9198	.0018
STL 2	14-30	.8677	.9212	.0032	.8663	.9198	.0018
STL 3	36+up •	.8368	.9212	.0032	.8358	.9202	.0022
B-1	6-12	.8792	.9212	0032	.8777	.9197	.0017
B-2	14-24	.8454	.9212	.0032	.8439	.9197	.0017
B-3	30-42	.8244	.9212	.0032	.8229	.9197	.0017
B-4	48-108	.7975	.9216	.0036	.7956	.9197	.0017
B-4	120+up •	.7975	.9226	.0046	.7956	.9207	.0027

•FOUNDRY MATRIX-MOULD SPECS•

STANDARD MOULDS

•SHRINKAGE FACTORS•

1. METAL ALLOY
2. EUTECTIC
3. KIND OF MOULD
4. CASTING PRESSURE

©1985 THE BENTON ENG. CO. & THE DALE GUILD INC. 2205 RT9 HOWELL, NEW JERSEY USA 07731

Conversion Table

Pt. Set	Type Per Line	Pt. Set	Type Per Line	Pt. Set	Type Per Line
1	432	8½	50	19	22
1⅛	384	8⅝	50	19¼	22
1¼	345	8¾	49	19½	22
1⅜	314	8⅞	48	19¾	21
1½	288	9	48	20	21
1⅝	265	9⅛	47	20¼	21
1¾	246	9¼	46	20½	21
1⅞	230	9⅜	46	20¾	20
2	216	9½	45	21	20
2⅛	203	9⅝	44	21¼	20
2¼	192	9¾	44	21½	20
2⅜	181	9⅞	43	21¾	19
2½	172	10	43	22	19
2⅝	164	10⅛	42	22¼	19
2¾	157	10¼	42	22½	19
2⅞	150	10⅜	41	22¾	18
3	144	10½	41	23	18
3⅛	138	10⅝	40	23¼	18
3¼	132	10¾	40	23½	18
3⅜	128	10⅞	39	23¾	18
3½	123	11	39	24	18
3⅝	119	11⅛	38	24¼	17
3¾	115	11¼	38	24½	17
3⅞	111	11⅜	37	24¾	17
4	108	11½	37	25	17
4⅛	104	11⅝	37	25¼	17
4¼	101	11¾	36	25½	16
4⅜	98	11⅞	36	25¾	16
4½	96	12	36	26	16
4⅝	93	12⅛	35	26¼	16
4¾	90	12¼	35	26½	16
4⅞	88	12⅜	34	26¾	16
5	86	12½	34	27	16
5⅛	84	12⅝	34	27¼	15
5¼	82	12¾	33	27½	15
5⅜	80	12⅞	33	27¾	15
5½	78	13	33	28	15
5⅝	76	13¼	32	28¼	15
5¾	75	13½	32	28½	15
5⅞	73	13¾	31	28¾	15
6	72	14	30	29	14
6⅛	70	14¼	30	29¼	14
6¼	69	14½	29	29½	14
6⅜	67	14¾	29	29¾	14
6½	66	15	28	30	14
6⅝	65	15¼	28	30¼	14
6¾	64	15½	27	30½	14
6⅞	62	15¾	27	30¾	14
7	61	16	27	31 to 33	13
7⅛	60	16¼	26	33¼ to 36	12
7¼	59	16½	26	36¼ to 39¼	11
7⅜	58	16¾	25	39½ to 43	10
7½	57	17	25	43¼ to 48	9
7⅝	56	17¼	25	48¼ to 54	8
7¾	55	17½	24	54¼ to 61½	7
7⅞	54	17¾	24	61¾ to 72	6
8	54	18	24	72¼ to 86¼	5
8⅛	53	18¼	23	86½ to 108	4
8¼	52	18½	23	108½ to 144	3
8⅜	51	18¾	23	144½ to 216	2

WEIGHT CONVERSION TABLE: Approx. weight per line & no. of lines per pound by body size

Body size (points)	Weight per line	No. of lines per pound
3	.0625	16.000
3½	.0729	13.717
4	.0833	12.004
4½	.0938	10.661
5	.1037	9.643
5½	.1146	8.726
6	.1250	8.000
8	.1660	6.024
9	.1875	5.333
10	.2080	4.808
12	.2500	4.000
14	.2900	3.448
16	.3330	3.003
18	.3750	2.667
20	.4160	2.404
24	.5000	2.000
28	.5790	1.727
30	.6250	1.600
36	.7500	1.333
42	.8750	1.143
48	1.000	1.000
54	1.125	.888
60	1.250	.800
72	1.500	.667
84	1.750	.571
96	2.000	.500
120	2.500	.400
144	3.000	.333

NOTE: Unusual body sizes are referred to the next highest body size as are all Didot point bodies.

PRACTICAL TYPECASTING: TABLE FOR 144POINT BOX GAUGE SET STANDARDS

SET	QUAN	STDS	SET	QUAN	STDS	SET	QUAN	STDS	SET	QUAN	STDS
1-1/8	128	0	7-1/8	16	30	13-1/8	8	39	24-1/4	4	47
1-1/4	112	4	7-1/4	16	38	13-1/4	8	38	24-1/2	4	46
1-3/8	96	12	7-3/8	16	26	13-3/8	8	37	24-3/4	4	45
1-1/2	96	0	7-1/2	18	9	13-1/2	10	9	25	5	19
1-5/8	80	14	7-5/8	16	22	13-5/8	8	35	25-1/4	4	43
1-3/4	80	4	7-3/4	16	20	13-3/4	8	34	25-1/2	4	42
1-7/8	72	9	7-7/8	16	18	13-7/8	8	33	25-3/4	4	41
2	72	0	8	18	0	14	10	4	26	5	14
2-1/8	64	8	8-1/8	16	14	14-1/4	8	30	26-1/4	4	39
2-1/4	64	0	8-1/4	16	12	14-1/2	8	28	26-1/2	4	38
2-3/8	56	11	8-3/8	16	10	14-3/4	8	26	26-3/4	4	37
2-1/2	56	4	8-1/2	16	8	15	9	9	27	5	9
2-5/8	48	18	8-5/8	16	6	15-1/4	8	22	27-1/4	4	35
2-3/4	48	12	8-3/4	16	4	15-1/2	8	20	27-1/2	4	34
2-7/8	48	6	8-7/8	8	73	15-3/4	8	18	27-3/4	4	33
3	48	0	9	16	0	16	9	0	28	5	4
3-1/8	40	19	9-1/8	8	71	16-1/4	8	14	28-1/4	4	31
3-1/4	40	14	9-1/4	12	33	16-1/2	8	12	28-1/2	4	30
3-3/8	40	9	9-3/8	8	69	16-3/4	8	10	28-3/4	4	29
3-1/2	40	4	9-1/2	14	11	17	8	8	29	4	28
3-5/8	32	28	9-5/8	8	67	17-1/4	8	6	29-1/4	4	27
3-3/4	36	9	9-3/4	12	27	17-1/2	8	4	29-1/2	4	26
3-7/8	32	20	9-7/8	8	65	17-3/4	4	73	29-3/4	4	25
4	36	0	10	14	4	18	8	0	30	4	24
4-1/8	32	12	10-1/8	8	63	18-1/4	4	71	30-1/4	4	23
4-1/4	32	8	10-1/4	12	21	18-1/2	6	33	30-1/2	4	22
4-3/8	32	4	10-3/8	8	61	18-3/4	4	69	30-3/4	4	21
4-1/2	32	0	10-1/2	12	18	19	7	11	31	4	20
4-5/8	24	33	10-5/8	8	59	19-1/4	4	67	31-1/4	4	19
4-3/4	28	11	10-3/4	12	15	19-1/2	6	27	31-1/2	4	18
4-7/8	24	27	10-7/8	8	57	19-3/4	4	65	31-3/4	4	17
5	28	4	11	12	12	20	7	4	32	4	16
5-1/8	24	21	11-1/8	8	55	20-1/4	4	63	32-1/4	4	15
5-1/4	24	18	11-1/4	12	9	20-1/2	6	21	32-1/2	4	14
5-3/8	24	15	11-3/8	8	53	20-3/4	4	61	32-3/4	4	13
5-1/2	24	12	11-1/2	12	6	21	6	18	33	4	12
5-5/8	24	9	11-5/8	8	51	21-1/4	4	59	33-1/4	4	11
5-3/4	24	6	11-3/4	12	3	21-1/2	6	15	33-1/2	4	10
5-7/8	24	3	11-7/8	8	49	21-3/4	4	57	33-3/4	4	9
6	24	0	12	12	0	22	6	12	34	4	8
6-1/8	16	46	12-1/8	8	47	22-1/4	4	55	34-1/4	4	7
6-1/4	20	19	12-1/4	8	46	22-1/2	6	9	34-1/2	4	6
6-3/8	16	42	12-3/8	8	45	22-3/4	4	53	34-3/4	4	5
6-1/2	20	14	12-1/2	10	19	23	6	6	35	4	4
6-5/8	16	38	12-5/8	8	43	23-1/4	4	51	35-1/4	4	3
6-3/4	20	9	12-3/4	8	42	23-1/2	6	3	35-1/2	2	73
6-7/8	16	34	12-7/8	8	41	23-3/4	4	49	35-3/4	4	1
7	20	4	13	10	14	24	6	0	36	4	0

ATF STANDARD

TABLE OF POINTS AND INCHES

Points	Inch	Points	Inch	Points	Inch	Points	Inch	Points	Inch	Points	Inch
		6	.0830	12	.1660	18	.2490	24	.3320	30	.4150
1/8	.0017	1/8	.0847	1/8	.1677	1/8	.2508	1/8	.3338	1/8	.4168
1/4	.0035	1/4	.0865	1/4	.1695	1/4	.2525	1/4	.3355	1/4	.4185
3/8	.0052	3/8	.0882	3/8	.1712	3/8	.2542	3/8	.3372	3/8	.4202
1/2	.0069	1/2	.0899	1/2	.1729	1/2	.2559	1/2	.3390	1/2	.4220
5/8	.0086	5/8	.0917	5/8	.1747	5/8	.2577	5/8	.3407	5/8	.4237
3/4	.0104	3/4	.0934	3/4	.1764	3/4	.2594	3/4	.3424	3/4	.4254
7/8	.0121	7/8	.0951	7/8	.1781	7/8	.2611	7/8	.3441	7/8	.4272
1	.0138	7	.0968	13	.1799	19	.2629	25	.3459	31	.4289
1/8	.0156	1/8	.0986	1/8	.1816	1/8	.2646	1/8	.3476	1/8	.4306
1/4	.0173	1/4	.1003	1/4	.1833	1/4	.2663	1/4	.3493	1/4	.4323
3/8	.0190	3/8	.1020	3/8	.1850	3/8	.2681	3/8	.3511	3/8	.4341
1/2	.0208	1/2	.1038	1/2	.1868	1/2	.2698	1/2	.3528	1/2	.4358
5/8	.0225	5/8	.1055	5/8	.1885	5/8	.2715	5/8	.3545	5/8	.4375
3/4	.0242	3/4	.1072	3/4	.1902	3/4	.2732	3/4	.3562	3/4	.4393
7/8	.0259	7/8	.1090	7/8	.1920	7/8	.2750	7/8	.3580	7/8	.4410
2	.0277	8	.1107	14	.1937	20	.2767	26	.3597	32	.4427
1/8	.0294	1/8	.1124	1/8	.1954	1/8	.2784	1/8	.3614	1/8	.4444
1/4	.0311	1/4	.1141	1/4	.1971	1/4	.2802	1/4	.3632	1/4	.4462
3/8	.0329	3/8	.1159	3/8	.1989	3/8	.2819	3/8	.3649	3/8	.4479
1/2	.0346	1/2	.1176	1/2	.2006	1/2	.2836	1/2	.3666	1/2	.4496
5/8	.0363	5/8	.1193	5/8	.2023	5/8	.2853	5/8	.3684	5/8	.4514
3/4	.0380	3/4	.1211	3/4	.2041	3/4	.2871	3/4	.3701	3/4	.4531
7/8	.0398	7/8	.1228	7/8	.2058	7/8	.2888	7/8	.3718	7/8	.4548
3	.0415	9	.1245	15	.2075	21	.2905	27	.3735	33	.4566
1/8	.0432	1/8	.1262	1/8	.2093	1/8	.2923	1/8	.3753	1/8	.4583
1/4	.0450	1/4	.1280	1/4	.2110	1/4	.2940	1/4	.3770	1/4	.4600
3/8	.0467	3/8	.1297	3/8	.2127	3/8	.2957	3/8	.3787	3/8	.4617
1/2	.0484	1/2	.1314	1/2	.2144	1/2	.2975	1/2	.3805	1/2	.4635
5/8	.0502	5/8	.1332	5/8	.2162	5/8	.2992	5/8	.3822	5/8	.4652
3/4	.0519	3/4	.1349	3/4	.2179	3/4	.3009	3/4	.3839	3/4	.4669
7/8	.0536	7/8	.1366	7/8	.2196	7/8	.3026	7/8	.3857	7/8	.4687
4	.0553	10	.1383	16	.2214	22	.3044	28	.3874	34	.4704
1/8	.0571	1/8	.1401	1/8	.2231	1/8	.3061	1/8	.3891	1/8	.4721
1/4	.0588	1/4	.1418	1/4	.2248	1/4	.3078	1/4	.3908	1/4	.4738
3/8	.0605	3/8	.1435	3/8	.2265	3/8	.3096	3/8	.3926	3/8	.4756
1/2	.0623	1/2	.1453	1/2	.2283	1/2	.3113	1/2	.3943	1/2	.4773
5/8	.0640	5/8	.1470	5/8	.2300	5/8	.3130	5/8	.3960	5/8	.4790
3/4	.0657	3/4	.1487	3/4	.2317	3/4	.3147	3/4	.3978	3/4	.4808
7/8	.0674	7/8	.1505	7/8	.2335	7/8	.3165	7/8	.3995	7/8	.4825
5	.0692	11	.1522	17	.2352	23	.3182	29	.4012	35	.4842
1/8	.0709	1/8	.1539	1/8	.2369	1/8	.3199	1/8	.4029	1/8	.4860
1/4	.0726	1/4	.1556	1/4	.2387	1/4	.3217	1/4	.4047	1/4	.4877
3/8	.0744	3/8	.1574	3/8	.2404	3/8	.3234	3/8	.4064	3/8	.4894
1/2	.0761	1/2	.1591	1/2	.2421	1/2	.3251	1/2	.4081	1/2	.4911
5/8	.0778	5/8	.1608	5/8	.2438	5/8	.3269	5/8	.4099	5/8	.4929
3/4	.0796	3/4	.1626	3/4	.2456	3/4	.3286	3/4	.4116	3/4	.4946
7/8	.0813	7/8	.1643	7/8	.2473	7/8	.3303	7/8	.4133	7/8	.4963

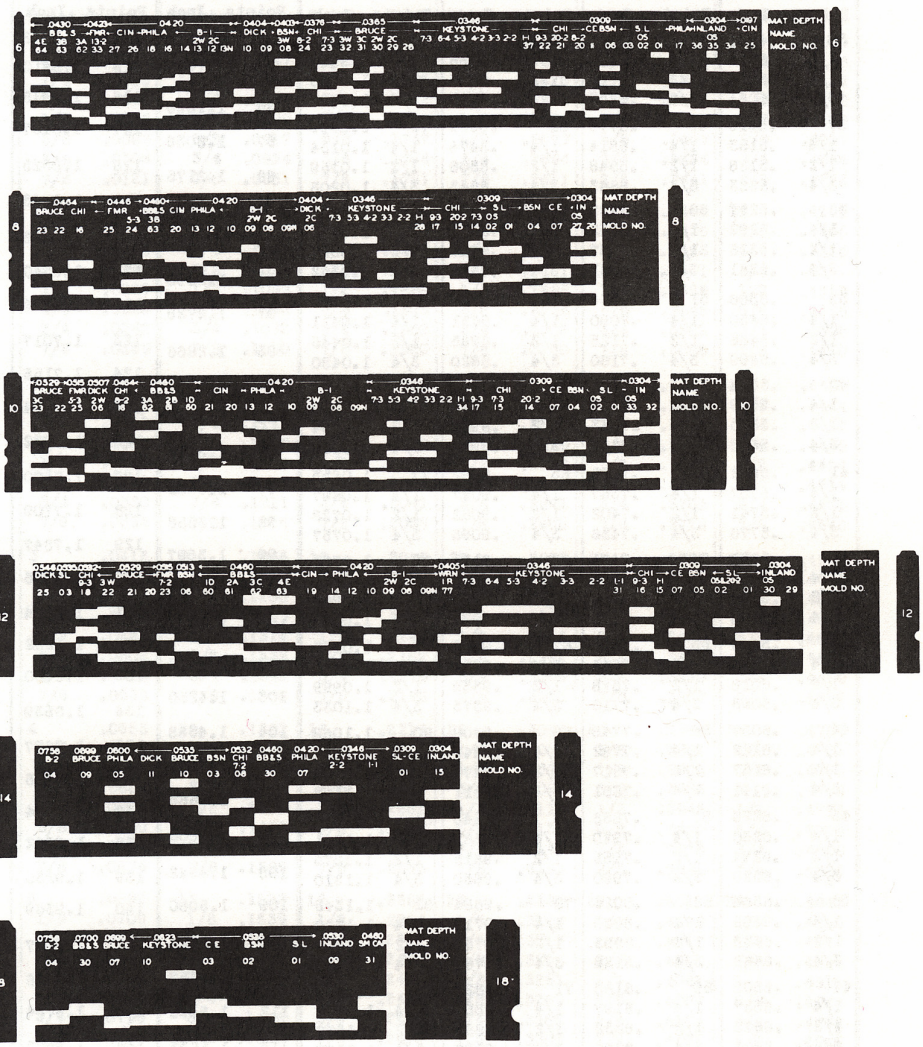
American Type Founders, Inc.
Elizabeth, N. J.

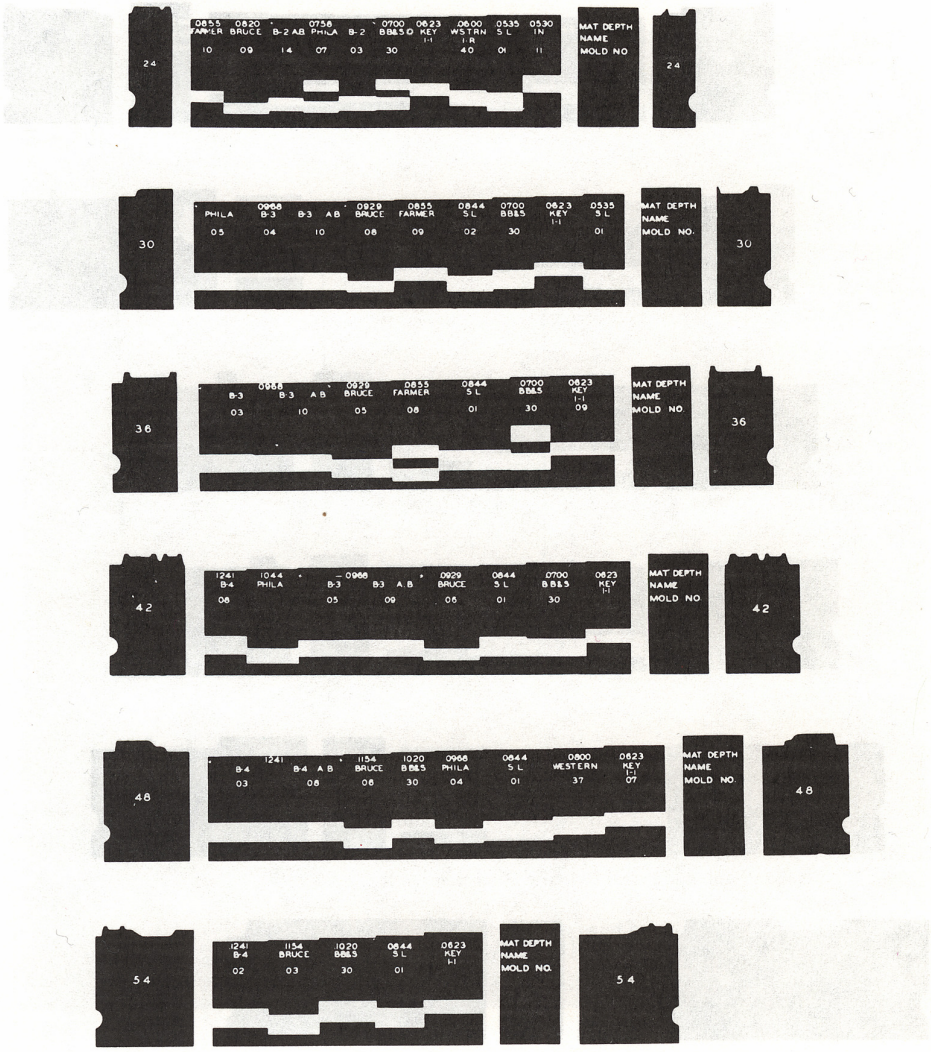
ATF STANDARD — **C - 100.4**

TABLE OF POINTS AND INCHES

Points	Inch	Points	Inch	Points	Inch	Points	Inch	Points	Inch	Points	Inch
36	.4981	48	.6641	60	.8301	72	.9961	84	1.1621	114	1.5772
1/4	.5015	1/4	.6675	1/4	.8336	1/4	.9996	85	1.1760	115	1.5910
1/2	.5050	1/2	.6710	1/2	.8370	1/2	1.0030	86	1.1898	116	1.6048
3/4	.5084	3/4	.6745	3/4	.8405	3/4	1.0065	87	1.2036	117	1.6187
37	.5119	49	.6779	61	.8439	73	1.0099	88	1.2175	118	1.6325
1/4	.5153	1/4	.6814	1/4	.8474	1/4	1.0134	89	1.2313	119	1.6463
1/2	.5188	1/2	.6848	1/2	.8508	1/2	1.0169	90	1.2451	120	1.6602
3/4	.5223	3/4	.6883	3/4	.8543	3/4	1.0203	91	1.2590	121	1.6740
38	.5257	50	.6917	62	.8578	74	1.0238	92	1.2728	122	1.6879
1/4	.5292	1/4	.6952	1/4	.8612	1/4	1.0272	93	1.2866	123	1.7017
1/2	.5326	1/2	.6987	1/2	.8647	1/2	1.0307	94	1.3005	124	1.7155
3/4	.5361	3/4	.7021	3/4	.8681	3/4	1.0342	95	1.3143	125	1.7294
39	.5396	51	.7056	63	.8716	75	1.0376	96	1.3281	126	1.7432
1/4	.5430	1/4	.7090	1/4	.8751	1/4	1.0411	97	1.3420	127	1.7570
1/2	.5465	1/2	.7125	1/2	.8785	1/2	1.0445	98	1.3558	128	1.7709
3/4	.5499	3/4	.7160	3/4	.8820	3/4	1.0480	99	1.3697	129	1.7847
40	.5534	52	.7194	64	.8854	76	1.0514	100	1.3835	130	1.7985
1/4	.5569	1/4	.7229	1/4	.8889	1/4	1.0549	101	1.3973	131	1.8124
1/2	.5603	1/2	.7263	1/2	.8923	1/2	1.0584	102	1.4112	132	1.8262
3/4	.5638	3/4	.7298	3/4	.8958	3/4	1.0618	103	1.4250	133	1.8400
41	.5672	53	.7332	65	.8993	77	1.0653	104	1.4388	134	1.8539
1/4	.5707	1/4	.7367	1/4	.9027	1/4	1.0687	105	1.4527	135	1.8677
1/2	.5741	1/2	.7402	1/2	.9062	1/2	1.0722	106	1.4665	136	1.8815
3/4	.5776	3/4	.7436	3/4	.9096	3/4	1.0757	107	1.4803	137	1.8954
42	.5811	54	.7471	66	.9131	78	1.0791	108	1.4942	138	1.9092
1/4	.5845	1/4	.7505	1/4	.9166	1/4	1.0826	109	1.5080	139	1.9230
1/2	.5880	1/2	.7540	1/2	.9200	1/2	1.0860	110	1.5218	140	1.9369
3/4	.5914	3/4	.7575	3/4	.9235	3/4	1.0895	111	1.5357	141	1.9507
43	.5949	55	.7609	67	.9269	79	1.0930	112	1.5495	142	1.9646
1/4	.5984	1/4	.7644	1/4	.9304	1/4	1.0964	113	1.5633	143	1.9784
1/2	.6018	1/2	.7678	1/2	.9339	1/2	1.0999			144	1.9922
3/4	.6053	3/4	.7713	3/4	.9373	3/4	1.1033				
44	.6087	56	.7748	68	.9408	80	1.1068				
1/4	.6122	1/4	.7782	1/4	.9442	1/4	1.1102				
1/2	.6157	1/2	.7817	1/2	.9477	1/2	1.1137				
3/4	.6191	3/4	.7851	3/4	.9511	3/4	1.1172				
45	.6226	57	.7886	69	.9546	81	1.1206				
1/4	.6260	1/4	.7920	1/4	.9581	1/4	1.1241				
1/2	.6294	1/2	.7955	1/2	.9615	1/2	1.1275				
3/4	.6329	3/4	.7990	3/4	.9650	3/4	1.1310				
46	.6364	58	.8024	70	.9684	82	1.1345				
1/4	.6399	1/4	.8059	1/4	.9719	1/4	1.1380				
1/2	.6433	1/2	.8093	1/2	.9754	1/2	1.1414				
3/4	.6468	3/4	.8128	3/4	.9788	3/4	1.1448				
47	.6502	59	.8163	71	.9823	83	1.1483				
1/4	.6537	1/4	.8197	1/4	.9857	1/4	1.1518				
1/2	.6572	1/2	.8232	1/2	.9892	1/2	1.1552				
3/4	.6606	3/4	.8266	3/4	.9927	3/4	1.1587				

Appr'vd. Stds. Comm.
Date of Approval_____


MAT DEPTH
NAME
MOLD NO.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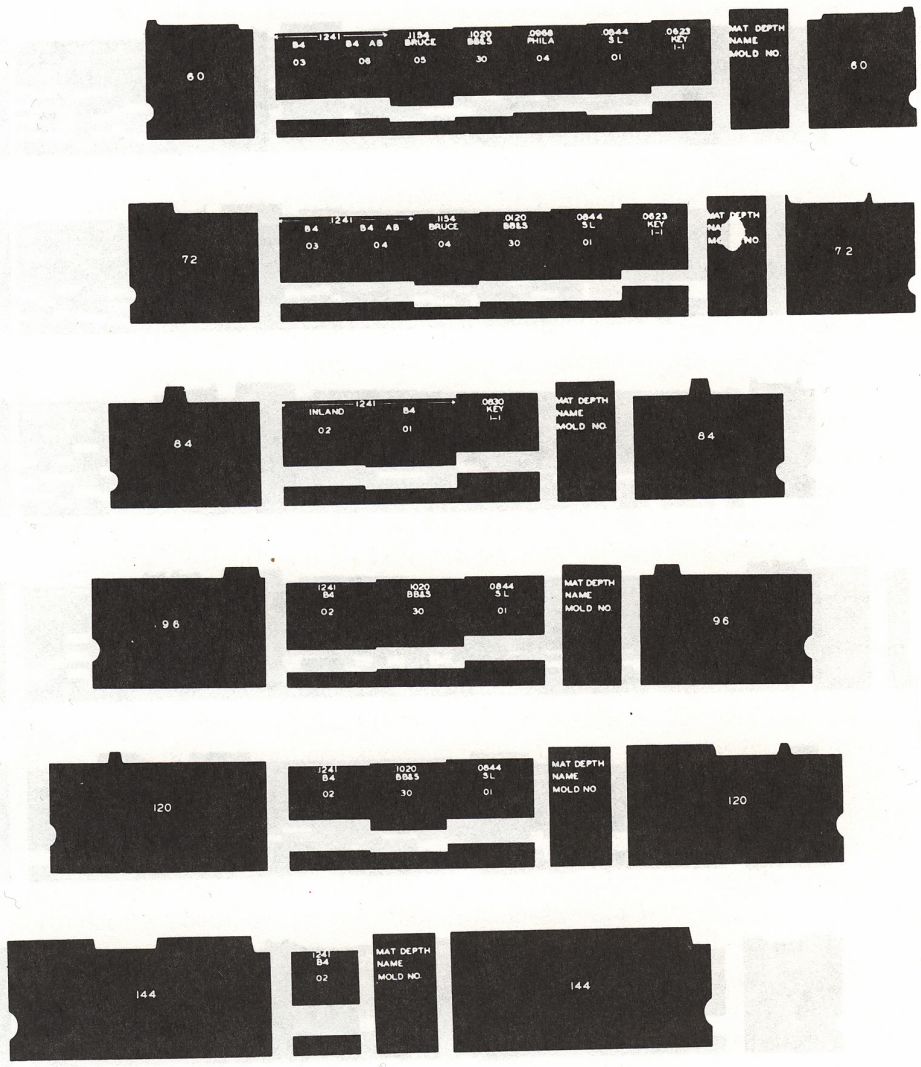
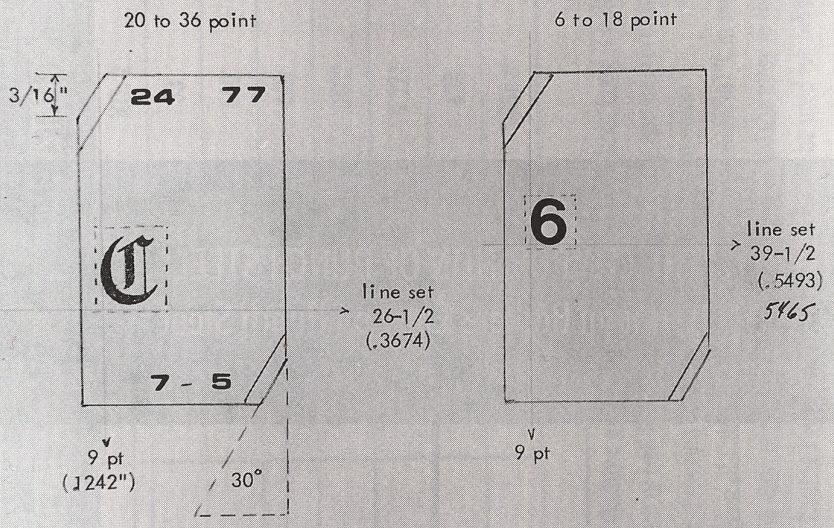
0855 FARMER 10
0820 BRUCE 09
B-2 14
AB
0758 PHILA 07
B-2 03
0700 BB&S 30
0623 KEY 1-1
0600 WSTRN I R 40
0535 S L 01
0530 IN 11
MAT DEPTH NAME MOLD NO
24
30
PHILA 05
0968 B-3 04
B-3 10
AB
0929 BRUCE 08
0855 FARMER 09
0844 S L 02
0700 BB&S 30
0623 KEY 1-1
0535 S L 01
MAT DEPTH NAME MOLD NO.
30
36
B-3 03
0968 B-3 10
AB
0929 BRUCE 05
0855 FARMER 08
0844 S L 01
0700 BB&S 30
0623 KEY 1-1 09
MAT DEPTH NAME MOLD NO.
36
42
1241 B-4 08
1044 PHILA
0968 B-3 05
B-3 09
AB
0929 BRUCE 06
0844 S L 01
0700 BB&S 30
0623 KEY 1-1
MAT DEPTH NAME MOLD NO
42
48
B-4 03
1241 B-4 08
AB
1154 BRUCE 08
1020 BB&S 30
0968 PHILA 04
0844 S L 01
0800 WESTERN 37
0623 KEY 1-1 07
MAT DEPTH NAME MOLD NO.
48
54
1241 B-4 02
1154 BRUCE 03
1020 BB&S 30
0844 S L 01
0623 KEY 1-1
MAT DEPTH NAME MOLD NO.
54


60
1241
B4 B4 AB
03 06
1134 BRUCE
05
1020 BB&S
30
0998 PHILA
04
0844 S L
01
0623 KEY
1-1
MAT DEPTH NAME MOLD NO.
60
72
1241
B4 B4 AB
03 04
1134 BRUCE
04
0120 BB&S
30
0844 S L
01
0623 KEY
1-1
MAT DEPTH NAME MOLD NO.
72
84
INLAND 1241 B4
02 01
0830 KEY
1-1
MAT DEPTH NAME MOLD NO.
84
96
1241 B4
02
1020 BB&S
30
0844 S L
01
MAT DEPTH NAME MOLD NO.
96
120
1241 B4
02
1020 BB&S
30
0844 S L
01
MAT DEPTH NAME MOLD NO.
120
144
1241 B4
02
MAT DEPTH NAME MOLD NO.
144

DISPLAY MATRIX DATA



Machining Brass (Alpha)
Blanks Finished Dimension @7 pt thick X 3/4" X1-1/8"
(Maximum thickness: 1/8")

Display flats can be grown, cut or driven (to be driven they must be fabricated from annealed copper)

Thompson-style flats need not have the beveled diagonal corners. Their lineset is somewhat higher.

Alloys and Metallurgy

"THE COMPOSITION OF PUNCH STEEL" Hermann Becker's Entry on Punch Steel					
Carbon	Manganese	Phosphorus	Sulphur	Silicon	Free Iron
.95 to 1.05	.20	.02	.027 or under	.10 to .20	Balance Hardening Steel

TYPE METAL ALLOYS PHYSICAL CONSTANTS			
PHYSICAL CONSTANT	NO. 1	NO. 2	NO. 4
Brinell Hardness	35	33	42
Melting Temperature °F	617	560	635
Freezing Temperature °F	460	460	465
Specific Heat	.0489	.0402	.0437
Specific Gravity	9.042	9.221	8.533
Casting Temperature °F	700	650	725
Casting Pressure (@)	750#	750#	750#

CONSTANTS D/F:
Brinell Hardness is measured on a Brinell Machine with a 250kg load on a 10mm ball. Load is held for 30 seconds prior to release. Hardness obtained by measurement of ball impression diameter. Accuracy non interpretive.
Melting Temperature = liquification point. Freezing Temperature = solidification point.
Specific Heat = Caloric measure. The number of Calories required to raise 1g of materia1°C in temperature, then converted to Farenheit. Specific Gravity = mass. It is the ratio of the weight of a given volume of the alloy to the weight of an equal volume of water at 4°C. Casting Temperature and Casting Pressure are mean averages to be used for reference. Variability of alloy will modify values represented. The constants given are optimum.

TYPE METAL CONSTITUENTS SPECIFICATIONS

(1) LEAD (Pb) Corroding Lead: Grade #1 ASTM - B 29 - 34 T		(2) TIN (Sn) Straits Tin: Typical Analysis		(3) ANTIMONY (Sb) R.M.M. Antimony: Typical Analysis	
Elements	% By Weight	Elements	% By Weight	Elements	% By Weight
Pb	Difference	Sn	99.844	Sb	99.858
Ag	.0015 (Max.)	Sb	.013	Fe	.022
Cu	.0015 (Max.)	As	.046	S	.065
As	.0015 (Max.)	Pb	.043	As	.031
Sb	.0095* (Max.)	Bi	.012	Pb	.020
Sn	.0095* (Max.)	Cu	.030	Cu	.004
Z	.0015 (Max.)	Fe	.007	Bi	0
Fe	.0020 (Max.)	S	.002		
Bi	.0500 (Max.)	Ni	.003*		
		Co	.003*		
TOTAL %	100	TOTAL %	100	TOTAL %	100

* Combined.

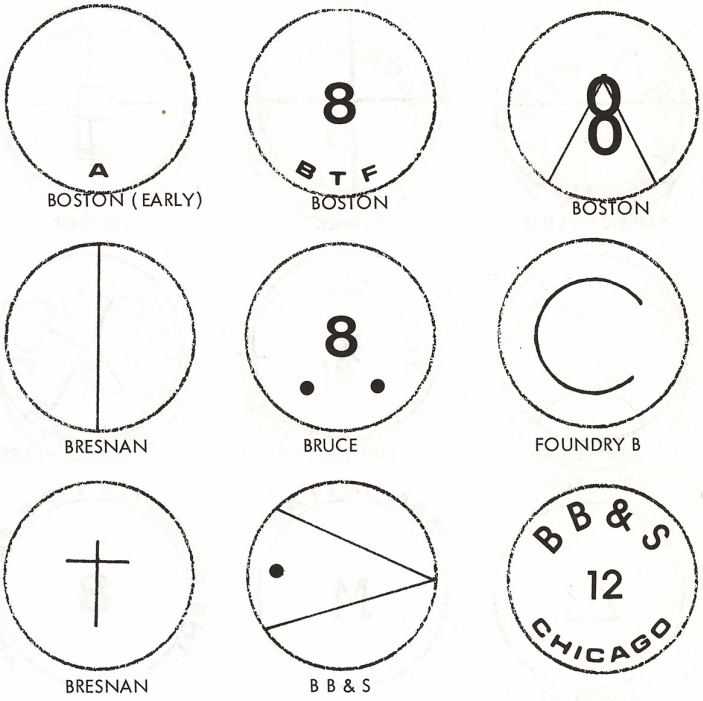
NOTE: Elements must be equivlent to the analysis shown.

NOTE: Elements must be equivlent to the analysis shown.

Appendix 3

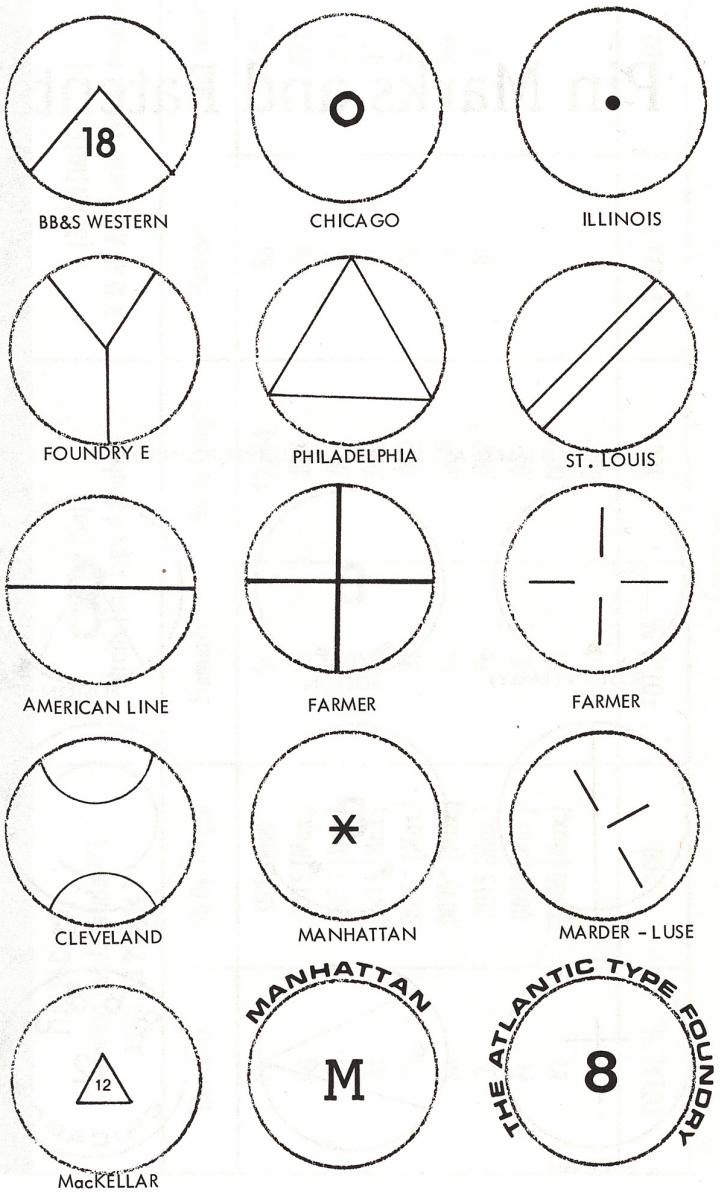
Pin Marks and Patents

PIN MARKS AS USED BY VARIOUS TYPE FOUNDRIES

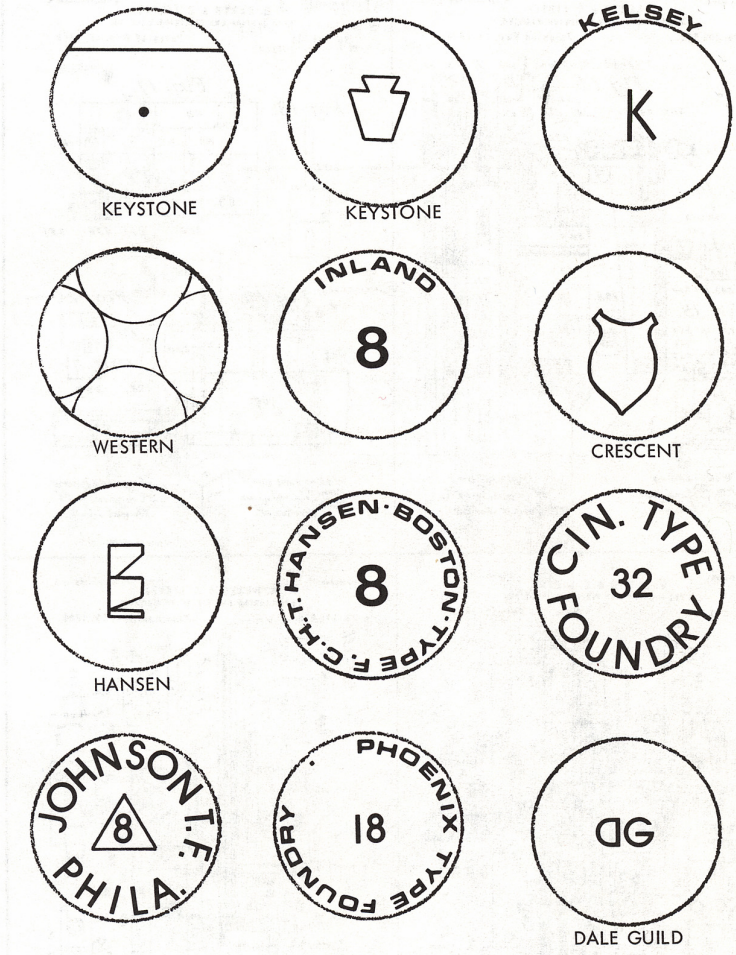


Appendix 3

PIN MARKS AS USED BY VARIOUS TYPE FOUNDRIES

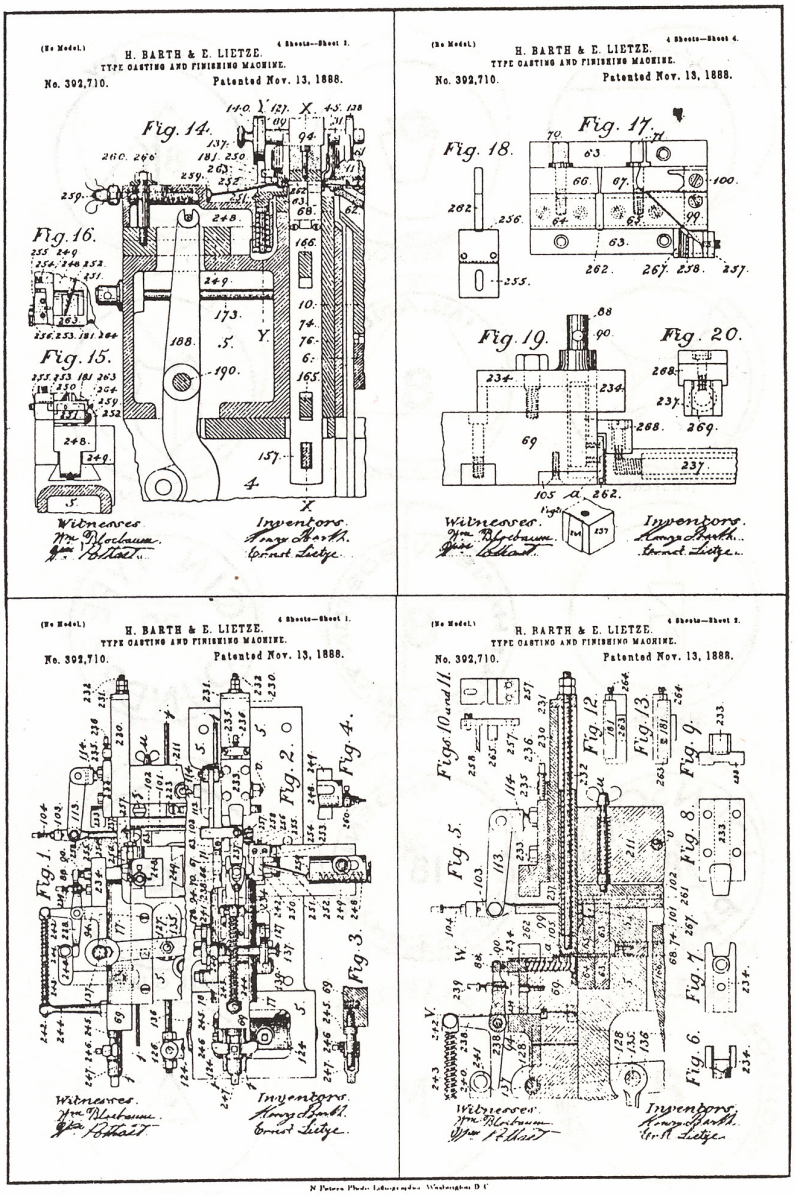


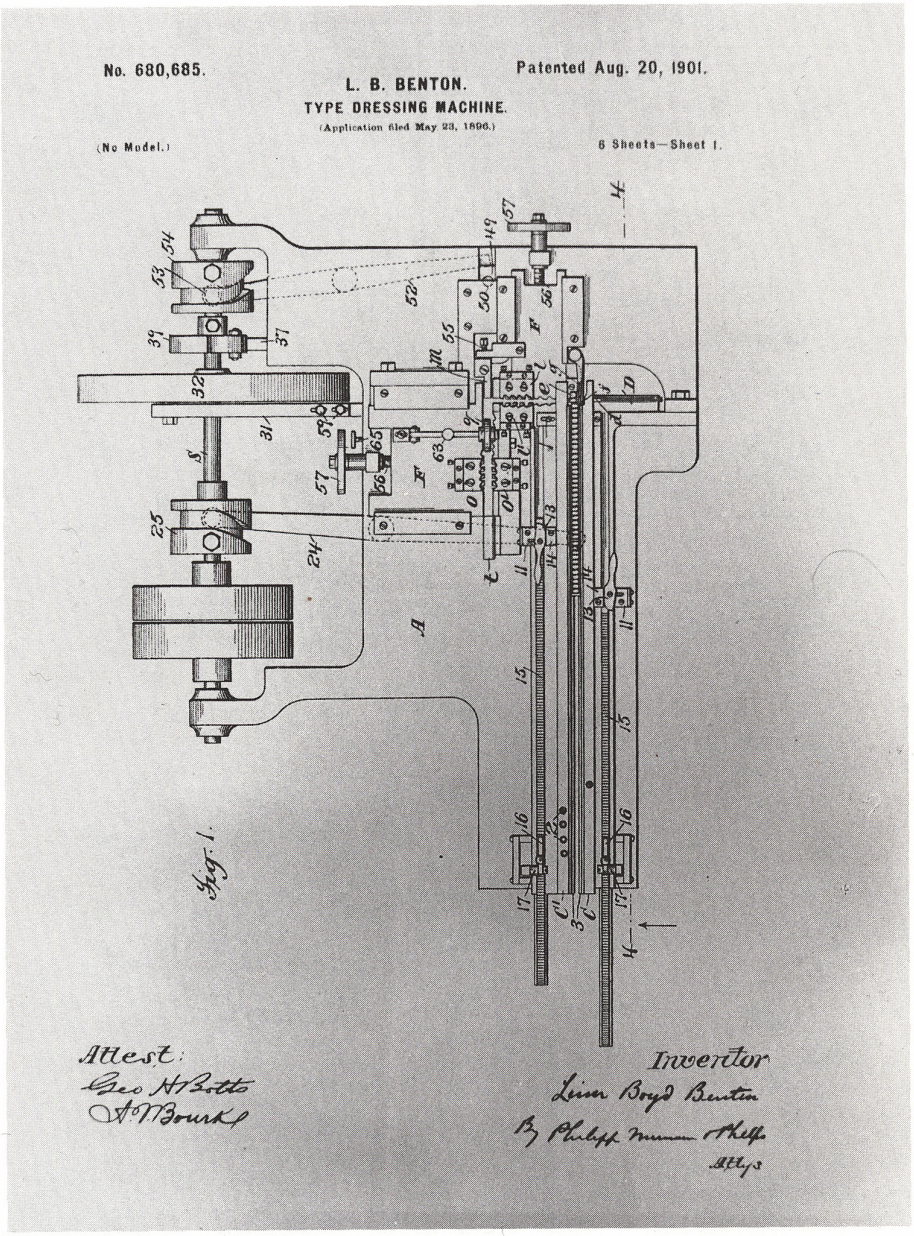
PIN MARKS AS USED BY VARIOUS TYPE FOUNDRIES



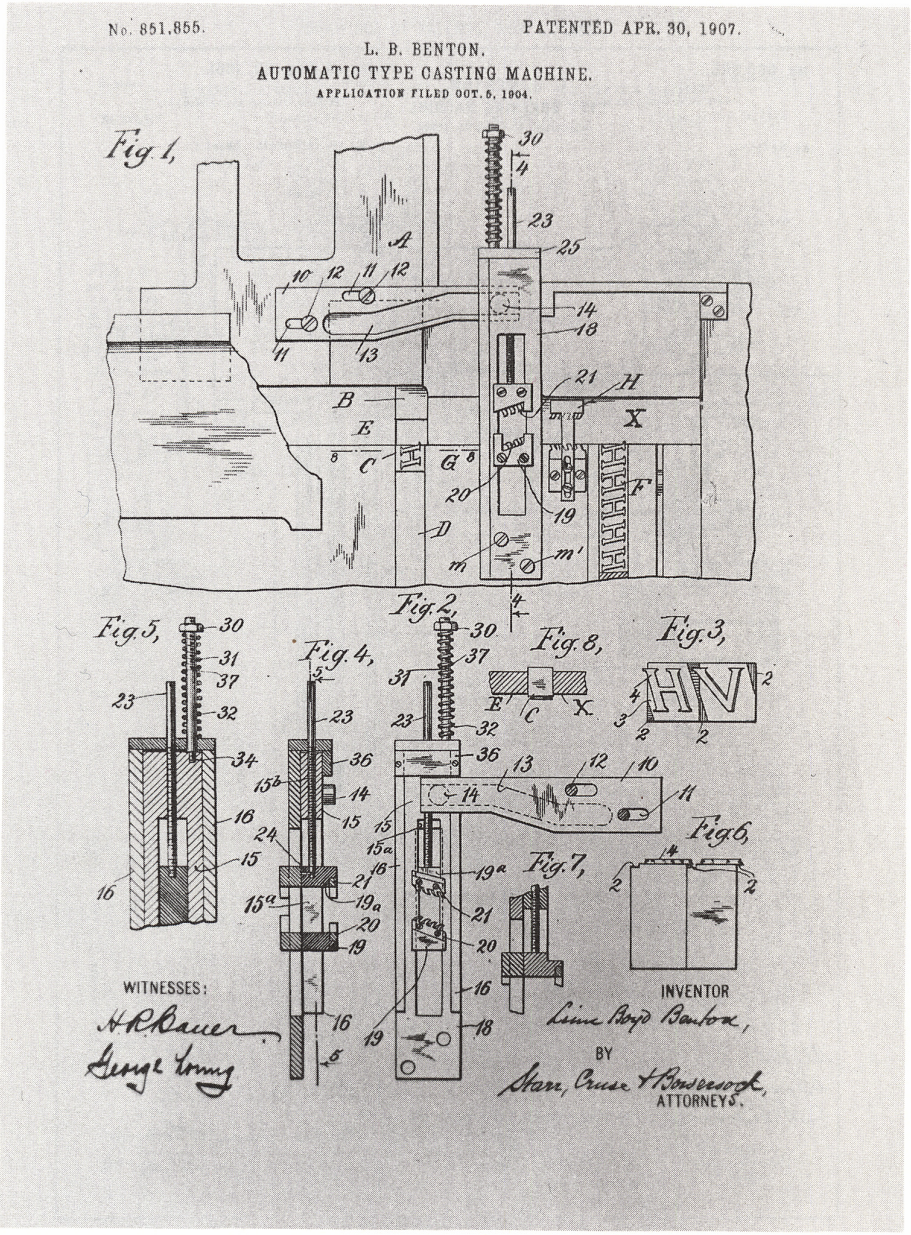
Appendix 3

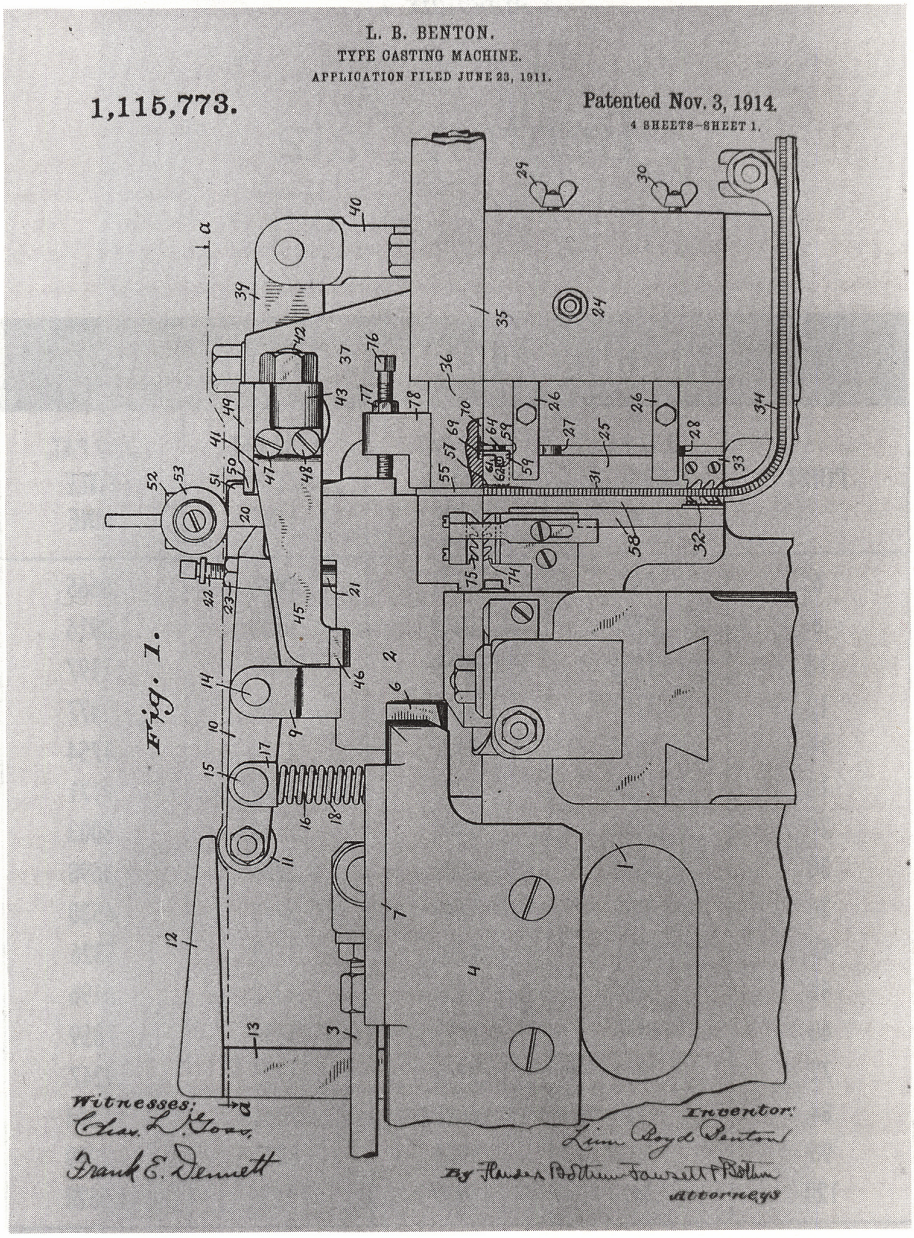
DRAWINGS OF PATENTS, NOV. 13, 1888.




No. 680,685.
Patented Aug. 20, 1901.
L. B. BENTON.
TYPE DRESSING MACHINE.
(Application filed May 23, 1896.)
(No Model.)
6 Sheets—Sheet 1.
Fig. 1.
Attest:
Geo. H. Bolte
A. M. Bourke
Inventor
Linn Boyd Benton
By Philipp Munn & Kelly
Attys

Appendix 3

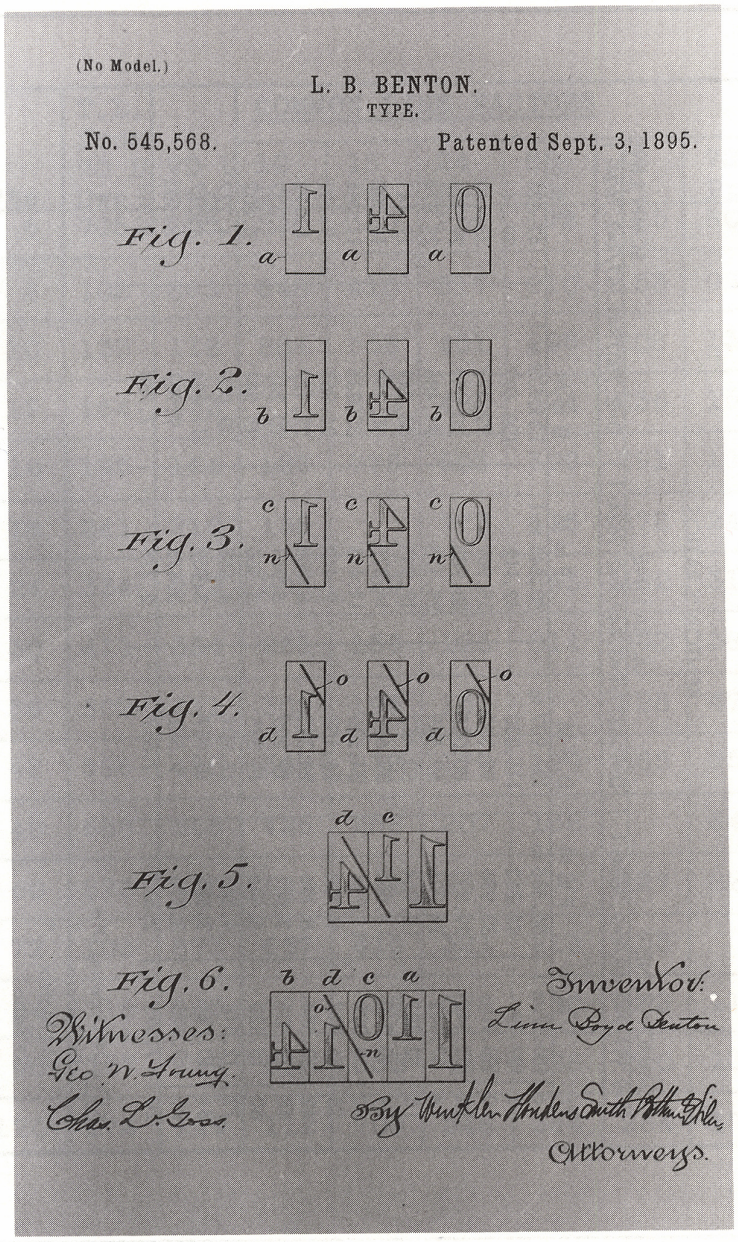

No. 851,855.
PATENTED APR. 30, 1907.
L. B. BENTON.
AUTOMATIC TYPE CASTING MACHINE.
APPLICATION FILED OCT. 5, 1904.
Fig. 1,
Fig. 2,
Fig. 3,
Fig. 4,
Fig. 5,
Fig. 6,
Fig. 7,
Fig. 8,
WITNESSES:
INVENTOR
BY
ATTORNEYS.


L. B. BENTON.
TYPE CASTING MACHINE.
APPLICATION FILED JUNE 23, 1911.
1,115,773.
Patented Nov. 3, 1914.
4 SHEETS—SHEET 1.
Fig. 1.
Witnesses:
Chas. L. Goss,
Frank E. Dennett
Inventor:
Linn Boyd Benton
By Flanders Bottum Fawsett & Bottum
Attorneys

Appendix 4

Benton Data

HEIGHT OF CHARACTER CHART				
POINT	3.59 PAT. COMMON LINE	3.45 PAT. ULTRA LINE	3.167 PAT. SCRIPT LINE	3.59 PAT. TITLE LINE
6	.0635	.0681	.0665	.0665
8	.0776	.0819	.0805	.0916
10	.1056	.0959	.0947	.1197
12	.1197	.1190	.1085	.1477
14	.1477	.1370	.1224	.1754
18	.1893	.1782	.1629	.2171
24	.2448	.2400	.2168	.3003
30	.3003	.3022	.2706	.3698
36	.3698	.3643	.3245	.4530
42	.4391	.4264	.3783	.5326
48	.5084	.4955	.4322	.6196
60	.6473	.6197	.5630	.7859
72	.7859	.7443	.6700	.9247
84	.9247	.8688	.7768	1.0634
96	1.0634	.9933	.8837	1.2299
120	1.3410	1.2427	1.1236	1.5628


(No Model.)
L. B. BENTON.
TYPE.
No. 545,568.
Patented Sept. 3, 1895.
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Witnesses:
Geo. W. Young.
Chas. L. Goss.
Inventor:
Linn Boyd Benton
By Wentler Flanders Smith Bothner & Sons
Attorneys.

BENTON'S RATIOS

	COMMON LINE D=9.917/P=3.59/R=2.7624: 1		ULTRA LINE D=9.5277/P=3.449/R=2.7624: 1		SCRIPT LINE D=8.750/P=3.167/R=2.7624: 1	
Pt	D to M	P to M	D to M	P to M	D to M	P to M
6	156.17 to 1	56.535 to 1	139.907 to 1	50.646 to 1	131.579 to 1	47.624 to 1
8	127.79	46.262	116.330	42.112	108.697	39.341
10	93.911	33.996	99.350	35.969	92.397	33.442
12	82.848	29.991	80.065	28.983	80.651	29.188
14	67.142	24.306	69.545	25.175	71.486	25.874
18	52.387	18.964	53.467	19.355	53.741	19.441
24	40.510	14.665	39.699	14.375	40.359	14.608
30	33.023	11.954	31.528	11.413	32.335	11.704
36	26.817	9.708	26.153	9.467	26.964	9.759
42	22.584	8.176	22.345	8.088	23.129	8.372
48	19.506	7.061	19.228	6.961	20.245	7.327
60	15.320	5.546	15.375	5.566	15.541	5.602
72	12.618	4.568	12.801	4.653	13.059	4.727
84	10.724	3.882	10.967	3.969	11.264	4.077
96	9.326	3.376	9.592	3.472	9.901	3.583
120	7.395	2.677	7.667	2.775	7.788	2.819

KEY: D= Drawing Dim.
P= Pattern "
M= Matrix "
R= Ratio

Pts	T.L. from 90 U Dwg	90 U Dwg	COMMON LINE FACTORS					
			12 Pt	18 Pt	24 Pt	36 Pt	48 Pt	72 Pt
6	705	705	530	335	259	172	125	809
8	102	863	648	410	317	210	153	988
10	133	118	884	558	431	296	208	134
12	164	133		632	488	324	236	152
14	195	164	123	779	603	399	291	188
18	241	210	158		773	513	372	241
24	334	272	205	129		663	482	312
30	411	334	251	159	123	814	592	382
36	502	411	309	195	151		728	471
42	596	488	367	232	179	119	865	559
48	688	565	425	268	207	138		647
60	873	720	541	342	264	175	127	825
72	103	873	657	415	321	213	155	
84	118	103	771	487	378	250	182	117
96	137	118	890	563	435	288	210	136
120	174	149	112	709	548	364	264	171

Pts	85 U Dwg	ULTRA LINE FACTORS 12 Pt	18 Pt	24 Pt	36 Pt	48 Pt	72 Pt	OLD DEPTH Brass	Scratch	Add.
6	788	552	382	276	184	137	915	1⅛"	8	245
8	948	664	459	332	221	165	110	"	"	"
10	111	778	538	388	259	194	129	"	"	"
12	143		693	500	333	249	166	"	"	"
14	159	111	770	555	370	277	184	1¼"	8½	265
18	207	145		723	482	360	240	"	"	"
24	286	200	139		665	498	332	"	"	"
30	350	245	170	123	815	610	407	"	"	"
36	429	301	208	151		748	500	2¼"	12	365
42	493	346	239	173	115	860	573	"	"	370
48	574	402	278	201	134		668	2½"	"	375
60	717	502	347	252	167	125	834	"	"	380
72	860	602	418	301	200	150		"	"	385
84	100	704	487	352	234	175	117	3 5/32	16	520
96	115	805	558	402	268	200	134	"	"	520
120	144	101	698	504	330	251	167	"	16	520

Pts	79½U Dwg	SCRIPT LINE FACTORS 12 Pt	18 Pt	24 Pt	36 Pt	48 Pt	72 Pt	NEW DEPTH Brass	Scratch	Add
6	837	613	408	306	205	154	993	1½"	8 pt	270
8	101	743	494	371	248	186	120	"	"	"
10	119	873	582	437	292	219	141	"	"	"
12	137		668	501	335	251	162	"	"	"
14	154	113	753	565	378	283	183	1¾"	8½	265
18	205	150		751	502	377	243	2	12	390
24	273	200	133		668	502	324	"	"	"
30	340	249	166	125	835	626	404	2¼	14	453
36	408	299	199	150		752	485	"	"	"
42	476	349	232	175	117	875	565	"	"	"
48	544	399	265	199	133		645	2½	16	517
60	708	519	346	260	173	130	840	"	"	"
72	843	617	411	309	206	155		"	"	"
84	977	716	477	358	239	180	116	3 5/32	"	520
96	111	813	542	407	272	204	132	"	"	"
120	142	104	691	518	347	260	168	"	"	"

A PROPORTIONAL SIMULATION OF EXPANSION AND CONDENSATION

This illustration shows proportional difference when cutting a character in three different point sizes from the same pattern. (Characters have been brought to the same height for ease of comparisn.) The 6-point character is expanded, the 36-point character is 'normal' and the 72-point character is condensed.

Matrix Machine Setting Record

Matrix Machine Setting Record

Name of Face..... Body 36 Points

Leverage Gauge 3.7155 inches Adjustable Gimbal Bearing at NORMAL 40 Points

Vertical outside dimension in Matrix .4643" from ± Pattern Depth of Cut .0725"

Head Bearing .350" Side Bearing 12 Points

Size of No. 1 Roughing Tool.....:.030".....Follower for same .280.. inches diameter

Size of No. 2 Rough-Facing Tool..:.010"....Follower for same .099.. inches diameter

Size of No. 3 Facing Tool .....:.010".....Follower for same ..099 inches diameter

Size of No. 4 Rough-Finishing Tool..003"..Follower for same .0259 inches diameter

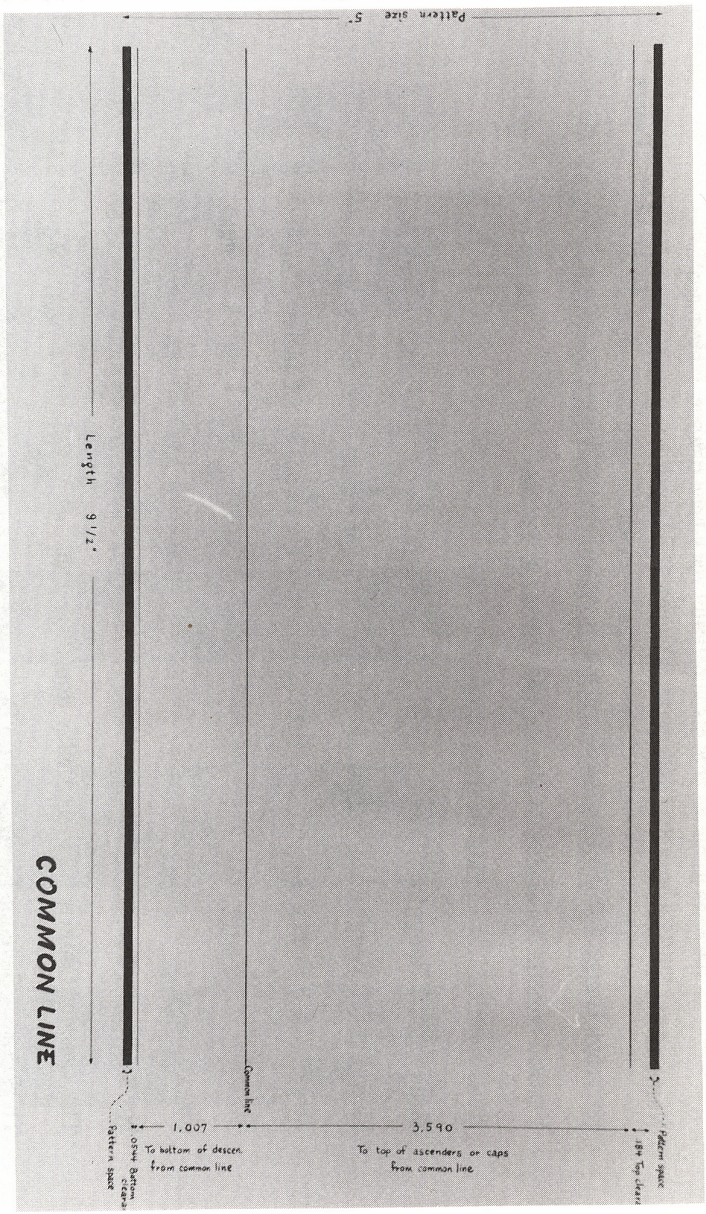
Size of No. 5 Finishing Tool.....:.003"....Follower for same .0259 inches diameter

No. 6 Beveling Tool (use Tool Stop.003".....) Follower for same .0259 inches diameter

Thickness of Counter Stop used with Roughing Tool ..3..... Points for cutting Counters

Thickness of Beveling Stop used with Beveling Tool....1....Points for beveling edge of Counters

Tracing from + Parallel Pattern, outside measurement .4645"


Pattern size 5"
Length 9 1/2"
COMMON LINE
Pattern space
.054 Bottom clearance
Common line
1.007
To bottom of descen from common line
3.590
To top of ascenders or caps from common line
.184 Top clearance
Pattern space

Glossary

Alignment. Invisible point of reference (line) to which all the characters of a particular font are cast for level uniformity.

Anode. The negative charged source of metal for deposition. The current and metal molecules flow from the negative anode to the positive cathode (which holds the "work" to be electro deposited upon).

Beard. That portion of a newly cast piece of type, usually from an engraved matrix, that projects beyond the body of the type. It occurs where the mold wall meets the surface area of the eye of the matrix. A beard should be rubbed or machine dressed completely and cleanly off (as opposed to a kern, which must be dressed by undercutting).

Body. Vertical height size standard of type.

Book font. Substantial amount of type scheme in proportion of usage in ranging weights for hand-setting a book's standing formes.

Botching. Spurious technique used by mediocre fitters to correct mistakes such as removal of too much material from matrix machining protocol, etc.

Capping. A condition caused by worn matrix/mold meeting surfaces, or overheated metal, or improperly adjusted delivery of matrix to the mold aperture, or a combination of all; cast appears with flashing of metal around and past beard; occurs only at beard, above the mold wall. If not resolved, a splash is likely to occur.

Caster. Machine or device which casts type.

Castor. Operator who casts type.

Catching type. Term used for the protective manipulation of new casts as ejected from a pivotal mold (with gloved hand).

Cathode. The positive-charged work being electro-deposited upon. The completed circuit causes metal molecules to flow to the work hung on the cathode bar from the *anode.*

Close mat. Matrix used by fitter as a guide to locating the correct justifying character in a suite of matrices to the dimensional requirements of the mold they are to be cast in.

Condensation. In type design dynamics, the amount of decrease in the weight of a design in proportion to its size so as to be comfortably "read" by the human eye (above 40 points in size).

Cross kerning. In special instances, drop-out characters such as a lowercase *f* with an extreme overhang requiring a high degree finishing knife and a prominent cross-bar extending out as a secondary beard; a separate machine cut or hand-filed operation is required in order to allow certain lowercase characters to fit up tightly in composition. Most cross kerning was accomplished on a special kerning machine that held the cast on a diagonal plane; however, a simple fine-cut flat file will work as well, being run up the side of the cast to just within the main kern of the character.

Drive. The depth of the character within the matrix; measured from the bearing surface of the matrix to the casting surface of the character it contains.

Dresser. The person who finishes type with vertical kerns.

Drop-outs. Type discharged from an automatic casting machine without having been passed through the finishing operations because of some structural constraint, such as kerning. The finishing of these casts is done by hand, as with pivotal casts.

Dwell. The rate at which the nipple lingers in contact with the mold aperture and the molten metal solidifies in the mold.

Edging. A condition caused by improper adjustment of ejecting functions of a caster; one or more body edges of a new cast which shows a chopped or rounded edge.

Electro (matrix). A matrix made by electro deposition of copper and/or nickel by electrolytic bath.

Electrolyte. A solution of specially prepared chemicals and water used as a "bath" in electro deposition of metals.

Eutectic. The specific melting temperature peculiar to an alloy and not necessarily the melting temperature of any of its individual components.

Expansion. In type design dynamics, the amount of increase in the weight of a design in proportion to its size so as to be comfortably "read" by the human eye (below 40 points in size).

Eye. The aperture of the character in the matrix.

Faced up. Well-cast type with crisp character and no blemish.

Fitting. The protocols involved in justifying a matrix for position and depth.

Grade. Particular lining characters, singled out to establish fitting and casting of intended justification of a given design. Grade characters are usually H, m, O and o.

Grooving. The cutting away of the rough area (where the jet was attached) on the bottom of a newly cast piece of type. On pivotal cast type the groove is cut with an "iron" held in a hand plow, and a finished piece of type sits squarely on the two "feet" thus created (on either side of the groove).

Head-bearing. A predetermined, fixed dimension of the character's location in a matrix; measured (usually) from the alignment line to the top bearing surface of the matrix.

Heel stops. See *Pawls.*

Height to paper. The standard height of a piece of type from the foot to the printing surface (in Anglo-American usage it is .918″).

Jet. The sprue (waste) of the casting void that is separated from the type body ("jet-breaking").

Justification. Precise machining of character in matrix to cast uniformly with regard to alignment, grade and letter-spacing.

Job font. Standard commercial working font, primarily for proofing and sundry projects.

Kern. A projection of the character past the edge of the type body (either horizontal or, more rarely, vertical).

Kerning. The act of finishing a piece of type that has kern(s) by the removal of most of the lower portions of the beard up to, but not including the printing surface of the character. Good kerning removes enough beard for clearance (when set with other characters) but leaves enough metal to act as a web and foundation to leave the kerned projection strong and resistant to fracturing.

Liner. A person who is responsible for maintaining the continuity and integrity of the alignment of type designs cast in the foundry.

Lining font. A small font of type of a specific size and design to be used as a reference by the liner in setting a caster for correct casting.

Matrix. "Mother" of the type. A finely machined metal object containing an engraving or electro that carries a specific character or design (right-reading).

Model. The engraved or cast document (usually type metal) used as an electro deposition form in the production of matrices.

Mold. The working part of the casting machine containing the void into which the hot metal alloy is injected.

Mold height. The dimension of the walls of a mold from the foot of the type-body casting void to the matrix- bearing surface (or "top" of the mold). This dimension and the drive of the matrix determine the height of the cast type.

Nick. A groove cast or cut into the body of a type for purposes of identification. Also the means by which the cast type is keyed into the nick-plate of an automatic casting machine, thereby allowing it to be held accurately during finishing operations.

Patrix. "Father" of the type. A punch (or more loosely, a piece of type) that carries a specific character or design (wrong-reading).

Pawls. Adjustable bearing plates at the bottom of the pivotal mold.

Pin mark. Mold-cast depression in side of type body (usually denotes pivotal-cast, but some automatic foundry machine molds have them also); used to provenance a particular foundry.

Pontil. An extension applied to the bottom of a matrix to increase its length.

Pony font. Small font used for limited proofing or a collector's sample.

Quill. A Benton Engraving Machine cutting tool assembly.

Rubbing. The smoothing and removal of beards on a piece of type, usually on a stone or special dressing file.

Set-width. The correct dimension required to carry a specific character on its body.

Shoe. The part of the matrix carrier to which the matrix is fixed or attached.

Side-bearing. A predetermined, fixed dimension of the character's location in a matrix; the total area of matrix surface directly alongside the character in the matrix. It determines letter spacing and is keyed (as is the head-bearing) to the particular mold being used to cast the matrix.

Slipper. A right-angled piece of hardened steel used to adjust the particular head-bearing being used with the mold/matrix interface.

Slope. Specific degree of angle of italics and scripts (variable).

Turning gauge. Instruments used to prove out dimensions in an object (before the advent of the micrometer). The object to be measured was pushed into its tapered jaws, the jaws of the device first having been set by a standard of the desired dimension. Turning gauges are still used by the fitter to prove square and width dimensions of matrices being fitted.

Winging. A condition caused by worn-out mold meeting surfaces, or overheated metal, or too much pump pressure, or a combination of all three. The cast appears with flashing of metal around and past surface meets of the body and/or jet. This occurs below the matrix/mold interface and, if not resolved, a splash is likely to occur.

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